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RECOMMENDATIONS FOR THE IMPLEMENTATION OF FOUR PROJECTS

COMMUNICATION

FROM

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

TRANSMITTING

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

VOLUME IV OF VI



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LOUISIANA COASTAL AREA (LCA) ECOSYSTEM RESTORATION STUDY

Volume IV of VI

Final Integrated Feasibility Study and Supplemental Environmental Impact Statement

for the

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



October 2010

U.S Army Corps of Engineers
New Orleans District

Coastal Protection and Restoration Authority

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LOUISIANA COASTAL AREA (LCA) ECOSYSTEM RESTORATION STUDY

Volume IV of VI

Final Integrated Feasibility Study and Supplemental Environmental Impact Statement

for the

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

The responsible lead Federal agency for this study is the U. S. Army Corps of Engineers- Mississippi Valley, New Orleans District (CEMVN). The non-Federal sponsor for the study is Coastal Protection and Restoration Authority (CPRA). This report is a combined feasibility report and environmental impact statement complying with requirements of the U.S. Army Corps of Engineers (USACE) and the Council of Environmental Quality (CEQ), and is intended to reduce duplication and paperwork. An asterisk (*) in the table of contents notes paragraphs that are required for National Environmental Policy Act (NEPA) compliance.

October 2010

U.S Army Corps of Engineers
New Orleans District

Coastal Protection and
Restoration Authority

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This report contains six volumes.

You are at **Volume IV** which is the element-specific analysis for the **The Louisiana Coastal Area-Small Diversion at Convent/Blind RiverElement**.

Volume I:	Summary
Volume II:	Amite River Diversion Canal Modification
Volume III:	Atchafalaya Conveyance to N. Terrebonne Marshes
Volume IV:	**Small Diversion at Convent/Blind River Diversion**
Volume V:	Terrebonne Basin Barrier Shoreline Restoration
Volume VI:	White Ditch Diversion

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

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

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Final Integrated Feasibility Study and Supplemental Environmental Impact Statement
for the
LCA Small Diversion at Convent/Blind River

LEAD AGENCY: U.S. Army Corps of Engineers (USACE)– Mississippi Valley Division, New Orleans.

ABSTRACT: The USACE proposes to construct a freshwater diversion project from the Mississippi River in the vicinity of Romeville, Louisiana to provide freshwater, nutrients, and sediments to the southeast portion of the Maurepas Swamp to reverse the trend of deterioration in the swamp. The Mississippi River levee system has cut off the Maurepas Swamp (and Blind River) from the natural periodic, flooding by the Mississippi River and past construction of logging trails, drainage channels, pipelines and roads through the swamp has disrupted the natural flow and drainage patterns, and impacted the biological productivity of the swamp.

Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 21,369 acres (8,647 ha) of baldcypress-tupelo swamp projected to become marsh or open water over the 50-year period of analysis. Recent studies generally show that protecting wetlands has a net effect of lowering storm surge and wave heights compared to a future condition with extensive wetland loss. In addition to no action, twelve preliminary alternative plans to address the problems of swamp deterioration were developed and evaluated. After an iterative screening process, alternative plans were eliminated from further consideration because they did not adequately address the problems, planning goals or objectives. In addition to No Action, four alternatives were examined in detail as the final array. These four alternatives provide significant fish and wildlife habitat values and when compared to no action, contain elements that would work together to produce a greater overall benefit to restoring the swamp with limited detrimental environmental impacts to the study area.

Alternative 2, a 3,000 cfs diversion near Romeville is the Recommended Plan. It would improve and protect 21,369 acres (8,647 ha) of baldcypress-tupelo swamp, negatively impact 53 acres (21 ha) of forested wetland, and have a net value of 6,421 Average Annual Habitat Units (AAHUs) over the 50-year period of analysis. The Recommended Plan has a total estimated fully funded cost of $123,140,000. The Recommended Plan best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Environmental Operating Principles; and would best satisfy the Congressional mandate provided in Public Law 110-114 to reverse the trend of deterioration in the southeast part of the Maurepas Swamp.

COMMENTS: Please send comments or questions on this SEIS to the U.S. Army Corps of Engineers, New Orleans District, Attention: William P. Klein, Jr., P.O. Box 60267, New Orleans, Louisiana 70160-0267. Telephone: (504) 862-2540; FAX: (504) 862-2088. The official closing date for receipt of comments will be 30 days from the date on which the Notice of Availability of the SEIS appeared in the Federal Register.

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TABLE OF CONTENTS

Volume IV of VI – LCA Small Diversion at Convent/Blind River Integrated Feasibility and Environmental Analysis

Abstract A-1

EXECUTIVE SUMMARY E-1

TABLE OF CONTENTS ii
FIGURES xiii
TABLES xvi
APPENDICES xx

1.0 STUDY INFORMATION 1-1

1.1 Study Authority 1-1

1.2 Purpose and Scope* 1-3

1.3 Study Area* 1-3

1.4 History of Investigation 1-8

1.5 Prior Reports and Existing Projects 1-8

1.5.1 Comprehensive Planning Studies 1-8

1.5.2 Related Laws and Programs 1-12

1.5.2.1 Federal 1-12
1.5.2.2 State Laws 1-13
1.5.2.3 Local 1-13
1.5.3 Existing Water Projects 1-14

1.5.3.1 Navigation Projects 1-14
1.5.3.2 River Flood Control Projects 1-14
1.5.3.3 Coastal Restoration Projects 1-14
1.5.4 Planned Projects 1-15

1.6 Planning Process and Report Organization 1-16

1.7 USACE Campaign Plan 1-18

2.0 NEED FOR, AND OBJECTIVES OF ACTION 2-1

2.1 National Objectives 2-1

2.2 Public Concerns 2-1

2.3 Problems, Needs, and Opportunities* 2-2

2.3.1 Study Area Problems and Needs 2-2

2.3.2 Study Area Opportunities 2-3

2.4 Planning Objectives 2-4

2.5 Planning Constraints 2-5

2.6 Existing and Future Without Project Conditions 2-6

3.0 ALTERNATIVES* 3-1

3.1 Plan Formulation Rationale 3-1

3.1.1 Plan Formulation Rationale 3-1

3.1.2 Plan Formulation Criteria 3-1

3.1.2.1 Completeness 3-1

3.1.2.2 Effectiveness 3-2

3.1.2.3 Efficiency 3-2

3.1.2.4 Acceptability 3-2

3.1.3 Environmental Operating Principles 3-2

3.2 Management Measures 3-3

3.2.1 Development of Management Measures 3-3

3.2.2 Description of Management Measures 3-4

3.2.2.1 Structural Management Measures (Features) 3-4

3.2.2.2 Non-Structural Management Measures (Activities) 3-9

3.2.3 Screening/Evaluation of Management Measures 3-11

3.2.3.1 No Action 3-12
3.2.3.2 Structural Measures (Features) 3-12
3.2.3.3 Non-Structural Management Measures (Activities) 3-24
3.2.4 Management Measures not Carried for Further Analysis 3-25

3.3 Preliminary Alternative Plans 3-26

3.3.1 Development of Preliminary Alternative Plans 3-26

3.3.2 Description of Preliminary Alternative Plans 3-29

3.3.3 Screening/Evaluation of Preliminary Alternative Plans 3-32

3.3.4 Intermediate Alternative Plans 3-41

3.4 Final Array of Alternatives (Alternative Studied in Detail) 3-43

3.5 Comparison of Alternative Plans 3-44

3.5.1 Alternatives Hydraulic and Water Quality Modeling 3-68

3.5.2 Wetland Value Assessment 3-68

3.5.3 Cost Effective/Incremental Cost Analysis 3-74

3.6 The National Ecosystem Restoration (NER) Plan 3-78

3.7 Plan Selection – Tentatively Selected Plan/Recommeded Plan* 3-79

3.7.1 Significance of Outputs 3-80

3.7.2 Sustainability of Significant Resources 3-88

3.7.3 Components 3-90

3.7.4 Design, Environmental, and Construction Considerations 3-95

3.7.5 Real Estate Requirements 3-96

3.7.6 Operations and Maintenance Considerations 3-96

3.7.7 Monitoring Plan and Adaptive Management 3-99

3.7.8 Effectiveness of Recommended Plan in Meeting Goals and Objectives 3-103

3.7.9 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles 3-104

3.7.10 Compensatory Mitigation Measures 3-104

3.8 Risk and Uncertainty 3-104

3.8.1 Hydrologic Uncertainties 3-105

3.8.2 Environmental Uncertainties 3-111

3.8.2.1 WVA Results for Sea Level Rise 3-111

3.8.3 Construction and Economic Uncertainties 3-112

3.8.4 Real Estate Uncertainties 3-113

3.9 Implementation Requirements 3-114

3.9.1 Schedule 3-114

3.9.2 Implementation Responsibilities 3-115

3.9.3 Cost Sharing 3-118

3.9.4 Environmental Commitments 3-121

3.9.5 Financial Requirements 3-124

3.9.6 Views of Non-Federal Sponsor 3-124

4.0 AFFECTED ENVIRONMENT* 4-1

4.1 Environmental Setting of Study Area 4-1

4.1.1 Location 4-1

4.1.2 Climate 4-2

4.1.3 Geomorphic and Physiographic Setting 4-2

4.1.3.1 Coastal and Riverine Processes 4-4

4.2 Significant Resources 4-10

4.2.1 Soils and Waterbottoms 4-10

4.2.1.1 Soils 4-10
4.2.1.2 Water Bottoms 4-14
4.2.2 Hydrology 4-15

4.2.2.1 Flow and Water Levels 4-16
4.2.2.2 Sedimentation and Erosion 4-29
4.2.2.3 Groundwater 4-30
4.2.3 Water Quality and Salinity 4-32

4.2.3.1 Lower Mississippi River 4-32
4.2.3.2 Blind River and Maurepas Swamp 4-35
4.2.3.3 Salinity 4-38
4.2.4 Air Quality 4-42

4.2.5 Noise 4-43

4.2.6 Vegetation Resources 4-44

4.2.6.1 Wetland Vegetation 4-44
4.2.6.2 Upland Vegetation 4-56
4.2.6.3 Invasive Species - Vegetation 4-58
4.2.6.4 Rare, Unique, and Imperiled Vegetation 4-59
4.2.7 Wildlife and Habitat 4-60

4.2.7.1 Birds 4-61
4.2.7.2 Mammals 4-66
4.2.7.3 Reptiles 4-68
4.2.7.4 Invasive Wildlife Species 4-69
4.2.8 Aquatic Resources 4-70

4.2.8.1 Plankton 4-70
4.2.8.2 Benthic Resources 4-72
4.2.9 Fisheries 4-76

4.2.9.1 Lower Mississippi River 4-77
4.2.9.2 Blind River, Maurepas Swamp, and Lake Maurepas 4-78
4.2.10 Essential Fish Habitat (EFH) 4-80

4.2.11 Threatened and Endangered Species 4-81

4.2.12 Cultural and Historic Resources 4-87

4.2.12.1 Previous Investigations 4-90
4.2.12.2 Previously Conducted Cultural Resources Surveys 4-90
4.2.13 Aesthetics 4-91
4.2.13.1 Scenic Rivers and Streams 4-92

4.2.14 Recreation 4-92

4.2.15 Socioeconomics and Human Resources 4-94

4.2.15.1 Displacement of Population and Housing 4-96
4.2.15.2 Employment, Business, and Industrial Activity 4-98
4.2.15.3 Availability of Public Facilities and Services 4-107
4.2.15.4 Transportation 4-108
4.2.15.5 Disruption of Desirable Community and Regional Growth (including Community Cohesion) 4-109
4.2.15.6 Tax Revenues and Property Values 4-109
4.2.15.7 Infrastructure 4-110
4.2.15.8 Environmental Justices 4-111
4.2.15.9 Water Use and Supply 4-116
4.2.15.10 Navigation 4-119
4.2.15.11 Land Use Socioeconomics 4-119
4.2.15.12 Man-Made Resources 4-123
4.2.15.13 Natural Resources 4-131
4.2.16 Hazardous, Toxic, and Radioactive Wastes 4-133

5.0 ENVIRONMENTAL CONSEQUENCES* 5-1

5.1 Soils and Water Bottoms 5-35

5.1.1 No Action Alternative (Future without Project Conditions) 5-35
5.1.2 Alternative 2 5-36
5.1.3 Alternative 4 5-36
5.1.4 Alternative 6 5-37
5.1.5 Alternative 4B 5-37

5.2 Hydrology 5-39

5.2.1 Flow and Water Levels 5-39

5.2.1.1 Lower Mississippi River 5-39

5.2.1.2 Blind River and Maurepas Swamp 5-40
5.2.1.3 Lake Maurepas 5-46
5.2.2 Sedimentation and Erosion 5-48

5.2.2.1 Lower Mississippi River 5-48
5.2.2.2 Blind River and Maurepas Swamp 5-50
5.2.2.3 Lake Maurepas 5-52
5.2.3 Groundwater 5-54

5.3 Water Quality and Salinity 5-56

5.3.1 Lower Mississippi River 5-56

5.3.2 Blind River and Maurepas Swamp 5-58

5.3.3 Lake Maurepas 5-65

5.3.4 Salinity 5-67

5.3.4.1 Lower Mississippi River 5-67
5.3.4.2 Blind River and Maurepas Swamp 5-69
5.3.4.3 Lake Maurepas 5-71
5.4 Air Quality 5-73

5.5 Noise 5-75

5.6 Vegetative Resources 5-77

5.6.1 Upland Vegetation Resources 5-83

5.6.2 Invasive Species - Vegetation 5-84

5.7 Wildlife and Habitat 5-86

5.7.1 Birds 5-86

5.7.2 Mammals 5-89

5.7.3 Reptiles 5-92

5.7.4 Amphibians 5-94

5.7.5 Invasive Wildlife Species 5-96

5.8 Fisheries 5-989

5.8.1 Lower Mississippi River 5-98

5.8.2 Blind River and Maurepas Swamp 5-101

5.8.3 Lake Maurepas 5-104

5.9 Aquatic Resources 5-105

5.9.1 Plankton 5-105

5.9.2 Benthic Resources 5-107

5.10 Essential Fish Habitat (EFH) 5-109

5.11 Threatened and Endangered Species 5-112

5.12 Cultural and Historic Resources 5-114

5.13 Aesthetics 5-116

5.14 Recreation 5-118

5.15 Socioeconomics and Human Resources 5-127

5.15.1 Displacement of Population and Housing 5-127

5.15.2 Employment, Business, and Industrial Activity 5-129

5.15.3 Availability of Public Facilities and Services 5-132

5.15.4 Transportation 5-134

5.15.5 Disruption of Desirable Community and Regional Growth (including Community Cohesion) 5-136

5.15.6 Tax Revenues and Property Values 5-138

5.15.7 Infrastructure 5-140

5.15.8 Environmental Justice 5-143

5.15.9 Navigation 5-145

5.15.10 Land Use Socioeconomics 5-147
5.15.9.2 Agriculture 5-147
5.15.9.3 Forestry 5-149
5.15.9.4 Public Lands 5-151

5.15.10 Water Use and Supply 5-153

5.15.11 Man-Made Resources 5-155

5.15.11.1 Oil, Gas, Utilities 5-155

5.16 Flood Control and Hurricane Protection 5-158

5.17 Natural Resources 5-160
5.17.1 Commercial Fisheries 5-160

5.17.2 Oyster Leases 5-162

5.18 Hazardous, Toxic, and Radioactive Wastes 5-163

5.19 Unavoidable Adverse Effects 5-165

5.20 Relationship of Short-Term Uses and Long-Term Productivity 5-166

5.21 Irreversible and Irretrievable Commitments of Resources 5-166

5.22 Mitigation 5-167

5.23 Environmental Consequences Summary 5-167

6.0 PUBLIC INVOLVEMENT* 6-1

6.1 NEPA Scoping 6-1

6.2 Other Public Comments 6-3

6.2.1 Land owner involvement 6-4

6.2.2 Non-Governments Organizational (NGO) Involvement 6-4

6.2.3 Parish Involvement 6-5

6.3 Public Comments on the Draft EIS 6-5

7.0 COORDINATION AND COMPLIANCES* 7-1

7.1 USACE Principle and Guidelines (P&G) 7-1

7.2 Environmental Coordination and Compliance 7-1

7.2.1 U.S. Fish and Wildlife Coordination Act 7-1

7.2.2 Clean Water Act – Section 401 Water Quality 7-5

7.2.3 Clean Water Act – Section 404(b)(1) 7-5

7.2.4 Coastal Zone Management Act of 1972 7-5

7.2.5 Endangered Species Act of 1973 7-6

7.2.6 Magnuson-Stevens Fishery Conservation and Management Act of 1996; And the Magnuson-Stevens Act Reauthorization of 2006 (Essential Fish Habitat) 7-6

7.2.7 Clean Air Act – Air Quality Determination 7-6

7.2.8 National Historic Preservation Act of 1996 7-7

7.2.9 Farmland Protection Policy Act (Prime and Unique Farmlands) 7-7

7.2.10 Executive Oder 13186 – Migratory Bird Habitat Protection 7-7

7.2.11 Executive Oder 12898 – Environmental Justice 7-8

7.2.12 Executive Oder 13112 – Invasive Species 7-9

7.2.13 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 7-9

7.2.14 Louisiana State Rare, Threatened, and Endangered Species, and Natural Communities Coordination 7-9

7.2.15 Section 122 Rivers and Harbors Act 7-9

7.2.16 Floodplain Management 7-10

7.2.17 Protection of Wetlands....7-10

7.2.18 Protection of Children from Environmental Health and Safety Risks....7-10

8.0 CONCLUSION AND DETERMINATIONS*....8-1

8.1 Areas of Controversy and Unresolved Issues....8-1

8.2 Conclusions....8-1

8.3 Recommendations....8-2

9.0 DISTRIBUTION LIST AND OTHER*....9-1

9.1 Distribution List....9-1

9.2 List of Preparers....9-1

9.3 Literature Cited....9-4

9.4 Glossary....9-23

9.5 Acronyms, Abbreviations, Symbols, and Initialisms....9-36

ATTACHMENT

Attachment 1: Non-Federal Sponsor's Letter of Intent

FIGURES

Figure 1-1: Lake Pontchartrain Basin and Sub-Basins, including the Upland, Upper, Middle, and Lower from northeast to southwest, respectively.....1-5

Figure 1-2: Upper Pontchartrain Sub-Basin.....1-6

Figure 1-3: Study area with hydrologic boundaries and units (areas characterized by similar hydrology).....1-7

Figure 1-4: Location of study area in relation to other proposed restoration projects in southeastern Maurepas Swamp.....1-16

Figure 3-1: Location of screened diversion routes.....3-34

Figure 3-2: Assessment of hydrologic benefits received in relation to flow rate.....3-38

Figure 3-3: Comparison of Romeville structure options based on price and desired flow rate (cfs).....3-40

Figure 3-4: Assessment of project first costs for the final array of alternatives.....3-46

Figure 3-5: Amortized first costs and annual operation and maintenance for the final array of alternatives.....3-47

Figure 3-6: Annual Habitat Units.....3-72

Figure 3-7: Hydrologic Units and Habitat Condition Classes.....3-73

Figure 3-8: Benefits and Cost of the Final Array.....3-75

Figure 3-9: Cost Effectiveness Analyses of the Final Array.....3-77

Figure 3-10: Cost Analysis of Final Array.....3-78

Figure 3-11: Recommended Plan Features.....3-91

Figure 3-12 Accretion and Sea Level Rise Forecasts for Recommended Plan.....3-108

Figure 3-13: Accretion Minus Sea Level Rise for Recommended Plan.....3-108

Figure 4-1: Relationship between the deltaic cycle and biological productivity and diversity (from LCA FPEIS, 2004)....4-5

Figure 4-2: Historical stage data and trend analysis for West End at Lake Pontchartrain gauge....4-10

Figure 4-3: Map of soil series with the study area (USGS, 2007)....4-12

Figure 4-4: Lower Mississippi River discharge (ft^3 sec^{-1}) at Tarbert Landing, MS, from January 1, 1978, to December 31, 2008 (USACE 2009) 4-17

Figure 4-5: Lower Mississippi River discharge (ft^3 sec^{-1}) annual tends at Tarbert Landing, MS, from January 1, 1978, to December 31, 2008 (USACE 2009)....4-18

Figure 4-6: Lower Mississippi River discharge (ft^3 sec^{-1}) monthly tends at Tarbert Landing, MS, from January 1, 1978, to December 31, 2008 (USACE 2009)....4-19

Figure 4-7: Lower Mississippi River daily stage (feet NAVD 88) trends at Romeville, LA, from January 1, 1978, to December 31, 2008 (USACE 2009)....4-20

Figure 4-8: CRMS 65 hourly water level data in relation to swamp elevation (NAVD 88) from January 28, 2008, to October 6, 2009 (LA DNR, 2009).... 4-24

Figure 4-9: CRMS 5167 hourly water level data in relation to swamp elevation (NAVD 88) from November 16, 2008, to October 16, 2009 (LA DNR 2009)....4-25

Figure 4-10: Blind River flow velocity and flow direction near U.S. Highway 61 measured hourly from November 6 to November 17, 2009....4-26

Figure 4-11: Pass Manchac daily stage analysis for 1974 to 2004....4-28

Figure 4-12: Mean salinity at Pass Manchac: 1951 to 2000 (from U.S. Army Corps of Engineers, New Orleans District)....4-40

Figure 4-13: Mean annual and monthly salinity at Pass Manchac 1955 to 1981 and during the 1998 to 2000 drought (from U.S. Army Corps of Engineers, New Orleans 4-40

Figure 4-14: Habitat analysis in study area for years 1956, 1978, 1988, and 2000 (Wicker 1980; Barras et al. 1994; Barras et al. 2003; Morton et al. 2007)....4-46

Figure 4-15: Habitat analysis for the project distribution area for 2005....4-47

Figure 4-16: Habitat condition map for the Study Area 4-57

Figure 4-17: Area of Potential Effect (APE) for Study Area 4-89

Figure 4-18: Cultural Resource Sites Located within the Study Area 4-89

Figure 4-19: Study area location relative to LDWF Wildlife Management Areas, boat launches, and self-clearing permitting stations 4-95

Figure 4-20: Population trends for Ascension and St. James parishes from 1900 to 2008..... 4-97

Figure 4-21 Housing trends for Ascension and St. James parishes from 1900 to 2008 4-97

Figure 4-22: Historic volume of cypress cut in the state of Louisiana (Louisiana Department of Conservation 1943; Louisiana Forestry Commission, 1957; Louisiana Forestry Commission Progress Reports 1956-76; Mistretta and Bylin 1987 compiled in Chambers et al. 2005)..... 4-122

Figure 4-23: Oil and Gas well and well bottoms within the vicinity (< 500 meters) of the study area 4-124

Figure 4-24: Location of berms within the distribution 4-130

Figure 5-1: Projected relative sea-level rise (feet) over the project life (2011-2061) in 5-year increments for low, intermediate, and high scenarios..... 5-43

TABLES

Table 1-1: Relevance of prior studies, reports, programs, and water projects to the Small Diversion at Convent/Blind River, Louisiana Feasibility Study..... ..1-9

Table 3-1: Management Measure Screening..... 3-13

Table 3-2: Diversion Locations 3-35

Table 3-3: Contribution of 1500 cfs Diversion Alternatives to the Planning Objectives 3-42

Table 3-4: Cost (millions of dollars) of alternatives in the final array..... 3-45

Table 3-5 Comparison of Final Array with Respect to Environmental Consequences 3-48

Table 3-6: Cost Effectiveness Analysis of the Final Array 3-77

Table 3-7: Incremental Cost Analysis of the Final Array..... 3-78

Table 3-8: Maximum Cost Including Inflation through Construction..... 3-79

Table 3-9: Significance of Specific Resources within the Project Study Area..... 3-83

Table 3-10: Recommended Plan Components..... 3-94

Table 3-11: Preliminary Cost for Implementation of Monitoring Program.....3-102

Table 3-12 Milestone Schedule.....3-114

Table 3-13 Cost Sharing 3-120

Table 4-1: Soil series characteristics within the project distribution area as described by the NRCS (2007)..... 4-13

Table 4-2: Lower Mississippi River summary water quality data recorded at LDEQ station 0081 (1969-1990) and LDEQ station 0321 (1991-1995) (LDEQ, 2009)..... 4-33

Table 4-3: Lower Mississippi River summary water quality data recorded at LDEQ station 0053 (2006-2009) near Plaquemine, Louisiana (LDEQ, 2009)..... 4-34

Table 4-4: Blind River summary water quality recorded near U.S. Highway 61 bridge (LDEQ station 0117) from 1978 to 1998 (LDEQ, 2009)..... 4-36

Table 4-5: Wetland community type acreage by location within the study area (USGS NWRC, 1999) 4-57

Table 4-6: Common plant species observed or likely to occur in the study area by habitat type..... 4-51

Table 4-7: Acreage by habitat condition class for the study area..... 4-56

Table 4-8: Upland Vegetation by Land Cover Class and Study Area Location (USGS 2003) 4-58

Table 4-9: Status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999)..... 4-62

Table 4-10: Mammal species likely to occur within the study area based in available habitat and species' distributions and habitat preferences..... 4-67

Table 4-11: Common macroinvertebrates by habitat type for the Lower Mississippi River (Baker et al. 1991)..... 4-74

Table 4-12: Fish species sampled by Kelso et al. (2005) in southwest Maurepas Swamp..... 4-79

Table 4-13: Federally listed threatened and endangered plant and animal species located within Louisiana organized by jurisdiction authority, and bolded if potentially occurring within study area..... 4-83

Table 4-14: Rare, threatened and endangered species of plants and animals, and natural communities tracked by LNHP for Ascension and St. James Parishes (April 2008)..... 4-87

Table 4-15: Population trends from 2000 to 2008 for St. James and Ascension Parishes, Louisiana..... 4-98

Table 4-16 Housing trends from 2000 to 2008 for St. James and Ascension Parishes, Louisiana..... 4-98

Table 4-17: Major businesses in St. James Parish, Louisiana..... 4-99

Table 4-18: Employment characteristics and change from 2000 to 2008 for St. James Parish..... 4-99

Table 4-19: Major Businesses in Ascension Parish, Louisiana..... 4-101

Table 4-20: Employment characteristics and change from 2000 to 2008 for Ascension Parish..... 4-102

Table 4-21: Income statistics and change from 2000 to 2008 for residents of St. James Parish..... 4-103

Table 4-22: Income statistics and change from 2000 to 2008 for residents of Ascension Parish..... 4-105

Table 4-23: Public Service Infrastructure present in St. James Parish and Ascension Parish, Louisiana..... 4-107

Table 4-24: Median owner-occupied home values from 1930 to 2000..... 4-110

Table 4-25: Telecommunication and energy infrastructure within the study area..... 4-111

Table 4-26: Minority populations from 1900 to 2000..... 4-114

Table 4-27: Proportion of the population living below the poverty line from 1990 to 2000..... 4-114

Table 4-28: Demographic Data for Proposed Study area from 2000 U.S. Census..... 4-115

Table 4-29: Water use in millions of gallons per day in 2005 for surface water and groundwater resources by water source for Ascension and St. James Parishes..... 4-117

Table 4-30: Annual water withdrawals (millions of gallons per day) from 1960 through 2005 for St. James and Ascension parishes..... 4-118

Table 4-31: Oil/gas wells within or adjacent to the study area..... 4-125

Table 4-32: Well bottoms and bores within or near the study area..... 4-125

Table 4-33: Summary information for pipelines within the study area....4-129

Table 4-34: Summary information for aboveground and belowground transmission lines within the study area....4-130

Table 5-1: Comparison of Cumulative Impacts....5-3

Table 5-2: Net Acres Created, Restored, and/or Protected by Other Federal, State, Local, and Private Restoration Efforts (USACE, 2004)....5-38

Table 5-3: Projected relative sea-level rise (feet) over the project life (2012-2062) in 5-year increments for low, intermediate, and high scenarios in the project area based on West End at Lake Pontchartrain tide gauge daily stage data from 1959-2009 and USACE Circular No. 1165-2-211 (2009) 5-42

Table 5-4: Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) 5-44

Table 5-5 Nutrient Concentrations and Areal Rate Constants....5-60

Table 5-6: Average Diversion Flows to Blind River Project swamp Area for Alternative 2....5-61

Table 5-7: Average Diversion Flows to Blind River Project swamp Area for Alternative 4....5-62

Table 5-8: Average Diversion Flows to Blind River Project swamp Area for Alternative 6....5-63

Table 5-9: Average Diversion Flows to Blind River Project swamp Area for Alternative 4B 5-64

Table 5-10: Projected Land Loss from 1990 to 2050 for Upper Pontchartrain Sub-Basin by General Habitat Type (LCWCRTF & WCRA, 1999)....5-78

Table 5-11: Guidelines for assigning points within the Unit Day Value Method....5-119

Table 6-1: Categorization of Scoping Comments by DSEIS Subject Matter....6-3

Volume IV Appendices

ENVIRONMENTAL REPORTS

APPENDIX A Biological Assessment

APPENDIX B U.S. Fish and Wildlife Service Coordination Letter and Report

APPENDIX C NOAA Fisheries Service Coordination Letter

APPENDIX D 404(b)(1) Water Quality Report

APPENDIX E Louisiana Coastal Resources Program Consistency Determination

APPENDIX F State Historic Preservation Officer Coordination

APPENDIX G Responses to Public Comments

APPENDIX H Value Engineering Report Summary

APPENDIX I Adaptive Management / Monitoring Plan

APPENDIX J Real Estate Plan

APPENDIX K Benefit / Cost – Incremental Cost Analysis

ANNEX K-1 WVA Report

ANNEX K-2 Response to Comments on WVA Certification

APPENDIX L Engineering Appendix

APPENDIX M Phase I ESA Summary

EXECUTIVE SUMMARY

ES-1 Summary Introduction and Study Information

This integrated feasibility study and supplemental environmental impact statement investigates alternatives to reverse the current decline of a portion of the Maurepas Swamp and to prevent the transition of the freshwater swamp into freshwater marsh and subsequently open water. Specifically, this feasibility study of the Small Diversion at Convent/Blind River evaluates a small hydraulic diversion (less than 5,000 cfs) from the Mississippi River into Maurepas Swamp and the the Blind River. Alternative locations for the proposed control structure in the vicinity of Convent, Louisiana, located at Mississippi River mile 159, were investigated. Reversing this decline will aid development of a more sustainable wetland ecosystem that will serve to protect the local environment, economy, and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The study identifies and evaluates management measures and alternatives that might contribute to reversing the current decline of the southeastern Maurepas Swamp. The purpose of this study is to identify reasonable alternatives and to screen the alternatives down to a recommended plan. The Blind River headwaters are located in St. James Parish approximately 2-3 miles north of the east bank of the Mississippi River at Convent. The Blind River flows then northeast through Ascension and St. John the Baptist Parishes before it empties into Lake Maurepas. The objective of this project is to introduce freshwater, sediment, and nutrients into the southeast portion of the Maurepas Swamp to improve biological productivity that will facilitate accretion in the swamp, and prevent further swamp deterioration.

The Study Area for this project included portions of the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. The Lake Pontchartrain Basin consists of four sub-basins—the Upper, the Middle, the Lower, and the Upland Sub-basins. The Study Area for this project is within the Upper Lake Pontchartrain Sub-basin. The Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River.

Louisiana parishes in the Study Area include St. James and Ascension. The benefit area consists of the Maurepas Swamp and Blind River southwest of I-10. These boundaries define hydrologically distinct areas that can be individually addressed in the plan formulation process.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamps in Louisiana. The Blind River flows from St. James Parish, through

Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the Interstate 10 (I-10)/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities and has considerable cultural significance since it is the largest contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area.

ES- 2 Need For and Objectives of Action

Study Area problems and opportunities were drawn from prior comprehensive planning studies and from public input and inter-agency information exchange. System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities throughout the Study Area. Through the NEPA public scoping process, the study team solicited input on problems and opportunities from members of the public, government resource agencies, and other stakeholders

Study Area Problems & Needs:

The Mississippi River and Tributaries (MR&T) levee system has isolated the Maurepas Swamp (and Blind River) from the natural, periodic, near-annual flooding by the Mississippi River. This has resulted in a degradation/deterioration process and reduced biological productivity in the swamp due to lack of freshwater, nutrients, and sediment input from the Mississippi River. The swamp is also subsiding due to natural causes and possibly due to man-made activities such as oil, gas, and groundwater withdrawals. The reduced biological productivity combined with the lack of sediment from the river has reduced soil formation (accretion) to a rate less than the subsidence. Consequently, the land surface is sinking.

Additional ecosystem problems are associated with past construction of logging trails, drainage channels, pipelines, other utilities, and roads through the swamp. These features disrupt the natural water flow and drainage patterns and impact the biological productivity of the swamp. Short circuiting of the natural drainage patterns has created ponding in some areas which inhibits bald cypress and tupelo propagation.

The Blind River project is being planned to address the problem of severe deterioration of the Maurepas Swamp. Subsidence, storm surge, saltwater intrusion, impoundment, lack of substrate accretion, tree regeneration and the absence of freshwater, sediments, and nutrients from the Mississippi River have all caused significant adverse impacts to the Maurepas Swamp and Blind River, resulting in swamp ecosystem degradation.

Specific problems identified in the Study Area are:

- Tree mortality and decline in the overall health of the swamp
- Exposure to stochastic risks, particularly increased salinities
- Potential impacts to populations of indigenous fish and wildlife species
- Vulnerability of the area to hurricane-related damage and conversion to open water areas

Study Area Opportunities: As management measures are developed opportunities within the Study Area will be identified and incorporated into the planning process. Opportunities identified in the 2004 LCA report and further developed for the Blind River study are listed below:

- Prevent future cypress swamp degradation and transition currently predicted to occur
- Restore the deltaic process impaired by levee and dredged material bank construction
- Enhance Blind River water quality by diverting freshwater from the Mississippi River to the Blind River
- Protect vital socioeconomic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas Wildlife Management Area.
- Enhance recreational opportunities in the Maurepas Swamp and Blind River

Planning Objectives

The goal of the Small Diversion at Convent/Blind River Project is to reverse the trend of degradation in the southeastern portion of the Maurepas Swamp, to help achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

The overall objective of the Small Diversion at Convent/Blind River Project is to reverse the trend of deterioration of southeast Maurepas Swamp and Blind River.

Specific Project Objectives

Objective 1: Promote water distribution in the southeastern portion of Maurepas Swamp to move stagnant water out of the system.

Objective 2: Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.

Objective 3: Establish hydro period fluctuation in the swamp to improve baldcypress and tupelo productivity and their seed germination and survival, by increasing the length of dry periods in the swamp.

Objective 4: Improve fish and wildlife habitat in the swamp and in the Blind River

ES-3 Existing and Future Without Project Condition

With no connectivity to the Mississippi River, the Blind River watershed has been cut-off from periodic Mississippi River flows resulting in much lower availability of freshwater, nutrients, and sediment. Without freshwater, nutrients, and sediment reintroduction into the Blind River watershed, observed conditions of deterioration are expected to continue into the future.

Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 21,400 acres (8,600 ha) of baldcypress-tupelo swamp projected to be lost over the 50-year period of analysis, including 3,300 acres (1,300 ha) of baldcypress-tupelo swamp that would become marsh in 20 to 30 years, 7,900 acres (3,200 ha) of baldcypress-tupelo swamp that would become marsh in 30 to 50 years, and 10,140 acres (4,100 ha) of baldcypress-tupelo swamp that would become marsh in greater than 50 years.

A more complete and detailed description of the existing and future without project conditions can be found in Sections 4 and 5 of this report.

ES-4 Plan Formulation and Alternative Screening

The following paragraphs summarize the alternative plan formulation process, alternative evaluation criteria, selected alternatives for detailed analysis and plan implementation and management.

Management Measures

Management measures were developed to address Study Area problems and to capitalize upon Study Area opportunities. A total of 99 measures were considered and evaluated. Management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, and the multidisciplinary, interagency PDT. Management measures identified were organized into structural and nonstructural measures.

Structural Measures (Features)

- **Water Management Modifications in Maurepas Swamp:** Various water management measures were identified to apply diverted freshwater to the swamp to beneficially allow transfer of freshwater and release of nutrients and sediments to the swamp. This category of management measures included the inflow of the water from a distribution system, sheet flow across the swamp through existing and proposed berm gaps, and then release and, if required, control of flow and final routing to the Blind River.
- **Distribution System within the Maurepas Swamp:** After being delivered to the fringes of the distribution area, the freshwater will have to

be transported and distributed throughout the swamp to avoid short-circuiting into existing pipeline and drainage channels and into the Blind River.

- **Separate Distribution System:** This measure would keep the freshwater conveyance separate from the existing drainage systems. The initial concept is to provide the distribution system, consisting of either canals or underground conduits, to transport the freshwater to the upstream ends of sub-basins (hydrologic units), where it will be released. Outlet controls may be required to prevent channelization and to control the hydroperiod in the swamp
- **Transmission (Transfer) System:** The transmission or transfer system includes the facilities necessary to transfer the freshwater from the diversion point and deliver it to the distribution system at the edge of the swamp.
- **Diversion System:** The diversion for the Blind River project will be located on the east bank of the Mississippi River at a point with available alignments into the Maurepas Swamp.
- **Diversion Point:** Seven potential diversion point locations were identified. In addition to a single diversion point, multiple diversion points were considered as the project progressed.
- **Water Quality Management:** Water quality management measures are required for two broad purposes:
    - Provide the desired water quality and parameters in the freshwater delivered to, and applied in, the swamp.
    - Protect and possibly improve the water quality in the streams and water bodies downstream of the targeted service area.

  The swamp has specific needs to promote revitalized growth, including the freshwater, suspended sediment, and nutrients in the water. The Mississippi River water may have pollutants that can be assimilated in the swamp, such as mercury, pesticides, and nutrients.
- **Sediment Management:** The existing ground surface in the swamp has had a net loss of elevation relative to sea level due to ground subsidence trends and sea level rise. Several measures were identified to introduce sediment directly into the swamp. Sediment can assist with vertical accretion and will be supplemented by vegetation and litter fall that will also add to the soil base in the swamp.

Non-Structural Management Measures (Activities)

- **Water Quality Management.**
    - **Extended diversion duration to freshen Blind River.** The anticipated diversion period will be in the spring. During the dry season, the Blind River becomes stagnant, due to lack of local rainfall and runoff. The diversion period could be extended into the dry seasons to freshen the Blind River and downstream water courses. This management measure would require a corresponding measure at

the diversion point, such as pumps, to allow diversion during low water levels in the Mississippi River.

- **Extended diversion duration to counter salinity intrusion.** The Study Area is subject to high levels of salinity backing up from the Gulf of Mexico due to stochastic events. These include extended droughts and tropical storm surges. Providing capabilities for extended diversion periods, as discussed above, could assist in flushing out the system after the salinity intrusion events.

- **Vegetation Management:** A major objective of the diversion project is to improve conditions for bald cypress and tupelo germination and seedling recruitment to promote regeneration. Measures can be taken to assist in regeneration and to protect against loss of seedlings and saplings, including:
  - Plant seedlings in targeted areas. This could be a one-time planting, or routine plantings in different areas over the design life of the project;
  - Identify areas and control the water levels to mimic the natural wet – dry cycle; and
  - Control herbivore grazing of the seedlings with fences or other means.
- **Recreational Access and Enhancements:** The swamp and the existing wildlife management area is a recreational destination for the general public. A diversion will enhance nutrient assimilation and thereby improve water quality and in turn fish and wildlife habitat which will enhance recreational activities.
- **Real Estate:** Real estate acquisition will be required for all elements of the project, including the diversion structure, the transmission system, and all elements within the targeted project service area in the swamp.

There were a total of 75 management features included in the initial screening and 24 management activities. As an initial step the screened list of management measures was evaluated based on benefits, constraints, and relative costs. Based on that initial screening of the management measures, 48 features and 3 activities were retained for further analysis.

The retained management measures were then grouped into a preliminary array of 12 alternatives and the no action alternative for further evaluation to achieve the overall project goals and objectives. The 12 alternatives were formulated to consider 11 different options for the diversion point, different diversion methods, the transmission system, the distribution system, and the benefit area. Through iterative screening of the alternatives with respect to their viability to meet project goals, a final array of five alternatives was considered for further detailed analysis.

Identification of the Final Array of Alternatives

The following five alternatives were identified for further consideration and inclusion in the Final Array are:

- No Action (required to establish baseline conditions and the need for a diversion)
- Alternative 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
- Alternative 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
- Alternative 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
- Alternative 6 – Two 1,500 cfs Diversions at Romeville and South Bridge (Gated Culvert Systems)

No Action (Future without Project Conditions)
The No Action Alternative will lead to the eventual degradation of the swamp in the distribution area. Local drainage occurs in episodic events and sends large quantities of water to the Blind River and the swamp. This local drainage can contain significant pollutants in terms of sediment, nutrients, pesticides, and herbicides. Without the natural assimilation capacity of the swamp, these pollutants can cause stresses on the aquatic life in the Blind River.

Without adequate flow of water through the swamp and with issues relating to subsidence, and relative sea level rise as well as ponding and drainage from pipeline channels, the hydro period of the swamp is not conducive to the health and regeneration of several native tree species, including baldcypress and water tupelo. The swamp has been traversed with many man-made features, including railroad embankments and channels, which have disrupted the natural hydro period of the swamp and limited the vertical accretion that would occur from sediment input and prolific vegetation growth from the nutrient input from the Mississippi River.

Alternative 2 – A 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp, and adds 4 new culverts under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Alternative 4 – A 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp, and adds 4 new culverts under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Alternative 4B – A 3,000 cfs Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp, and adds 4 new culverts under U.S. HWY 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Alternative 6 – A 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp, and adds 4 new culverts under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Comparison of Alternative Plans
The four alternatives in the final array were compared to each other and to no action based on benefits, costs, and impacts. The first cost and annual costs for the final four alternatives are below.

Alternative 2 is the least expensive with a first cost of about $102 million with Alternative 6 being the most expensive at over $155 million. Alternatives 4 and 4B are slightly less expensive than Alternative 6 at $152.2 million and $146.9 million, respectively. A cost summary comparison of the final array of alternatives is provided in Table ES-1.

ES-1: Cost (millions of dollars) of Final Array Alternatives[1,2]

Item	Cost (millions of dollars)			
	Alt. 2	Alt. 4	Alt. 4B	Alt 6
Construction Subtotal	$73.5	$110.7	$106.8	$111.2
Engineering & Design (E&D)	$3.7	$5.5	$5.3	$5.6
Supervision & Administration (S&A)	$2.2	$3.3	$3.2	$3.3
Real Estate	$2.2	$2.2	$2.2	$4.4
Subtotal	$81.6	$121.8	$117.5	$124.5
Contingencies @ 25%	$20.4	$30.4	$29.4	$31.1
Total First Cost	$102.0	$152.2	$146.9	$155.6

Annualized First Cost	$5.06	$7.55	$7.28	$7.72
Annual O&M Costs	$0.59	$0.59	$0.67	$0.74
Total Annual Cost	$5.65	$8.14	$7.95	$8.46

* Costs for Adaptive Management are not included in Table ES-1.

Table ES-2 summarizes the results of the Wetlands Value Assement (WVA) benefit analysis and of the IWR-PLAN incremental cost analysis. Although Alternative 6 provides the greatest number of environmental benefits in terms of AAHUs estimated using the WVA process. Alternative 2 provides over 90% of the benefits for about 67% of the cost of Alternative 6. As can be seen from Table ES-2 below, the cost per AAHU is much lower for Alternative 2 that for the other three alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Another factor to consider is that Alternative 2 impacts the smallest number of wetland acres. Accordingly, Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the National Ecosystem Restoration Plan (NER).

Table ES-2: Summary of WVA Analysis AAHUs, IWR-PLAN benefits, and Wetland Impacts (acres) for Final Array Alternatives[3],[4]

	Alt. 2	Alt. 4	Alt. 4B	Alt. 6
AAHUs	6,421	6,124	7,103	7,114
Cost ($1,000s)	$5,646	$8,135	$7,954	$8,455
Cost-effective	Yes	No	Yes	Yes
Best Buy	Yes	No	Yes	Yes
Cost/HU	$879	$1,328	$1,120	$1,189
Incremental Cost/HU		negative	$3,385	$4,054
Wetland Acres Impacted*	53	271	306	287

*Wetlands impacted during project construction.

ES-5 NER Plan

The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. Based on the comparison of alternatives above, Alternative 2, a 3,000 cfs diversion at Romeville is designated as the NER Plan.

ES-6 Plan Selection – Tentatively Selected Plan

After comparing the four alternative plans carried over for detailed analysis and the No Action Alternative, Plan 2, a 3,000 cfs diversion at Romeville was selected, as the Tentatively Selected Plan (TSP) and later confirmed as the Recommended Plan. Plan 2 best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the southeast part of the

[3] All costs are in October 2009 prices

[4] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

Maurepas Swamp. The Recommended Plan would improve a total of 21,369 acres (8,648 ha) of baldcypress-tupelo swamp that are in various stages of deterioration. The Recommended Plan would improve 3,295 acres (1,333 ha) of baldcypress-tupelo swamp that would become marsh in 20 to 30 years without project implementation, 7,934 acres (3,211 ha) of baldcypress-tupelo swamp that would become marsh in 30 to 50 years without project implementation, and 10,140 acres (4,104 ha) of baldcypress-tupelo swamp that would become marsh in greater than 50 years without project implementation.

Components

Alternative 2, a 3,000 cfs diversion at Romeville, has six major components: a diversion structure, a transmission canal, control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along the U.S 61, and instrumentation. The Recommended Plan components are summarized in the following table.

Table ES-3: Recommended Plan Components

Item	Description
Diversion Culvert	3,000 cfs
Box Culverts[5]	3 – 10' x 10' reinforced concrete, multi-cell box culvert
Sluice Gates	3 – 10' x 10' cast iron gates with motor operators
Trash Racks	Coarse grid
Inlet Canal	Earthen channel – 40' bottom width, 4:1 SS, 27' deep
Transmission Canal	3,750 cfs (1.25x diversion flow rate)
Earthen Canal	155' bottom width, 4:1 SS, 12' deep
Berms	Earthen embankments, 12' top width, 3:1 SS (exterior)
Culverts at CN RR	8 – 12'x8' reinforced concrete multi-cell box culverts
Culverts at LA 3125	8 – 12'x8' reinforced concrete multi-cell box culverts
Control Structures	
Control Structure	Large concrete structure in existing channel
Control Building	Housing for instrumentation, HPU, generator
Berm Gaps	
500-foot Wide Gaps	Excavate gaps at 2,500-foot spacing in spoil banks
Cross Culverts at Hwy 61	
Box Culverts	3 – 3'x4' Box Culverts at 4 locations
Instrumentation	
Local instrumentation	Monitoring and control at diversion and control structures
Stream Stage Monitors	Monitoring in Blind River and drainage channels
Communication	Remote satellites for communication to control building

[5] Box culvert dimensions are horizontal x vertical inside dimensions.

ES-7 Monitoring Plan and Adaptive Management
A feasibility level monitoring and adaptive management (AM) plan was developed for the LCA Small Diversion at Convent/Blind River project. The monitoring and AM plan for this project was developed with assistance from the LCA AM Formulation Team. The feasibility level monitoring and AM plan was developed to include a sufficient description of the proposed monitoring and AM activities to identify the nature of proposed AM activities and to estimate the costs and duration of the monitoring and AM plan.

The project monitoring and AM plan describes and justifies AM in relation to the proposed project management alternatives identified in the Feasibility Study. The plan also identifies how AM will be conducted for the diversion at Convent/Blind River and who will be responsible for this specific AM program. The results of this project-specific AM program will be used to adaptively manage the project, including specification of conditions that will qualify project success and terminate the AM program.

ES-8 Effectiveness of Recommended Plan in Meeting Goals and Objectives
The Overall Small Diversion at Convent/Blind River project objective is to reverse the trend of deterioration of Maurepas Swamp and Blind River.

The Recommended Plan would meet the overall and the specific project objectives. The diversion will bring nutrients, sediment, and water to the swamp to increase productivity and accretion (swamp building). The construction of new gaps in berms, maintenance of existing gaps in the berms, and strategically placed control structures in the major conveyance channels, along with the diversion, will promote water distribution to increase productivity and accretion (swamp building). The operational flexibility provided in the Recommended Plan will allow establishment of hydroperiod fluctuations in the swamp to improve seedling germination and survival. Nutrient assimilation in the swamp of water diverted from the Mississippi River will improve water quality and thereby the fish and wildlife habitat in the swamp and in Blind River. These activities would reverse the trend of deterioration of Maurepas Swamp (west) and Blind River.

ES-9 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles
The Recommended Plan is effective in meeting the environmental operating principles developed by the U.S. Army Corps of Engineers to apply to all its decision-making and programs and to reaffirm its commitment to the environment. The Recommended Plan is environmentally sustainable as it minimizes operational activities to the extent possible while maintaining operational flexibility to restore a viable natural system. The Recommended Plan was developed to reverse deterioration of the swamp and Blind River by utilizing the natural swamp building and assimilation processes balanced with appropriate management activities while minimizing environmental consequences. The improvement of bald cypress-tupelo

swamp provided by the Recommended Plan will mitigate for the unavoidable wetland impacts resulting from project implementation. Monitoring and adaptive management will provide knowledge on how to effectively implement small diversion projects to maintain and protect valuable swamp ecosystems. In addition, the Recommended Plan was developed with the inclusion of important stakeholder input.

ES-10 Compensatory Mitigation Measures

Compensatory mitigation is not needed for this project. Wetland impacts were avoided and minimized to the extent possible in the preliminary design of the Recommended Plan. The Recommended Plan will impact 53 acres (21ha) of wetlands with construction of the Romeville diversion canal. The wetlands that will be impacted are not part of Maurepas Swamp that will be improved (as described above). The improvement of 21,369 acres (8,648 ha) of bald cypress-tupelo swamp will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal.

ES-11 Risk and Uncertainty

The study addresses risk and uncertainty as related to the ability of the proposed system to meet the project objectives. Areas of risk and uncertainty analyzed include hydrologic, environmental, engineering design, operational performance and maintenance needs, construction, and economics. In summary the Recommended Plan is a robust solution to the identified problems and considered likely to be successful in meeting and/or exceeding the planning objectives. See **Section 3.8** for a more complete discussion of the risk and uncertainty analysis.

ES-12 Implementation Responsibilities and Cost Sharing

The State of Louisiana, acting through the Coastal Protection and Restoration Authority of Louisiana (CPRA), will be the non-Federal sponsor for the LCA Small Diversion at Convent/Blind River project. In November 2008, the USACE and CPRA executed a single Feasibility Cost-Share Agreement covering six Louisiana Coastal Area near-term plan elements listed in Section 7006(e) of the Water Resources Development Act of 2007. The six features each underwent a separate feasibility analysis and environmental compliance analysis culminating in a single master feasibility document. The cost-share during the feasibility phase was 50% Federal and 50% non-Federal. However, the individual elements have been divided so that each entity had lead responsibility for preparing three of the six report components. At the end of the feasibility phase the total cost for all elements will have been shared on a 50/50 basis, yet for work on each individual element during the feasibility phase the ratio of funds expended by either the Federal or non-Federal sponsor will be higher depending upon their level of responsibility. CPRA had the technical planning lead for this particular LCA project element.

Following the feasibility phase, the cost share for the planning, design and construction of the project will be 65% Federal and 35% non-Federal. The CPRA

must provide all lands, easements, rights-of-way, utility or public facility relocations, and disposal areas (LERRDs) required for the project. Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) of the project would be a 100% CPRA responsibility.

Table ES-4 below provides the distribution of cost for the fully funded project cost estimated. The estimate includes contingencies based on a risk and uncertainty analysis using the Crystal Ball computer program, price escalation to October 2011, and inflation to the midpoint of construction. According to the MCACES cost estimate developed, the total fully funded cost of constructing the Recommended Plan is $123,140,000. The Federal cost-share for construction of the Recommended Plan would be $80,041,000 and the non-Federal cost share would be $43,099,000. Operation and maintenance costs will be $462,000 annually and the cost to dredge sediments from the transfer canal will be $2,200,000 annually. The State of Louisiana is in full support of the LCA Small Diversion at Convent/Blind River project at the current cost share ratio of 65 percent Federal, 35 percent non-Federal, with operations, maintenance, repair, replacement and rehabilitation being a 100 percent non-Federal responsibility, as required in WRDA 2007. Additionally, project monitoring and any Adaptive Management deemed necessary will be cost shared at 65/35 for the first ten years of the project life.

Table ES-4: Cost Sharing

ITEM	FEDERAL	NON-FEDERAL	TOTAL (Rounded)
LERRDs to be acquired		$4,040,000	$4,040,000
Facility/Utility Relocation		$14,060,000	$14,060,000
Highway modifications/Relocations		$1,820,000	$1,820,000
Railroad modifications/Relocations		$2,090,000	$2,090,000
Subtotal Real Estate		$22,010,000	$22,010,000
Construction	$77,610,000		$77,610,000
Planning, Engineering, & Design	$5,812,500	$1,937,500	$7,750,000
Construction Management	$9,150,000		$9,150,000
Subtotal Construction	$94,510,000		$94,510,000
Adaptive Management	$6,620,000		$6,620,000
Subtotal 65/35 Cost Share	$101,130,000	$22,010,000	$123,140,000
Adjustment for 65/35 Cost Share	($19,151,500)	$19,151,500	
TOTAL FIRST COST*	$80,041,000	$43,099,000	$123,140,000
PERCENT OF FIRST COST	65%	35%	
Annual Operation & Maintenance		$462,000	
Annual maintenance dredging		$2,200,000	

**Represents fully funded costs including insterest during construction*

ES-13 Environmental Commitments

A summary of the environmental and related commitments made during the planning process and incorporated into the proposed project plan is as follows.

Management practices would be employed during construction activities to minimize environmental effects and would be included in construction specifications. Many of these measures are required in order to comply with Federal, State, or local laws and regulations, regardless of whether they are specifically identified in this document. Project implementation will comply with all relevant Federal, State, and local laws, ordinances, regulations, and standards during the implementation of the preferred alternative. Implementation of the environmental commitments for the proposed project will be documented to track the completion of the environmental commitments.

Environmental Commitments:

- Ensure that construction contractors limit ground disturbance to the smallest feasible areas.
- Use accepted erosion control measures during construction.
- To minimize disturbance to bald eagles and other raptors nest searches will be conducted up to three-quarters of a mile of proposed activities prior to construction to avoid active nests. Appropriate protective measures will be implemented to avoid or minimize nest disturbance if active nests are found.
- Contact pipeline and gas well companies prior to construction activities to identify and avoid existing hazards.
- Construction contractors will use and implement measures contained in erosion control guidelines and BMPs to control soil erosion from construction areas.
- Construction contractors will implement measures to control fugitive dust during construction.
- Implement a program to compensate for losses of archaeological sites (if any) that would occur as a result of construction and operation of the proposed project.

ES-14 Views of Non-Federal Sponsor

CPRA has expressed the desire to implement and sponsor the LCA Small Diversion at Convent/Blind River project in accordance with the items of local cooperation that are set forth in Section 3.9.2 and subject to the discussion provided in Sections 3.9.3 and 3.9.5 in the main report. In addition, CPRA supports the NER plan (Alternative 2) since this plan best meets the screening criteria; would accomplish the planning objectives and goals; is cost-effective and is a best-buy, and would reverse the trend of deterioration in the southeast part of the Maurepas Swamp. Specifically, Alternative 2 would improve over 21,000 acres of baldcypress-tupelo swamp that are in various stages of deterioration.

ES-15 Public Involvement

NEPA Scoping

A Notice of Intent to prepare a SEIS for the Small Diversion at Convent / Blind River, Louisiana, was published on December 22, 2008, in the Federal Register (Volume 73, Number 246, Pages 78339-78340). A public scoping meeting was organized and hosted in accordance with NEPA on February 12, 2009.

A total of 83 comments were received during the comment period; 12 multi-part comments were expressed at the scoping meetings and 10 multi-part written (letter, fax, and email) and verbal comments were received during the comment period. Commenters were generally supportive of the project and stressed a need for urgency.

Two additional meetings were conducted with groups associated with recreational use of the Study Area. Based on comments received from attendees of the meetings, it is very apparent that the main recreational feature(s) associated with the swamp include fishing and hunting. Comments were supportive of the project.

For the DSEIS, two additional public meetings were held in April and June of 2010 to describe the plan formulation process and obtain feedback on the Tenatively Selected Plan. Comments received during these meetings also were supportive of the project.

Other Public Comments, Areas of Controversy, Unresolved Issues

Meetings and discussions with the public and local, State, and Federal agencies indicated support for the project and did not identify any areas of controversy or unresolved issues.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time. The impacts of the oil spill as well as the various emergency actions taken to address oil spill impacts (e.g., use of oil dispersants, creation of sand berms, use of Hesco baskets, rip-rap, sheet piling, and other actions) could potentially impact USACE water resources projects and studies within the Louisiana coastal area. Potential impacts could include factors such as changes to existing, future-without, and future-with-project conditions, as well as increased project costs and implementation delays. The USACE will continue to monitor and closely coordinate with other Federal and State resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact project implementation. Supplemental planning and environmental documentation may be required as information becomes available.

ES-16 Coordination and Compliance

USACE Principles and Guidelines

The guidance for conducting Civil Works planning studies (ER 1105-2-100) requires the systematic formulation of alternative plans that contribute to the Federal objective. In order to ensure that sound decisions are made with respect to development of alternatives and ultimately plan selection, the plan formulation process requires a systematic and repeatable approach. The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) describe the USACE study process and requirements.

Planning for this feasibility study has been conducted in accordance with ER 1105-2-100. This report is a summary of the integrated feasibility study and SEIS conducted for this project. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

Environmental Coordination and Compliance

Coordination and compliance efforts were conducted pursuant to statutory authorities. These include environmental laws, regulations, executive orders, policies, rules, and guidance applicable to this project.

Full compliance with statutory authorities will be accomplished upon review of the integrated feasibility study and supplemental environmental impact statement by appropriate agencies and the public and the signing of a ROD.

ES-17 Conclusions and Recommendations

The LCA Small Diversion at Convent/Blind River project recommended in this report is in the overall public interest and would work to restore the natural ecology within Maurepas Swamp. The estimated fully funded cost of the recommended plan is $123,140,000.

1.0 STUDY INFORMATION

1.1 Study Authority

Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007 authorizes the Louisiana Coastal Area Near-term Restoration Plan. The authority includes requirements for comprehensive coastal restoration planning, program governance, project modification investigations, a Science and Technology (S&T) program, restoration project construction, a program for beneficial use of dredged material, feasibility studies for restoration plan components, and other program elements.

In total the LCA Near-term Restoration Plan has authority for 25 elements falling into various components including investigations, research, demonstrations, and construction. This report outlines the study elements requiring Congressional reporting that will be undertaken in partnership between the USACE and the State of Louisiana.

Specifically, Section 7006(e)(3) requires the Secretary of the Army to submit feasibility reports to Congress on six projects by December 31, 2008 and a Chief's Report by December 31, 2010. Due to delays in executing a Feasibility Cost Sharing Agreement for the projects the requested feasibility reports were not submitted to the Congress by the December 31, 2008 deadline. The contingent authorization provided in Section 7006(e)(3)(B) for the six projects however remains subject to the December 31, 2010 deadline for a Chief's report. The six elements are:

1 LCA Multipurpose Operation of Houma Navigation Lock

2 LCA Terrebonne Basin Barrier Shoreline Restoration

3 LCA Small Diversion at Convent/Blind River

4 LCA Amite River Diversion Canal Modification

5 LCA Medium Diversion at White Ditch

6 LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes

The Convent/Blind River Diversion Project is proposed to be a small freshwater diversion from the Mississippi River to the Maurepas Swamp. A small diversion as defined in the 2004 Louisiana Coastal Area (LCA) Ecosystem Restoration Study is a diversion between: 1000 cubic feet per second and 5000 cubic feet per second. The purpose of the project is to reintroduce freshwater, sediment, and nutrients to the swamp, approximating the natural historic flooding cycle, to rebuild wetlands at a rate greater than the subsidence rate. This is to improve biological productivity and reverse the current trend of degradation and restore the swamp.

An excerpt from WRDA 07 outlining the project authority is listed below:

SEC. 7003. LOUISIANA COASTAL AREA.

(a) IN GENERAL.—The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005.

(b) PRIORITIES.—

(1) IN GENERAL.—In carrying out the program under subsection a), the Secretary shall give priority to—

(A) any portion of the program identified in the report described in subsection (a) as a critical restoration feature;

(B) any Mississippi River diversion project that—

(i) will protect a major population area of the Pontchartrain, Pearl, Breton Sound, Barataria, or Terrebonne basins; and

(ii) will produce an environmental benefit to the coastal Louisiana ecosystem;

(C) any barrier island, or barrier shoreline, project that—

(i) will be carried out in conjunction with a Mississippi River diversion project; and

(ii) will protect a major population area;

(D) any project that will reduce storm surge and prevent or reduce the risk of loss of human life and the risk to public safety; and

(E) a project to physically modify the Mississippi River-Gulf Outlet and to restore the areas affected by the Mississippi River-Gulf Outlet in accordance with the comprehensive plan to be developed under section 7002(a) and consistent with sections 7006(c)(1)(A) and 7013.

SEC 7006. CONSTRUCTION

(e) Additional Projects

(3) PROJECTS SUBJECT TO REPORTS.—

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

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

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

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

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

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

(vi)Convey Atchafalaya River Water to Northern Terrebonne Marshes

at a total cost of $221,200,000.

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

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

1.2 Purpose and Scope*

The study investigates alternatives to reverse the current decline of a portion of the Maurepas Swamp and to prevent the transition of the freshwater swamp into freshwater marsh and subsequently open water. Reversing this decline will aid development of a more sustainable wetland ecosystem that will serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The study identifies and evaluates management measures and alternatives that might contribute to reversing the current decline of the southeastern Maurepas Swamp. The purpose of this study is to identify reasonable alternatives and to screen the alternatives down to a recommended plan. The Blind River headwaters are located in St. James Parish approximately 2-3 miles north of the east bank of the Mississippi River at Convent. The Blind River flows north then east through Ascension and St. John the Baptist Parishes before emptying into Lake Maurepas. The objective of the project is to introduce freshwater, sediment, and nutrients into the southeast portion of the Maurepas Swamp to improve biological productivity and facilitate swamp accretion, and prevent further swamp deterioration.

The environmental consequences of the proposed project are evaluated in the Feasibility Study/ Supplemental Environmental Impact Statement (FS/SEIS). This FS/SEIS is a supplement of the *Final Programmatic Environmental Impact Statement, Louisiana Coastal Area (LCA), Louisiana, Ecosystem Restoration Study (FPEIS).*

1.3 Study Area*

This feasibility study of the Small Diversion at Convent/Blind River evaluates a small hydraulic diversion (less than 5,000 cfs) from the Mississippi River into Maurepas Swamp via the Blind River. Alternative locations for the proposed control structure in the vicinity of Convent, Louisiana, located at Mississippi River mile 159, were investigated.

The Study Area for this project included portions of the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. The Lake Pontchartrain Basin and its four sub-basins—the Upper, the Middle, the Lower, and the Upland Sub-basins—are shown in **Figure 1-1**. The Study Area for this project is within the Upper Lake Pontchartrain Sub-basin (**Figure 1-2**). The Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River.

Louisiana parishes in the Study Area include St. James and Ascension. The benefit area consists of the Maurepas Swamp and Blind River southwest of (I-10). **Figure 1-3** shows the boundary for the benefit area and the hydrologic boundaries within the benefit area. These boundaries define hydrologically distinct areas that can be individually addressed in the plan formulation process.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial land use. Being the largest contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area this area has considerable cultural significance and is used for fishing, hunting, and other recreational activities.

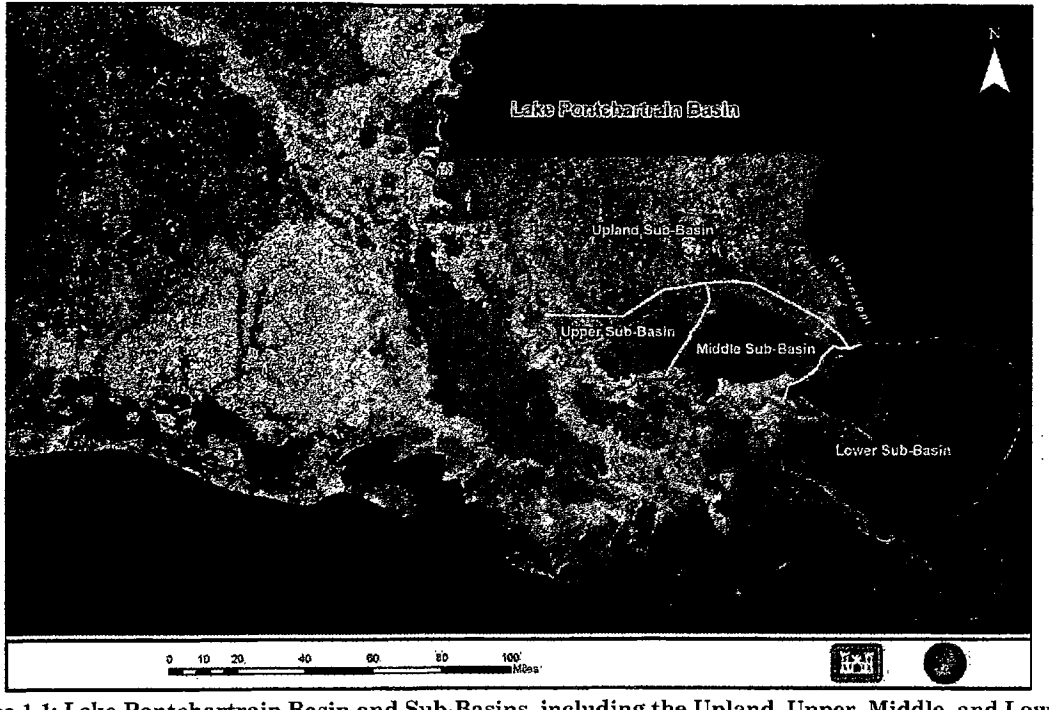


Figure 1-1: Lake Pontchartrain Basin and Sub-Basins, including the Upland, Upper, Middle, and Lower from northeast to southwest, respectively.

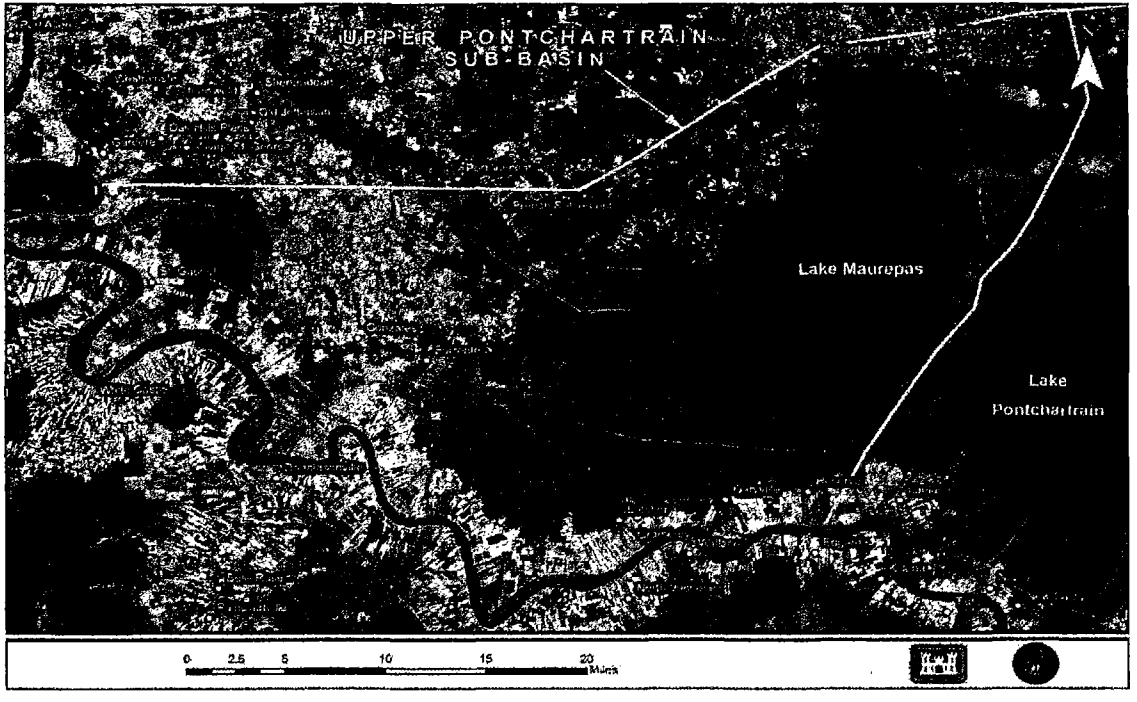


Figure 1-2: Upper Pontchartrain Sub-Basin

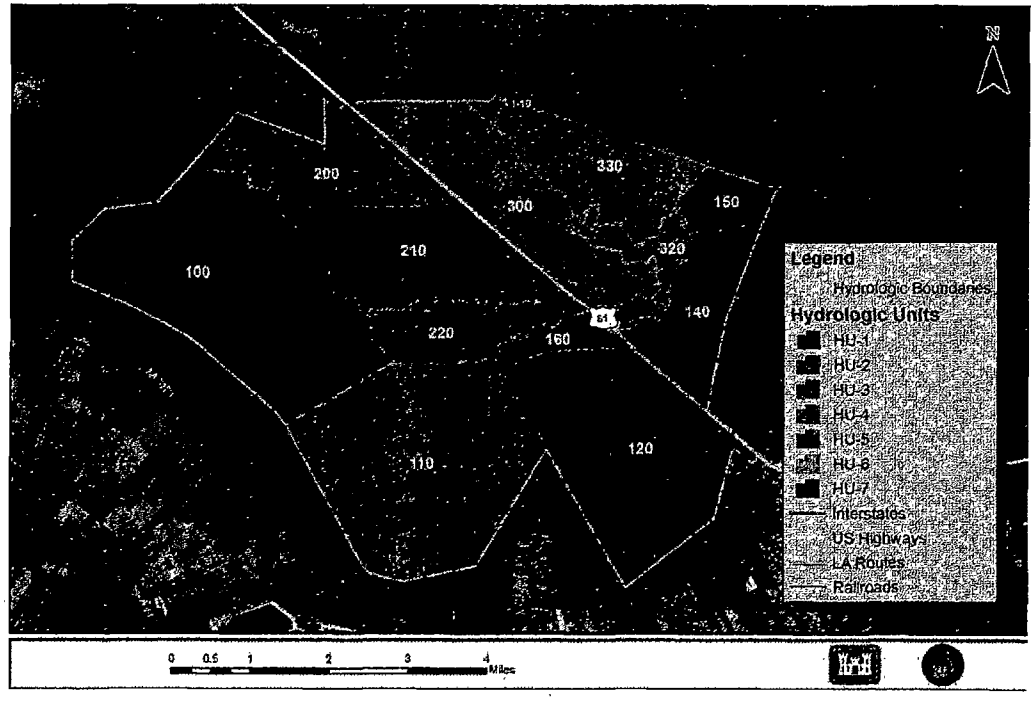


Figure 1-3: Study Area - Small Diversion at Convent / Blind River

1.4 History of Investigation

This study was designed to address general ecosystem restoration problems and opportunities in the Study Area. These have been documented since 1998 through numerous comprehensive planning studies. Specifically this study builds upon the following comprehensive planning efforts for the Louisiana coastal areas:

- 1998 Coast 2050 Plan
- 2004 Louisiana Coastal Area (LCA) Report
- 2006 Louisiana Coastal Protection and Restoration (LACPR) Preliminary Technical Report
- 2007 Integrated Ecosystem Restoration and Hurricane Protection: Louisiana's Comprehensive Master Plan for a Sustainable Coast
- 2009 Louisiana Coastal Protection and Restoration (LACPR) Final Technical Report

Planning for this project utilizes data from these reports and other studies. Alternative plans were formulated based upon the 2004 LCA Report.

1.5 Prior Reports and Existing Projects

A number of prior water resources development efforts are relevant to the LCA Near-term Restoration Plan. **Table 1-1** lists these efforts and denotes how each is relevant to the Small Diversion at Convent/Blind River, Louisiana study followed by a discussion of each report or project.

1.5.1 Comprehensive Planning Studies

Several comprehensive planning efforts have covered the Blind River swamp, including the Coast 2050 Plan; the LCA Near-term Restoration Plan, the Louisiana's Comprehensive Master Plan for a Sustainable Coast; and the Louisiana Coastal Protection and Restoration (LACPR) Technical Reports. These comprehensive planning efforts are described below.

Table 1-1: Relevance of prior studies, reports, programs, and water projects to the Small Diversion at Convent/Blind River, Louisiana Feasibility Study

Prior Studies, Reports, Programs, and Water Projects	Relevance to Convent/Blind River Diversion				
	Data Source	Consistency	Structural Measures	Non-Structural Measures	Future Without Project Condition
Comprehensive Planning Studies					
Coast 2050 Report, 1999	x	x		x	x
Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007	x	x	x	x	x
Louisiana Coastal Protection and Restoration (LACPR), 2009	x	x	x	x	
Louisiana Coastal Area (LCA) Near-term Restoration Plan Critical Restoration Features 2004 LCA Small diversion at Hope Canal (1,000 – 5,000 cfs) LCA Small diversion at Convent/Blind River (1,000 – 5,000 cfs) LCA River Diversion Canal Modification	x	x	x	x	x
Mississippi River Sediment, Nutrient, and Freshwater Redistribution Study, 2000	x	x		x	x
Prior Studies, Reports and Water Projects					
LCA Small Diversion at Hope Canal					
2001 Diversion into Maurepas Swamp	x	x	x	x	x
2003 Potential Nitrate Removal from a Diversion into Wetlands	x	x		x	
2003 Ecosystem Health of the Maurepas Swamp	x	x		x	x
2006 Impacts of Freshwater Diversion on Wildlife and Fisheries	x	x		x	x
2007 Mississippi River Reintroduction into Maurepas Swamp	x	x	x	x	x
2007 Evaluation of Potential Impact of Diversion on Gulf and Pallid Sturgeon	x	x		x	
2007 Cultural Resources Survey of River Reintroduction Corridor	x	x		x	
LCA Amite River Diversion Canal Modification					
2002 Amite Gapping	x	x		x	
2010 Amite Feasibility Study	x	x	x	x	x
Other reports					
1996 Diversion and Feasibility of Bonnet Carré Spillway	x	x	x	x	x
2001 Water Quality Analysis	x	x		x	x
2008 Swamp Ecology in a Dynamic Coastal Landscape	x	x		x	
2006 Pontchartrain Basin Research Program	x	x		x	x
2007 Pontchartrain Basin Research Program	x	x		x	x

Prior Studies, Reports, Programs, and Water Projects	Relevance to Convent/Blind River Diversion				
	Data Source	Consistency	Structural Measures	Non-Structural Measures	Future Without Project Condition
2002 Hydrologic Modeling to Evaluate MR Diversion into Maurepas Swamps	x	x		x	x
(n.d) Growth and Development of Bald cypress-Tupelo	x	x		x	
1992Effects of Flooding on Bald cypress	x	x		x	
1972 Effects of Aeration, Water Supply, and Nitrogen on Tupelo and Bald cypress	x	x		x	
2004 Through Droughts and Hurricanes: Survival and Productivity of a Coastal swamp	x	x		x	
1995 Interaction of Flooding and Salinity Stress on Bald cypress	x	x		x	
2005 Comprehensive Habitat Management Plan	x	x		x	x
2008 Interim Feasibility Report: Convent/Blind River Freshwater Diversion	x	x	x	x	x
Laws and Programs					
The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) 1990	x	x		x	x
Act 8 of the First Extraordinary Session of 2005	x	x		x	
Louisiana Coastal Zone Management Program, 1980	x	x		x	
Coastal Impact Assistance Program	x	x	x	x	x

Coast 2050 Report, 1998: Federal and state agencies, local governments, academia, numerous non-governmental groups, and private citizens participated in developing the Coast 2050 Plan. The Plan built upon lessons learned through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) and other programs. It reflected a growing recognition that a more comprehensive "systemic" approach to restoring coastal wetlands was needed. The Plan formed the basis for the May 1999 905(b) reconnaissance report for the LCA Ecosystem Restoration Study.

Louisiana Coastal Area (LCA) Near-term Restoration Plan, 2004: In 2000, the USACE and State of Louisiana initiated the LCA Ecosystem Restoration Study to address Louisiana's severe coastal land loss problem. The LCA study used the best available science to develop a plan addressing the most critical coastal ecological needs. An FPEIS entitled *Final Programmatic Environmental Impact Statement, Louisiana Coastal Area (LCA), Louisiana, Ecosystem Restoration Study* was prepared for this study. The FPEIS is hereby incorporated by reference. The

small diversion at Convent Blind River Project is one of the elements included in the LCA Near-term Plan:

> ***Description of Small Diversion at Convent/Blind River Project in 2004 LCA Report-*** *This restoration feature involves a small diversion from the Mississippi River into Blind River through a new control structure. The objective of this feature is to introduce sediment and nutrients into the southeast portion of Maurepas Swamp. This feature is intended to operate in conjunction with the Hope Canal diversion to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration.*

Louisiana's Comprehensive Master Plan for a Sustainable Coast, 2007: Act 8 of the First Extraordinary Session of the 2005 Louisiana Legislature established the Coastal Protection and Restoration Authority (CPRA). The CPRA developed a comprehensive coastal protection master plan and annual coastal protection plans. The master plan discusses diverting Mississippi River water into areas of deteriorated wetland and swamp habitat, including the Maurepas Swamp.

Louisiana Coastal Protection and Restoration (LACPR), 2009: In 2006, Congress authorized development of a Technical Report for coastal restoration and "Category 5" hurricane risk reduction in south Louisiana. The USACE submitted a Preliminary Technical Report to Congress in July 2006. A Final Technical Report completed in 2009 includes different structural alignments and measures such as floodgates, floodwalls, and levees. The report includes nonstructural measures such as elevating homes. In addition, the report reviews various wetland restoration measures and highlights the role of wetlands in coastal risk reduction. Although the potential for LaCPR measures affecting the LCA Small Diversion at Convent/Blind River is recognized, no specific impacts have been identified.

Mississippi River Sediment, Nutrient and Freshwater Redistribution Study, 2000: This report presents the technical background and rationale for developing Mississippi River diversions to redistribute freshwater and nutrients to parts of the coastal floodplain that have been cut off by levees and manmade structures. Each floodplain area is evaluated with respect to current conditions, conditions that will prevail if no action is taken, and future conditions with project implementation. The report provides a conceptual implementation plan for river diversions as they relate to coastal restoration, wetland maintenance, and land building. The Maurepas Swamp is specifically described as a feature within the Lake Pontchartrain Basin that needs freshwater.

Prior Studies, Reports, and Projects

In addition to the comprehensive planning efforts described above, the studies, reports, and projects listed in **Table 1-1** are relevant to the Small Diversion at

Convent/Blind River, Louisiana Feasibility Study as noted. A brief description of relevant prior studies and reports is provided.

1.5.2 Related Laws and Programs: Over the past three decades, the Federal government and the State of Louisiana have established policies and programs that are intended to halt and reverse the loss of coastal wetlands and to restore and enhance ecosystem function.

1.5.2.1 Federal

Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), 1990: The Coastal Wetlands Planning, Protection and Restoration Act of 1990 was the first Federal statutory mandate for restoration of Louisiana's coastal wetlands. The CWPPRA Task Force is composed of five Federal agencies: U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE), National Marine Fisheries Service (NMFS), and Natural Resources Conservation Service (NRCS), and the State of Louisiana. The Task Force prepared a comprehensive restoration plan in 1993 to coordinate and integrate coastal wetlands restoration projects to ensure the long-term conservation of coastal wetlands of Louisiana. The Task Force prepares annual Project Priority Lists and funds coastal restoration planning and the project construction. As of July 2008, 145 active CWPPRA projects have been approved, 74 have been constructed, 17 are under construction, and 26 have been de-authorized or transferred to other programs.

Coastal Impact Assistance Program (CIAP). The Energy Policy Act of 2005 (Public Law 109-58) was signed into law by President Bush on August 8, 2005. Section 384 of the Act establishes the Coastal Impact Assistance Program (CIAP) which authorizes funds to be distributed to Outer Continental Shelf (OCS) oil and gas producing States to mitigate the impacts of OCS oil and gas activities.

Under the CIAP, the Secretary of the Interior is authorized to distribute to producing States and coastal political subdivisions (CPSs) $250 million for each of the fiscal years 2007 through 2010. This money is shared among Alabama, Alaska, California, Louisiana, Mississippi, and Texas and is allocated to each producing State and eligible CPS based upon allocation formulas prescribed by the Act.

Pursuant to the Act, a producing State or CPS shall use all amounts received under this section for one or more of the following purposes:

- Projects and activities for the conservation, protection, or restoration of coastal areas, including wetland
- Mitigation of damage to fish, wildlife, or natural resources
- Planning assistance and the administrative costs of complying with this section

- Implementation of a federally-approved marine, coastal, or comprehensive conservation management plan
- Mitigation of the impact of OCS activities through funding of onshore infrastructure projects and public service needs

Each eligible State is allocated their share based on the State's Qualified Outer Continental Shelf Revenue (QOCSR) generated off of its coast in proportion to the total QOCSR generated off the coasts of all eligible States.

1.5.2.2 State Laws

Louisiana Coastal Zone Management: Louisiana began participating in the Federal Coastal Zone Management program in 1978. Shortly thereafter, the State developed a coastal zone management plan. The Louisiana Coastal Resources Program, approved by NOAA in 1980, is administered by the Department of Natural Resources through the Coastal Management Division (CMD). The State and Local Coastal Resources Management Act of 1978 required the state to develop Coastal Use Guidelines, a set of comprehensive coastal policies governing various activities. The Louisiana coastal zone is a 5.3 million-acre area that includes 40 percent of the nation's coastal wetlands. One of the primary objectives of this plan was to ensure that future coastal development activities would be accomplished with the greatest benefit and the least amount of environmental damage.

Act 8 of the First Extraordinary Session of 2005: Act 8 of the First Extraordinary Session of 2005 created the Coastal Protection and Restoration Authority (CPRA) and charged it with coordinating the efforts of local, State, and Federal agencies to achieve long-term and comprehensive coastal protection and restoration. The CPRA created a Master Plan to integrate flood control and wetland restoration activities.

1.5.2.3 Local

Non-governmental organizations have also participated in various coastal restoration projects. In particular, the Lake Pontchartrain Basin Foundation (LPBF) has supported a multitude of studies and reports that include ecological interest and restorative issues associated with the Maurepas Swamp. Coordination of LPBF with other public and private parties involved in wetlands preservation or restoration activities in coastal Louisiana include Coastal America, Corporate Wetlands Restoration Partnership, Audubon Society, National Fish and Wildlife Foundation, the Nature Conservancy, and the Louisiana Wildlife Federation. These efforts are primarily concerned with preservation. The restoration activities of these organizations will support the overall goals of the Small Diversion at Convent/Blind River, Louisiana; however, these efforts are small in scale and will not appreciably influence plan formulation.

1.5.3 Existing Water Projects

Several existing and authorized navigation, river flood control, and coastal restoration, projects are related to the Small Diversion at Convent/Blind River, Louisiana Feasibility Study. These projects are briefly described below.

1.5.3.1 Navigation Projects

Mississippi River, Baton Rouge to the Gulf of Mexico: The Mississippi River, Baton Rouge to the Gulf of Mexico project currently provides a 45-foot deep draft channel between Baton Rouge and the Gulf of Mexico. This project includes points on the river near Convent investigated for the Blind River diversion.

1.5.3.2 River Flood Control Projects

Mississippi River and Tributaries Project (MR&T): The Mississippi River and Tributaries (MR&T) Project is a comprehensive project for flood control on the Lower Mississippi River below Cape Girardeau, Missouri. The project was authorized by the Flood Control Act of 1928 in response to the 1927 Lower Mississippi River flood. The 1927 flood resulted in levee failures and extensive flooding of populated areas. The four major elements of the MR&T Project are: 1) levees for containing flood flows; 2) floodways for the passage of excess flows past critical reaches of the Mississippi River; 3) channel improvement and stabilization to provide an efficient navigation alignment, increase the flood carrying capacity of the river, and protect the levee system; and 4) tributary basin improvements for major drainage and for flood control, such as dams and reservoirs, pumping plants, and auxiliary channels. The MR&T system controls and confines the river system before it reaches the coastal area.

1.5.3.3 Coastal Restoration Projects

LCA Small Diversion at Hope Canal: The LCA Small Diversion at Hope Canal project is located northeast of the Convent/Blind River project. This project is included in the Louisiana Coastal Area, Louisiana Report of the Chief of Engineers, dated 31 January 2005 in a list of five priority projects for implementation approval. The project is being investigated under the CWPPRA program described above.

The LCA Small Diversion at Hope Canal consists of diverting approximately 0-5,000 cfs from the Mississippi River into the Hope Canal. The objective is to introduce sediment and nutrients into Maurepas Swamp south of Lake Maurepas. The introduction of additional freshwater via the diversion would facilitate organic deposition, improve biological productivity, and prevent further deterioration of the swamp.

The LCA Small Diversion at Hope Canal has a significant number of project-specific biological, environmental, and hydrology/hydraulic studies. The hydrodynamic

analysis includes an Advanced Circulation (ADCIRC) model with overlap onto the potential Convent/Blind River service area.

Mississippi River Hydrodynamic Study (and other studies): The LCA Near-term Restoration Plan recommended authorization of a hydrodynamic study of the Mississippi River (and Atchafalaya River) covering the reaches of both rivers from the Old River Control Structure (ORCS) to their mouths. This comprehensive modeling and study effort will provide reliable estimates of water and sediment resources in the Mississippi River for future restoration projects and for maintenance of navigation and water supplies. The USACE and the LDNR have combined the Mississippi River Hydrodynamic Study with the Mississippi River Delta Management Plan (which was also recommended for authorization under the LCA Near-term Restoration Plan). These studies are currently in the strategic development and data collection stages and output data and results are not yet available.

1.5.4 Planned Projects

LCA Amite River Diversion Canal Modification, 2010: This project is located north of the LCA Small Diversion at Convent/Blind River study area. This restoration feature involves the construction of gaps in the existing dredged material banks of the Amite River Diversion Canal. The objective of this project is to allow floodwaters to introduce additional nutrients and sediment into western Maurepas Swamp. The exchange of flow would occur during flood events on the river and from the runoff of localized rainfall events. This project would provide nutrients and sediment to facilitate organic deposition in the swamp, improve biological productivity, and prevent further swamp deterioration. The project is being studied concurrently with and under the same authority as the LCA Small Diversion at Convent/Blind River project.

This project will restore a different portion of the Maurepas swamp than the Small Diversion at Convent/ Blind River project. **Figure 1-4.** The ARDC project is independent of but will be additive to the restoration benefits of the LCA Small Diversion at Convent/Blind River and Small Diversion at Hope Canal projects. All projects will aid in restoring the second largest stand of continuous swamp in Louisiana.

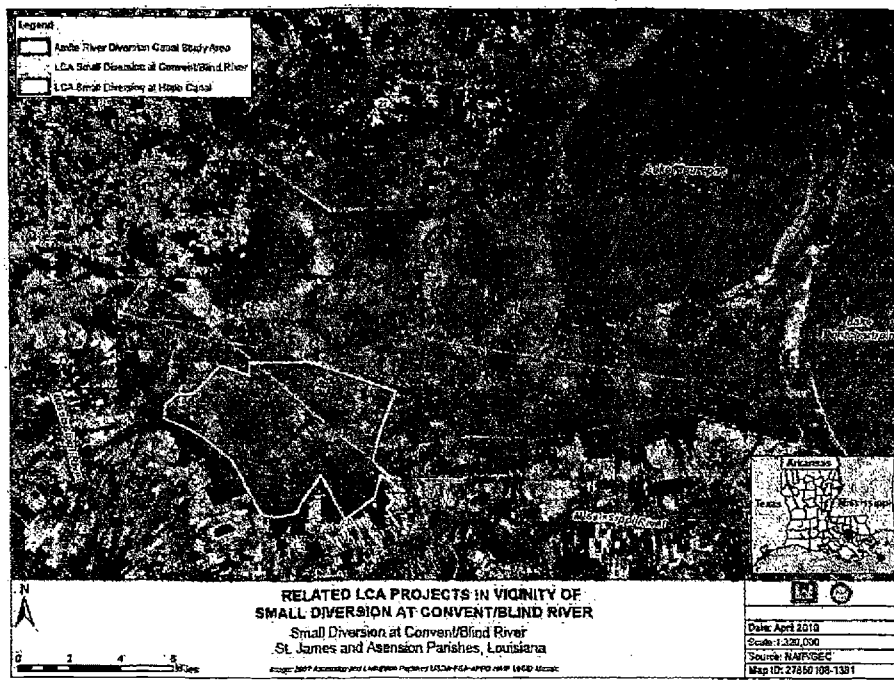


Figure 1-4. Location of study area in relation to other proposed restoration projects in southeastern Maurepas Swamp

1.6 Planning Process and Report Organization

This study followed the 6-step planning process prescribed in the Water Resources Council's "Principles and Guidelines" (See **Section 7.1** for additional information on the "Principles and Guidelines"). The following paragraphs describe that process.

The first step of the planning process defines study area problems and opportunities, as well as study constraints, goals, and objectives. Because this is an ecosystem restoration study, problems and opportunities are developed to address the Federal objective of National Ecosystem Restoration (NER). Goals, objectives, and constraints are identified to aid in the development of solutions to problems and to aide in the achievement of opportunities within the confines of legislative authority, policies, and other restrictions.

The second planning step consists of the inventory and forecast of resources within the study area. This evaluation, or inventory step, accounts for the level or amount of a particular resource that currently exists within the study area, i.e., identification of existing conditions. This step also involves forecasting to predict what changes will likely occur throughout the 50-year period of analysis, assuming no actions are taken to address reveal problems in the study area. Comparison of existing conditions to the forecast conditions assists with the identification of potential problems arising from the change in resources that could occur during the period of analysis. Study area problems are quantified based on predicted changes in resources. This second step is the delineation of opportunities that fully or partially address the problems in the study area. An opportunity is a resource, action, or policy that, if acted upon, may alter the conditions related to an identified problem.

The third step in the planning process is to generate alternative solutions. Alternative plans are formulated across a range of potential scales to demonstrate the relative effectiveness of various approaches at varying scales.

In the fourth step, alternative plans are evaluated for their potential effectiveness in addressing the specific problems, needs, and objectives of the study. The measure of output is expressed by the difference in amount or effect of a resource between the "No Action Alternative" conditions and those predicted to occur with each "Action Alternative" in place. This difference is referred to as the benefits of the action alternative. The evaluation focuses on ecosystem benefits, which are measured in metrics that reflect the area, productivity, and value of habitats that are restored or maintained.

The planning process continues with the fifth step, which is devoted to the comparison of alternative plans according to the expected benefit outputs and costs of the alternative. A relationship between costs and varying levels of ecosystem restoration outputs across a full range of scales is compared.

The sixth and final step in the process is the selection of the plan that best meets the study objectives and the four criteria in the Principles and Guidelines: completeness, effectiveness, efficiency, and acceptability. Using the six-step planning process, a Tentatively Selected Plan is identified.

This report is organized into nine sections with supporting appendices. The nine sections in the main report are described below:

1 Study Information – This section provides basic background on the study, including such information as study authority, study purpose and scope, study area delineation, and related reports and authorities.

2 Need for, and Objective of Action – This section describes the need for the action and the objectives of the study. Additional information in the section

includes Project goals and identified problems, opportunities, and constraints.

3 Alternatives – This section describes the plan formulation process.

4 Affected Environment – This section paints a picture of the historic and existing condition of the environmental, social, and economic resources in the vicinity of the project.

5 Environmental Consequences – This section describes the affect or impact of each of the alternatives in the final array of alternatives on the resources identified in Section 4.

6 Public Involvement – This section describes the public involvement process and the results of that process.

7 Coordination and Compliances – This section describes the coordination that took place during the study and documents the compliance of the process and the study recommendations with applicable laws and regulations.

8 Conclusions and Determinations – This sections documents and supports the study recommendations.

9 Distribution Lists and Other – This section includes the list of individuals and organizations receiving copies of study documents, the list of prepares, literature cited, Acronyms list, the Glossary, and the index.

1.7 USACE Campaign Plan

The U.S. Army Corps of Engineers is marching forward with a new Campaign Plan to transform the way it does business. The "Campaign Plan" has informed this study process from its inception, and will continue to influence planning decisions and methods utilized throughout the study.

The study is being planned in an open cooperative framework designed to lead to a sustainable solution to the problem of degradation of the Maurepas Swamp and ultimately contributing to the long-term recovery of the Gulf Coast of Louisiana.

2.0 NEED FOR, AND OBJECTIVES OF ACTION

2.1 National Objectives

The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to national economic development (NED outputs) are increases in the net value of the national output of goods and services, expressed in monetary units, and are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed and also of those that may not be marketed. Protection of the Nation's environment is achieved when damage to the environment is eliminated or avoided and important cultural and natural aspects of our nation's heritage are preserved. Various environmental statutes and executive orders assist in ensuring that water resources planning are consistent with protection. The objectives and requirements of applicable laws and executive orders are being considered throughout the planning process in order to meet the Federal objective.

The National objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured in the planning area and in the rest of the Nation. Single purpose ecosystem restoration plans shall be formulated and evaluated in terms of their net contributions to increases in ecosystem value (NER outputs), expressed in non-monetary units. Multipurpose plans that include ecosystem restoration shall contribute to both NED outputs and NER outputs. In this latter case, a plan that trades off NED and NER benefits to maximize the sum of net contributions to NED and NER is usually recommended.

2.2 Public Concerns

Study Area problems and opportunities were drawn from prior comprehensive planning studies and from public input and inter-agency information exchange. System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities in the study area. Through the NEPA public scoping process, the study team solicited input on problems and opportunities from members of the public, government resource agencies, and other stakeholders.

2.3 Problems, Needs, and Opportunities*

The first step in the planning process is the identification of problems and opportunities. Problems are undesirable, negative conditions that the study will address. Opportunities are desirable conditions that could be achieved in the future. Study area problems and opportunities were drawn from prior comprehensive planning studies and from public input and inter-agency information exchange. System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities throughout the study area. Throughout the NEPA public scoping process, the study team solicited input on problems and opportunities from members of the public, government resource agencies, and other stakeholders.

Following an extensive literature review and NEPA scoping the PDT met to consider all the available information in order to identify specific problems and opportunities as well as develop a general problem statement, goal statement and an initial list of project specific objectives and constraints. The results of the PDT deliberations are provided in the following paragraphs.

2.3.1 Study Area Problems and Needs

The Mississippi River and Tributaries (MR&T) levee system has isolated the Maurepas Swamp (and Blind River) from the natural, periodic, near-annual flooding by the Mississippi River. This has resulted in a degradation/deterioration process and reduced biological productivity in the swamp due to lack of freshwater, nutrients, and sediment input from the Mississippi River. The swamp is also subsiding due to natural causes and possibly due to man-made activities such as oil, gas, and groundwater withdrawals. The reduced biological productivity combined with the lack of sediment from the river has reduced soil formation (accretion) to a rate less than the subsidence. Consequently, the land surface is sinking.

Additional ecosystem problems are associated with past construction of logging trails, drainage channels, pipelines, other utilities, and roads through the swamp. These features disrupt the natural water flow and drainage patterns, and impact the biological productivity of the swamp. Short circuiting of the natural drainage patterns has created ponding in some areas which inhibits bald cypress and tupelo propagation.

With no connectivity to the Mississippi River, the Blind River watershed has been cut-off from periodic Mississippi River flows resulting in much lower availability of freshwater. A higher quantity of freshwater if properly distributed throughout the watershed, would help restore natural hydrologic conditions and allow for increased vegetative growth and nutrient uptake. These processes would result in water filtration prior to the Blind River discharging into Lake Maurepas. Without

freshwater reintroduction into the Blind River watershed, observed conditions of deterioration are expected to continue into the future.

The lack of freshwater input into the Blind River results in oxygen depletion because of low water flow and inadequate mixing that would otherwise flush out algae and other biological growth that result from agricultural runoff. Freshwater inputs will increase flow and reduce the excessive biological growth causing oxygen depletion in Blind River. Reintroduction of Mississippi River freshwater will also provide additional nutrients which can be used to increase vegetative productivity in the Blind River watershed, including bald cypress and tupelo trees. Without additional nutrients, vegetative growth will continue to be restricted. Restricted vegetative growth will also reduce soil building processes (vertical accretion) which are vital in reversing current trends of subsidence and degradation. Lack of seasonal flushing by the river can also impacts the swamp following storm surge events which force higher salinity water into the swamp. Without seasonal flushing to force higher salinity water out of the system, vegetation becomes stressed.

With subsidence, the lack of substrate accretion, and reduced organic productivity, this area is at high risk for the type of die-off that is already occurring in lake-rim areas in western Lake Pontchartrain. The combination of little to no tree regeneration and more frequent incidence of higher than tolerable salinities result in a higher risk of conversion to open water in the Maurepas Swamp. With the increasing water depth and year-round wet conditions in these areas, it is highly likely that swamp habitat will be converted to intermediate marsh and eventually open water.

The Blind River project is being planned to address the problem of severe deterioration of the Maurepas Swamp. Subsidence, storm surge, and saltwater intrusion, impoundment, lack of substrate accretion and tree regeneration and the absence of freshwater, sediments, and nutrients from the Mississippi River have all caused significant adverse impacts to the Maurepas Swamp and Blind River, resulting in swamp ecosystem degradation.

Specific problems identified by the PDT in the Study Area that need attention are:

- Tree mortality and decline in the overall health of the swamp
- Exposure to stochastic risks, particularly increased salinities
- Potential impacts to populations of indigenous fish and wildlife species
- Vulnerability of the area to hurricane-related damage and conversion to open water areas

2.3.2 Study Area Opportunities

Opportunities identified in the 2004 LCA report and further developed for the Blind River study area are listed below:

- Prevent future cypress swamp degradation and transition currently predicted to occur
- Restore the deltaic process impaired by levee and dredged material bank construction
- Enhance Blind River water quality by diverting freshwater from the Mississippi River to the Blind River
- Protect vital socioeconomic and public resources, such as the growing eco-tourism industry resident in the Maurepas Swamp and the Maurepas Wildlife Management Area.
- Enhance recreational opportunities in the Maurepas Swamp and Blind River

2.4 Planning Objectives

The project goal of the Small Diversion at Convent/Blind River Project is to reverse the trend of degradation in the southeastern portion of the Maurepas Swamp, to help achieve and sustain a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

The overall objective of the Small Diversion at Convent/Blind River Project was to reverse the trend of deterioration of southeast Maurepas Swamp and Blind River.

Specific Project Objectives

Objective 1: Promote water distribution in the swamp

Target for Objective 1: Increase the area of freshwater inundation for low to average flood events by 10 to 25 percent from existing conditions in order to increase swamp productivity and wetland assimilation. Increase nutrient input to the swamp in order to increase swamp productivity as measured by a 5 to 10 percent annual increase in the diameter at breast height (dbh) of baldcypress and tupelo from existing conditions, and increase wetland assimilation as measured by a 10 to 25 percent decrease in the average TN and TP in Blind River and a 5 to 10 percent increase in the average dissolved oxygen in Blind River from existing conditions.

Objective 2: Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise.

Target for Objective 2: Increasing swamp productivity, as described above and by increasing sediment input by up to 1,000 grams per square meter per year in order to decrease the annual subsidence rate 50 to 100 percent in the swamp.

Objective 3: Establish hydro period fluctuation in the swamp to improve baldcypress and tupelo productivity and their seeding germination and survival.

Target for Objective 3: Decreased flood duration in the swamp by 10 to 25 percent for high flood events, increasing the length of dry periods in the swamp (no standing water) by 10 to 25 percent, and by increasing the number of baldcypress and tupelo saplings per acre by 25 to 50 percent from existing conditions.

Objective 4: Improve fish and wildlife habitat in the swamp and in Blind River

Target for Objective 4: Increase the existing Wetland Value Assessment (WVA) Habitat Suitability Index (HSI) value in the swamp by 10 to 25 percent five years after project implementation and by a 5 to 10 percent increase in the average dissolved oxygen in Blind River from existing conditions.

2.5 Planning Constraints

Planning constraints in general include legal and policy constraints that are applicable to all Federal water resources planning efforts and project-specific constraints. The implementation and operation of the project will be constrained by the following identified project-specific constraints:

Institutional Constraints

- Minimize impact for the ability of the Mississippi River & Tributaries flood control project to continue to fulfill its authorized purposes.
- Minimize impact for the ability of authorized navigation projects to continue to fulfill their purpose.
- Do not violate limitations imposed by the designation of the Blind River as a scenic river by the LDWF. (e.g. do not include structures in the Blind River).
- The project will have to be constructed and operated so it would not conflict with the Wildlife Management Area in the study area.

Technical Constraints

- The operation of the project is constrained by the availability of freshwater, nutrients, and sediments from the Mississippi River. The Mississippi River annual high water (spring) and low water (summer) cycle will impact the hydraulic design of the diversion structure, transmission channel and swamp distribution system. The annual cycle could also reduce the ability to intercept a significant sediment load and to control the nutrient level received by the swamp.

- The operation of the project will be constrained by Lake Maurepas tail water conditions (i.e. The Lake Maurepas tailwater is of the higher than the water level in Maurepas Swamp).

Environmental Constraints

- Do not violate water quality standards as administered by the Louisiana regulatory agency.

2.6 Existing and Future Without Project Condition

The Mississippi River levee system has cut off the Maurepas Swamp (and Blind River) from the natural periodic, near annual flooding by the Mississippi River. This has resulted in a degradation/deterioration process and reduced biological productivity in the swamp due to lack of freshwater, nutrients, and sediment input from the Mississippi River. In addition, the swamp is subsiding due to natural causes and possibly due to man-made activities such as oil and gas, and groundwater withdrawals. The reduced biological productivity and lack of inorganic sediment has reduced soil build-up (accretion).

Additional ecosystem problems are associated with past construction of logging trails, drainage channels, pipelines and other utilities, and roads through the swamp. These facilities disrupt the natural flow and drainage patterns, and impact the biological productivity of the swamp. Short circuiting of the natural drainage patterns has created ponding in some areas which inhibits baldcypress and tupelo propagation.

Without freshwater, nutrient and sediment reintroduction into the Blind River watershed, observed conditions of deterioration are expected to continue into the future.

Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 21,400 acres (8,600 ha) of baldcypress-tupelo swamp projected to be lost over the 50-year period of analysis, including 3,300 acres (1,300 ha) of baldcypress-tupelo swamp that would become marsh in 20 to 30 years, 7,900 acres (3,200 ha) of baldcypress-tupelo swamp that would become marsh in 30 to 50 years, and 10,140 acres (4,100 ha) of baldcypress-tupelo swamp that would become marsh in greater than 50 years.

A more complete and detailed description of the existing and future without project conditions can be found in Sections 4 and 5 of this report.

The impacts of the Deepwater Horizon oil spill on coastal Louisiana are uncertain at this time. This spill could potentially adversely impact USACE water resources projects and studies within the Louisiana coastal area. Potential impacts could include factors such as changes to existing or baseline conditions, as well as changes to future-without and future with project conditions. The USACE will continue to

monitor and closely coordinate with other Federal and state resource agencies and local sponsors in determining how to best address any potential problems associated with the oil spill that may adversely impact USACE water resources development projects/studies. Supplemental planning and environmental documentation may be required as information becomes available.

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3.0 ALTERNATIVES

This chapter presents the alternative plan formulation process, alternative evaluation criteria, selected alternatives for detailed analysis and plan implementation. In order to ensure that sound decisions are made with respect to development of alternatives and plan selection, the plan formulation and selection process requires a systematic approach. This chapter documents this approach and ultimately the plan implementation and management.

3.1 Plan Formulation Rationale

The guidance for conducting Civil Works planning studies (ER 1105-2-100) requires the systematic formulation of alternative plans that contribute to the Federal objective. In order to ensure that sound decisions are made with respect to development of alternatives and ultimately plan selection, the plan formulation process requires a systematic and repeatable approach. The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) describe the USACE study process and requirements.

See http://www.usace.army.mil/CECW/PlanningCOP/Pages/planlib.aspx for additional information on the plan formulation rationale, ER 1105-2-100 and the Principles and Guidelines.

3.1.1 Plan Formulation Rational

This section presents an overview of the plan formulation process for the study. Specifically, management measures are presented, screening criteria are discussed, and preliminary and intermediate alternative arrays are presented along with the screening process to obtain the final array of alternatives. The preliminary alternative plans identified through the plan formulation process were first screened based on the diversion locations, flow rates, and the diversion method. The remaining alternatives were then evaluated, based on study area problems and opportunities, as well as study goals, objectives and constraints. As specified in ER 1105-2-100, four criteria were considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability further described below in Section 3.1.2. Additionally, ecosystem benefits, cost-effectiveness, and environmental impacts were considered to ensure that the Recommended Plan best meets the project objectives. This chapter also describes the TSP which was later confirmed as the Recommended Plan and its implementation requirements.

3.1.2 Plan Formulation Criteria

3.1.2.1 Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

3.1.2.2 Effectiveness

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

3.1.2.3 Efficiency

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

3.1.2.4 Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies.

3.1.3 Environmental Operating Principles

In 2002, the USACE reaffirmed its long-standing commitment to environmental conservation by formalizing a set of Environmental Operating Principles applicable to decision-making in all programs. The principles are consistent with NEPA; the Department of the Army's Environmental Strategy and its four pillars of prevention, compliance, restoration, and conservation; WRDA; and other environmental statutes that govern USACE activities. The Environmental Operating Principles inform the plan formulation process and are integrated into all proposed program and project management processes. The Environmental Operating Principles are:

- Strive to achieve environmental sustainability and recognize that an environment maintained in a healthy, diverse, and sustainable condition is necessary to support life;
- Recognize the interdependence of life and the physical environment, and proactively consider environmental consequences of USACE programs and act accordingly in all appropriate circumstances;
- Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another;
- Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that impact human health and welfare and the continued viability of natural systems;
- Seek ways and means to assess and mitigate cumulative impacts to the environment and bring systems approaches to the full life cycle of our processes and work;

- Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and impacts of our work; and

- Respect the views of individuals and groups interested in USACE activities, listen to them actively, and learn from their perspective in the search to find innovative win-win solutions to the Nation's problems that also protect and enhance the environment.

3.2 Management Measures

A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can either work alone or be combined with other management measures to form alternative plans. Management measures were developed to address study area problems and to capitalize upon study area opportunities. Management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, and the multidisciplinary, interagency project delivery team (PDT).

3.2.1 Development of Management Measures

To restore the swamp and promote its long-term perpetuation, conditions must be reestablished that contribute to survival of existing baldcypress and tupelo trees and allow at least periodic reproduction and recruitment of seedlings. Within the Maurepas Swamp and Blind River system, non-stagnant water, accretion of soil, nutrients, and freshening are all needed to achieve these goals. From the perspective of sustainable ecosystem management, it is believed that implementation of a freshwater reintroduction project of appropriate size into the Maurepas Swamp is essential for bringing the area back toward environmental sustainability. Implementation of the proposed diversion and flow reintroduction will greatly increase flow through the study area, which will provide periodic renewal of oxygen- and nutrient-rich waters to the swamps. In addition to the diversion alternatives one or more alternatives may be considered which redirects local hydrology to improve the hydro period of the swamp so as to accomplish the ecosystem restoration similar to the water obtained through diversion. In either case, it is important to understand that management measures for properly distributing and controlling the hydro period of the swamp are as important as those management measures designed to divert the water from the Mississippi River. It is also important to note that a proposed alternative would be operated such that reintroductions are reduced or stopped when climate and soil conditions are conducive to tree regeneration.

Based on a review and analysis of prior studies, initial site visits, and input received through the scoping process, an initial list of management measures was developed. Management measures identified are organized into structural and nonstructural measures and then into nine categories as described below. In

addition to the management measures identified below the no action alternative will be carried forward in the plan formulation process.

3.2.2 Description of Management Measures

3.2.2.1 Structural Management Measures (Features)

A feature is a "structural" element that requires construction or assembly on-site. A total of 75 features were developed for consideration in this study.

Water Management Modifications in Maurepas Swamp. Various water management measures have been identified to apply diverted freshwater to the swamp to beneficially allow transfer of freshwater and release of nutrients and sediments to the swamp. This category of management measures include the inflow of the water from a distribution system, sheet flow across the swamp which is facilitated by existing and proposed berm gaps, and then release and, if required, control of flow and final routing to the Blind River. Swamp building is slow because the sediment load and freshwater that historically created the swamps are no longer available. The flow rate will need to be controlled at both the inlets and outlets to the swamp in order to control the depth and detention time of the water directed into the benefit area. A fluctuating hydroperiod characterized by occasional dry periods is critical to the germination and sapling survival of baldcypress and tupelo because seedlings can only withstand complete submergence over short intervals, up to 45 days (Souther and Shaffer, 2000), and increased mortality occurs when seedlings are inundated for greater than two weeks (Brandt and Ewel. 1989). Such conditions will also enhance assimilation and improve the quality of water exchanged with the Blind River.

> **Flow controls.** Flow control devices, such as weirs, flow control gates, and control valves, with and without features such as rock filters can be used to manage flow rates and depth of flow. Additionally, the water will have to be transported across existing topographic and man-made features that interfere with the natural flow gradients, such as existing drainage courses and pipelines.
>
> **Crossings at existing drainage and infrastructure.** There are existing features in the swamp, such as pipelines and drainage courses, which will have to be crossed. Inverted siphons can be used to convey the water under the conflict. These structural management measures will be included in alternatives as needed.

Distribution System within the Maurepas Swamp. After being delivered to the fringes of the distribution area, the freshwater will have to be transported and distributed throughout the swamp to avoid short-circuiting into existing pipeline and drainage channels and into the Blind River. Alternate measures and approaches to distributing freshwater throughout the distribution area were identified, including conveyance channels (canals) and conveyance conduits.

Specific approaches and measures are discussed below. The distribution is a critical component in each alternative because there are more than a dozen distinct hydrologic units that are separated by existing channels. These channels have disconnected the hydrology of the individual drainage units, and therefore, the hydro period of each unit must be addressed individually.

St. James Parish drainage canals. There is an interconnected network of existing man-made drainage channels along the south and west boundary of the distribution area, with several outfall channels discharging to the Blind River. The drainage channels are maintained by St. James Parish. These channels are large, varying in size from approximately 30 to 100 feet (9 to 30 meters) wide at the top, and 6 to 12 feet (1.8 to 3.7 meters) deep.

- **Pumps.** Pump the freshwater from the drainage channels into the swamp. Multiple pump stations will be required along the drainage channels to accomplish complete distribution of the water into the swamp. Power would likely be electrical, and would require a significant extension of the electrical grid into the swamp. Solar power was considered, but the power requirement would be on the upper range to use solar cells. Maintaining a large solar grid is not practical for the remote locations due to limited vehicular access. Strategic location of the pumping stations and the use of low cost piping may be an economical option. The pump stations would need security (fences) and scheduled monitoring and maintenance.
- **Control structures.** The drainage channels could be isolated from the Blind River by blocking the downstream ends of the drainage channels. This would allow an increase in the water surface level, providing a hydraulic gradient to force the freshwater into the swamp. The channels currently serve drainage and flood control purposes and measures would be incorporated into the design to accommodate these needs. Active monitoring and management would be required for this management measure to avoid negative flood impacts to the developed areas adjacent to the swamp.

Separate Distribution System. This alternative keeps the freshwater conveyance separate from the existing drainage systems. The initial concept is to provide the distribution system, consisting of either canals or underground conduits, to transport the freshwater to the upstream ends of sub-basins (hydrologic units), where it will be released. The freshwater will then flow through the swamp uniformly and slowly drain to the existing natural and man-made drainage channels. Additional earthwork may be necessary to rectify man-made disturbances to the terrain and to direct overland flow to desired routes and locations as discussed under the section for Water Management in the swamp. Outlet controls may be required to prevent channelization and to control the hydro period in the swamp.

- **Earthen Trapezoidal Channels**. The first alternative for distribution into the swamp is to use earthen trapezoidal channels. The earthen channels will transition to inverted siphons of significant size to cross under infrastructure conflicts and avoid connection to existing drainage channels. The open channels will use raised berms to keep the water elevation in the channels sufficiently higher than the swamp's natural ground elevations to be able to distribute freshwater at numerous discharge points throughout the swamp. The channels will be excavated approximately 3 to 5 feet (0.9 to 1.5 meters) below grade on average with berm heights of approximately 4 to 8 feet (1.2 to 2.4 meters). This would allow sufficient water surface elevation for distribution. The channels will incorporate side slopes of 3:1 both inside and outside of the channels. Easement widths for the channels will be up to 200 feet (61 meters).
- **Concrete-lined Channels.** Concrete lining the channels will improve the hydraulic efficiency of the section, and allow design of smaller channels. However, concrete liners are expensive and normally used only where land is limited, or land acquisition is expensive.
- **Low-head Pressure System Conduits.** This alternative was developed to allow distribution of freshwater without disrupting wildlife migration paths. The conduits would be large pressure-rated pipes or concrete box culverts that would be installed slightly below grade. Inverted siphons will be required at the Blind River, drainage channels, and other obstacles.
- **Pressure Conduits.** This alternative is similar to the low head pressure system in that it uses underground conduits, but the head pressure is provided by a pumping system which allows for higher heads, higher velocities, and smaller diameter conduits. The operation of the system using flow release valves and discharge control gates is similar to the low-head system discussed above.
- **Crossings at Existing Channels and Infrastructure.** Obstacles to the distribution system in the swamp include the Blind River, man-made drainage channels, natural drainage courses, pipelines, abandoned railroad embankments, and other features. All of these can be crossed with inverted siphons; however, due to the costs, other options need to be reviewed. Smaller pipelines could be adjusted or relocated to eliminate the conflict. Other locations my allow flumes above the obstacle.

Transmission (Transfer) System. The transmission or transfer system includes the facilities necessary to transfer the freshwater from the diversion point and deliver it to the distribution system at the edge of the swamp. As with the distribution system in the swamp, alternate measures for the hydraulic conveyance of the freshwater into the swamp have been identified. These include a trapezoidal earthen channel, a trapezoidal concrete-lined channel, underground conduits, and existing natural and man-made drainage systems. The transfer system will be

designed for the range of flows expected to be diverted to the swamp including the maximum flow. Concerns of the system are: 1) maintaining an elevated water surface so there is sufficient head to allow distribution in the swamp; 2) sediment deposition which could reduce capacity of the system and require maintenance costs to dredge and transport; and 3) crossing existing infrastructure with an elevated conveyance system.

All transfer alignments cross two active roads and an active railroad. Temporary detour roadways will be required to maintain traffic flow while allowing open-cut construction across the existing roadways. A railroad spur will have to be constructed to maintain rail traffic during open-cut construction across the existing rail alignment.

Diversion System. The diversion for the Blind River project will be located on the east bank of the Mississippi River at a point with available alignments into the Maurepas Swamp.

Diversion Point. Seven potential diversion point locations were identified. In addition to a single diversion point, multiple diversion points were considered as the project progressed. The following potential alternative diversion point locations have been reviewed:

- Mile 152.5 – Belmont Crevasse
- Mile 159.0 – Convent
- Mile 161.8 – Nita Crevasse
- Mile 162.1 – Romeville
- Mile 162.5 – Proposed steel mill
- Mile 166.9 – South of the Bridge
- Mile 168.9 – North of the Bridge
- Dual Points – Miles 152.5 and 168.9
- Dual Points – Miles 161.8 and 168.9
- Dual Points – Miles 162.5 and 168.9

There are several factors that will be considered in selecting the diversion point in addition to the cost of transferring the water from the diversion point to the swamp. The location on the River may affect the way the diversion receives sediment due to the sediment load variations related to bends and depth in the Mississippi River. The upstream diversion points allow for greater areas of the swamp to be served without additional pumping.

Levee Crossing. Previous studies considered both siphons and gated culverts to divert the freshwater from the Mississippi River across the flood control levee on

the east bank of the river. In addition, a pumped diversion was also identified, which could be used to maintain a base diversion flow when the Mississippi River stage is too low for siphon operation for further consideration in the plan formulation process.

At the proposed diversion points, the batture is approximately 300 feet (90 meters) wide from the Mississippi River bank to the toe of the levee. The levee crossing measures will have to include provisions for batture crossing, namely:

- Intake Canal – An intake canal can be cut across the batture to nearly the levee, as with the Davis Pond diversion. The bar screens and inlets to the siphons, culverts, or pumps can be located near the base of the levee.
- Extended Siphon Pipes – The diversion siphon pipes could be extended across the batture to the Mississippi River bank, as with the Naomi siphon and other siphons. Bar screens would be located near the river. The siphon pipes would have to be extended down the river bank and protective bollards would be required for protection from navigation.
- Extended Culverts – The diversion culverts could be extended across the batture to the river bank. Bar screens would then be located near the river bank.

Water Quality Management. Water quality management measures are required for two broad purposes:

- Provide the desired water quality and parameters in the freshwater delivered to, and applied in the swamp.
- Protect and possibly improve the water quality in the streams and water bodies downstream of the targeted service area.

The swamp has specific needs to promote revitalized growth, including the freshwater, suspended sediment, and nutrients in the water. The Mississippi River water may have pollutants that can be assimilated in the swamp, such as mercury, pesticides, and nutrients.

After it discharges out of the swamp, diverted water can directly influence the Blind River (through and downstream of the swamp), existing man-made drainage channels in and adjacent to the swamp, Lake Maurepas, Lake Pontchartrain, and other waterbodies. Water quality management measures will be required to both avoid negative impacts in the downstream systems, and to improve water quality. Measures identified include intake elevation control, construction of a sedimentation basin to remove coarse sediments, treatment facilities such as wet detention treatment basins and wetland treatment to remove nutrients, aeration to add dissolved oxygen either mechanically or passively, and a salinity barrier in Blind River to prevent saltwater intrusion into the swamp.

Sediment Management. The existing ground surface in the swamp has had a net loss of elevation relative to sea level due to ground subsidence trends and sea level rise. Several measures were identified to introduce sediment directly into the swamp. Sediment can assist with vertical accretion and will be supplemented by vegetation and litter fall that will also add to the soil base in the swamp. Specific strategies to add sediments include:

Sediment diversions from the Mississippi River – The current Blind River program is based on a freshwater diversion from the Mississippi River, but takes advantage of the fine sediment load suspended in the water. The River has a significant sediment load that occurs primarily in the deeper parts of the River. A sediment diversion could be used, withdrawing water at deeper levels to intercept more sediment. This management measure includes the diversion, transfer to the swamp, application cells, sediment, and discharge facilities.

Disposal of construction spoils – During the construction phase, excess dirt may be generated. This spoil should stay in the swamp, and be used in a programmed manner to build ground elevations in carefully selected areas.

Imported dirt – Dirt could be imported into the swamp for land building.

Sediment Pumping from the River - If dredging occurs on the Mississippi River in the general area, disposal areas (cells) could be created in the swamp to build specific areas, and help with tree regeneration. Sediment could also be mined in this manner.

3.2.2.2 Non-Structural Management Measures (Activities)

An activity is defined as a "non-structural" action. An activity can be a one-time occurrence, or it can be a continuing or periodic occurrence. A total of 24 activities were developed for consideration in this study.

Water Quality Management.

Extended diversion duration to freshen Blind River. The anticipated diversion period will be in the spring. During the dry season, the Blind River becomes stagnant, due to lack of local rainfall and runoff. The diversion period could be extended into the dry seasons to freshen the Blind River and downstream water courses. This management measure would require a corresponding measure at the diversion point, such as pumps, to allow diversion during low water levels in the Mississippi River.

Extended diversion duration to counter salinity intrusion. The study area is subject to high levels of salinity backing up from the Gulf of Mexico due to stochastic events (Lane et al. 2003, Shaffer et al. 2003, Day et al. 2004).

These include extended area droughts and tropical storm surges. Providing capabilities for extended diversion periods, as discussed above, could assist in flushing out the system after the salinity intrusion events.

Vegetation Management. A major objective of the diversion project is to improve conditions for baldcypress and tupelo germination and saplings to promote regeneration. Measures can be taken to assist in regeneration and to protect against loss of seedlings and saplings, including:

- Plant seedlings in targeted areas. This could be a one-time planting, or routine plantings in different areas over the design life of the project;
- Identify areas and control the water levels to mimic the natural wet – dry cycle; and
- Control herbivore grazing of the seedlings with fences or other means.

Recreational Access and Enhancements. The swamp and the existing wildlife management area is a recreational destination for the general public. A diversion will enhance nutrient assimilation and thereby improve water quality and in turn fish and wildlife habitat which will enhance recreational activities. Opportunities may exist to improve access and care must be taken to maintain existing uses. For example, construction of open-channel water conveyance systems will limit the access across these waterways. Also, control structures within channels and canals will impede boat access. Potential management measures to improve recreational access include:

- Crossings at diversion and distribution channels, consisting of culverts of bridges
- Facilities to allow boat passage at weirs and control structures in the drainage canals
- Installation additional boat launches to allow full access to all of the existing and proposed channels
- Underground conduits to avoid loss of access and wildlife movement within the swamp
- Allowance for recreational access to use of construction and maintenance trails

Real Estate (purchase and preservation). Real estate acquisition will be required for all elements of the project, including the diversion structure, the transmission system, and all elements within the targeted project service area in the swamp. The following non-structural real estate management measures have been identified for further analysis in the plan formulation process:

Fee Ownership. Full property ownership rights (fee) can be obtained for the project facilities, especially where the land is currently in private ownership.

Project-specific Easements. Easements can be acquired from private and public agencies for the project, with project-specific purposes. Examples include easements with rights for the diversion facilities, the transmission system, drainage easements, and access easements. Flood inundation (or flowage) easements may be required, if the water surface elevations are increased in and adjacent to the study area.

Conservation Easements. Conservation easements are a proposed management measure to obtain the land rights to perform the swamp restoration activities. Conservation easements can also preserve and protect the improvements and benefits of the project.

Temporary Construction Easements. Temporary construction easements will be necessary to allow the construction of road detours and temporary railroad relocations while projects elements are being constructed.

Permits and Approvals. Some agencies will not grant easements, but will instead grant permits, or allow the facilities on the basis of written approvals. Other pre-project facilities are in place under easements or permits, and the facility owner, without land ownership rights, cannot issue easements. These entities can issue permits or approvals for the crossings. Examples of anticipated permits and approvals are the following:

- Pipelines - The project will cross pipeline easements, with the potential for conflicts between the project element and the pipeline. As a pre-project facility, the pipeline easement will typically have senior (prior) rights. As the pipeline is typically in an easement, and not a fee strip, the pipeline owner cannot grant an easement. The project facility will need a permit or approval from the pipeline owner.
- Roads – the highway and local roadway departments will typically issue permits for road crossings.
- Railroads – railroads have a permit system.

Inter-agency Agreements. Where one agency department owns the land, an inter-agency agreement may be sufficient to give the other department for the project.

3.2.3 Screening / Evaluation of Management Measures

Table 3-1 includes a complete list of management measures. The measures highlighted in red were screened-out and the measures highlighted in Blue were added during initial screening. The rationale for screening-out or adding specific management measures is provided in the last column of Table 3-1 and discussed in more detail below.

3.2.3.1 No Action

A specific "no action" management measure, NA-1, was added to form the basis of the "no action" alternative (also termed Alternative 0 later in this report).

3.2.3.2 Structural Measures (Features)

Water Management Measures in the swamp. Water management measures in the swamp are needed to direct the water in the swamp to ensure that the water introduced through diversion flows through the swamp are consistent with the ecosystem goals of the project. Fourteen management measures were identified under this category. Three measures were screened-out, one measure was added, and twelve were retained for further analysis. Management measure WM-14 was added to provide a path for water under Highway US-61 and Interstate 10 (I-10). Management measures WM-1, "no new control structures", was screened-out because it duplicates NA-1. WM-12, "water management in swamp – unit cost", and WM-13, "water management in swamp", were screened-out because they are not really management measures; they are combinations of measures already included under this category. The water management is critical to the success of this project. The management will include operational considerations for pulsing the hydrologic units or adjusting flow rates to achieve optimum water quality for discharge to the Blind River. Existing ponding and erosion issues will be addressed by the Water Management Measures in the swamp.

Table 3-1: Management Measure Screening[1],[2]

Project: Small Diversion at Convent/Blind River Project - Feasibility

Date: July 4, 2009

This spreadsheet contains a summary list of potential management measures and first level conceptual estimates of capital and O&M costs (May 2009)

Note red highlight indicates that this management measure was screened out and will not be pursued further.
Note blue highlight indicates that this management measure was added during screening

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
	NO ACTION						
NA	No Action						
	STRUCTURAL MANAGEMENT MEASURES						
WM	Water Management in the swamp					WM-1 thru WM-11 are flow control tools that will be used in various combinations and sizes to manage and control the flow of the freshwater onto, over, and out of the individual Hydrologic Units.	
	Flow controls						
WM-1	No new controls (No Action)						covered above under no action
WM-2a	Weirs - adjustable (US-61 and/or I-10)	30cfs	70,000	3,000	73,000	Assume 2 weirs to divert/release flow into each square mile of swamp service area.	
WM-2b	Weirs - fixed	30 cfs	35,000	0	35,000	Assume 2 weirs to divert/release flow into each	

[1] All costs are in October 2009 prices
[2] Present worth costs were computed using a discount rate of 4-3/8% over a 50-year period

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
						square mile of swamp service area.	
WM-3	Control valves/gates	10 cfs	25,000	0	25,000	Assume 6 canal gates (sluice gates) to divert/release flow into each square mile of swamp service area.	
WM-4	Filling and regarding	1 acre	4,120	0	4,120		
WM-5	Ditches and swales	30 cfs	117,000	0	117,000	15'x3' - 3 miles throughout study area	
WM-6	Earthen berms	10 cfs	289,291	0	289,291	10'x3' - 10 miles long throughout study area	
WM-7	Gap existing berms	10 cfs	15,000	0	15,000	Assume a 10' wide gap in an existing berm that is 4' high by 10' wide.	
WM-8	Rock flow control berms	10 cfs	1,062,917	0	1,062,917	10'x3' - 10 miles long throughout study area	
	Crossings at existing drainage and infrastructure						
WM-9	Inverted siphons under existing infrastructure	390 cfs	466,325	0	466,325	2 - 10'x8' - 200' long	
WM-10	Aqueduct over existing infrastructure	390 cfs	6,998,292	0	6,998,292	8.5' RCP Piping	
WM-11	Adjust existing infrastructure	390 cfs	684,000	0	684,000		
	Systematic controls						
WM-12	Water Management in Swamp - unit cost	1 square mile	600,000	200,000	800,000	Based on assumed water control needs. Can use some or all of the flow control tools in WM-1 thru WM-11	Not really a management measure, but some combination of the 12 management measures identified above.
WM-13	Water Management in swamp - total	1,000 cfs - 18.0 Sq. Mi	10,800,000	3,600,000	14,400,000	Based on assumed water control needs. Can use some or all of the flow control tools in WM-1 thru WM-11.	Not really a management measure, but some combination of the 12 management measures identified above.
WM-14	Culverts under US-61 and/or I-10	1,000 cfs - 18.0 Sq. Mi	1,100,000	0	1,100,000	4 - 10'x10' Box Culverts each 20 ft long	
DS	**Distribution System to the Hydrologic Units in the Swamp**						
	Use existing Parish drainage channels						
DS-1	No Modifications (No Action)	0 cfs	0	0	0		Covered above under no action
DS-2	Pump from channels	1,000 cfs - 18.0 Sq. Mi	13,000,000	8,200,000	21,200,000		

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
DS-3a	Control structures on canals with berm cuts (w/o Navigation)	1,000 cfs - 18.0 Sq. Mi.	7,400,000	1,200,000	8,600,000		
DS-3b	Control structures on canals with berm cuts (w/ Navigation)	1,000 cfs - 18.0 Sq. Mi.	9,000,000	1,200,000	10,200,000		
DS-3c	Control structures on channels (w/o Navigation) (Area 2)	390 cfs	2,900,000	1,200,000	4,100,000		
DS-3d	Roadway crossing culverts on Hwy. 61 (Area 3)	390 cfs	3,500,000	0	3,500,000	Serves 6.7 sq. mi. east of Hwy. 61, needs about 890 cfs.	
DS-3e	Pumps from Blind River (Area 3)	390 cfs	8,000,000	2,100,00	5,000,000	Serves 6.7 sq. mi. east of Hwy. 61, needs about 890 cfs.	
	Separate distribution system in Swamp						Mitigation required for impacts to swamp
DS-4	Earthen trapezoidal channels	1,000 cfs - 18.0 Sq. Mi.	48,900,000	1,700,000	50,600,000	Double the cost of earthen, based on Transfer Canal cost estimates.	
DS-5	Concrete-lined trapezoidal channels	1,000 cfs - 18.0 Sq. Mi.	97,800,000	1,700,000	99,500,000		Not cost effective relative to DS-4
DS-6	Gravity conduits	1,000 cfs - 18.0 Sq. Mi.	244,600,000	1,700,000	246,300,000		Not cost effective relative to DS-4
DS-7	Pressure conduits and pumpstation	1,000 cfs - 18.0 Sq. Mi.	272,100,000	1,700,000	273,800,000	DS-3 thru DS-10 will be sized for individual locations as data collection and design progresses	Not cost effective relative to DS-4
	Crossings at existing channels and infrastructure						
DS-8	Inverted siphons under existing infrastructure	390 cfs	466,325	0	466,325	2 - 10'x8' - 200' long	
DS-9	Aqueduct over existing infrastructure	390 cfs	6,998,292	0	6,998,292	8.5' RCP Piping	
DS-10	Adjust existing infrastructure	390 cfs	684,000	0	684,000		Adjustments for relocation, culverts under I-10 or US-61?
TS	**Transmission System From Diversion to Distribution System**						
	Use existing drainage courses						
TS-1	Existing drainage courses, minimal improvements	250 cfs	1,000,000	1,000,000	2,000,000	Assume minimal improvements to get minimal capacity.	
TS-2	Existing drainage courses, with improvements	1,000 cfs	16,300,000	2,000,000	18,300,000	Higher maintenance due to multiple uses	

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
	Alignments separate from existing drainage courses						
TS-3	Earthen trapezoidal channel with levees	1,000 cfs	16,300,000	1,000,000	17,300,000	The operating water surface in the canal will be above natural ground. Earthen channels are typically the lowest cost solution.	
TS-4	Concrete lined trapezoidal channel with levees	1,000 cfs	83,400,000	1,000,000	84,400,000	Concrete lined channels normally used where limited rights-of-way or where the right-of-way acquisition costs are very high.	Not as cost-effective relative to TS-3 and TS-6
TS-5	Conduits (underground pipes or culverts)	1,000 cfs	77,400,000	1,000,000	78,400,000	Underground conduits should be screened out on the basis of costs.	Not as cost-effective relative to TS-3 and TS-6
TS-6	Earthen trapezoidal channel at grade	1,000 cfs	16,100,000	1,000,000	17,100,000	The operating water surface will be below natural ground.	
	Crossings at infrastructure					Costs for the road and railroad crossings are included in TS-3 thru TS-6. Culverts are normally used for lower flow rates, bridges for high flow rates.	
TS-7	Culverts at LA 3125	1,000 cfs	1,500,000	0	1,500,000	O&M are in channel costs	
TS-8	Bridge at LA 3125	1,000 cfs	3,200,000	0	3,200,000	O&M are in channel costs	
TS-9	Inverted Siphons	1,000 cfs	1,400,000	0	1,400,000		Impractical to maintain due to issues with sediments
TS-10	Adjust existing infrastructure	1,000 cfs	2,400,000	0	2,400,000	O&M are in channel costs	Gas lines, fiber optics, power lines, water and sewer utilities, etc
TS-11	Culverts at Railroad	1,000 cfs	3,600,000		3,600,000	O&M are in channel costs	Railroad coordination required
TS-12	Bridges at Railroad	1,000 cfs	1,600,000	0	1,600,000	O&M are in channel costs	Considered impractical due to schedule delay for additional railroad coordination and permitting (will allow only two days for culverts vs. bridge with track closures)

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
TS-13	Culverts at elevated River Road	1,000 cfs				The River Road crossing cost is included in each of the Diversion Structure costs. The road is so close to the levee base that it needs to be dealt with as part of the diversion structure.	
DV	**Diversion System**						
	Diversion Point						
DV-1	No diversion (No Action)						covered above under no action
DV-2	Single diversion point					See DA-1 thru DA-7	Specific measures included under diversion alignments below
DV-3	Multiple diversion points					See DA-8 thru DA-11	Specific measures included under diversion alignments below
	Diversion Method					The siphon is the lowest cost option. However, may need a culvert or pumps if the diversion period is extended beyond spring.	
	Levee crossing						
DV-4	Culverts through the levee	1,000 cfs	19,700,000	1,300,000	21,000,000		
DV-5	Siphon over the levee	1,000 cfs	10,900,000	1,500,000	12,400,000		
DV-6	Pump over the levee	1,000 cfs	50,000,000	8,900,000	58,900,000	Siphon - 2/3 of time, pump - 1/3 of time	Allow pump station to pump both ways
DV-7	Combine siphon and pump	1,000 cfs	30,000,000	8,900,000	38,900,000	Siphon - 2/3 of time, pump - 1/3 of time	
	Batture crossing						Considered part of the levee crossing
DV-8	Canal	1,000 cfs		0		O&M are in diversion structure costs	Batture is short and pipes are needed
DV-9	Pipes (pressure conduits from pump station)	1,000 cfs		0		O&M are in diversion structure costs	Considered part of the levee crossing
DV-10	Culverts (w/and siphon)	1,000 cfs		0		O&M are in diversion structure costs	Considered part of the levee crossing
DV-11	Reverse Cycle Pumps			0			Suggested by VE Team for ecosystem restoration and incidental NED
	Diversion Alignment						Most alignments are similar in length, except Convent. The next screening step needs to consider

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
							performance in overall alternatives, and ease/difficulty of ROW acquisition.
DA-1	Mile 152.9 - Belmont Crevasse	1,000 cfs	15,100,000	900,000	17,000,000		May impact three historic mounds, least advantageous hydraulically
DA-2	Mile 159.0 - Convent	1,000 cfs	24,300,000	1,400,000	27,000,000		No information available yet, long route,
DA-3	Mile 161.8 - Nita Crevasse	1,000 cfs	16,300,000	1,000,000	17,300,000		No information available yet, but would impact healthy wetlands, and may impact the two plantations
DA-4	Mile 162.1 - Romeville	1,000 cfs	16,300,000	1,000,000	17,300,000		Impacts Helvetia and Wilton Plantations, shorter route, at the scour bend, low topographically, sugar cane fields adjacent to route allow for treatment as needed
DA-5	Mile 162.5 - Nucor - Future steel mill	1,000 cfs	16,500,000	1,000,000	17,500,000		No impacts to any known sites (Nucor is purchasing the Wilton and Helvetia Plantations), steel mill would develop the entire site - implications for the cultural resources?
DA-6	Mile 166.8 - South of Sunshine Bridge	1,000 cfs	16,300,000	1,000,000	17,300,000		Impacts Monroe Plantation, hydraulically allows access to a large benefit area
DA-7	Mile 168.9 - North of Sunshine Bridge	1,000 cfs	15,400,000	1,000,000	16,400,000		No known impacts, allows access hydraulically to the largest benefit area, not in St James Parish
DA-8	Mile 152.9/168.9 - Belmont & North of Sunshine Bridge	1,000 cfs	31,400,000	1,800,000	33,200,000	100 cfs each alignment. Cost to bottom two levees for low flow rates have minimum of base costs.	Belmont may impact three historic mounds, least advantageous hydraulically
DA-9	Mile 161.8/168.9 - Nita & North of Sunshine Bridge	1,000 cfs	31,700,000	1,800,000	33,500,000		
DA-10	Mile 152.9/162.1 - Belmont & Romeville	1,000 cfs	32,300,000	1,800,000	34,100,000		Belmont may impact three historic mounds, least advantageous hydraulically
DA-11	Mile 162.1/168.9 - Romeville & North of Sunshine Bridge	1,000 cfs	31,700,000	1,800,000	33,500,000		

88

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
WQ	**Water Quality Management**						
	Sediment Control						
WQ-1	Control intake elevation in Miss. River	1,000 cfs	4,200,000	2,000,000	6,200,000		
WQ-2	Sedimentation basin (remove coarse sediments)	1,000 cfs	18,000,000	3,400,000	21,400,000		
	Treatment facilities						
WQ-3	Wet detention treatment basins	5 acres	5,000,000	4,200,000	9,200,000	$1,000,000 per acre for construction costs	
WQ-4	Wetland treatment	12.5 acres	3,750,000	1,200,000	4,950,000	$300,000 per acre for construction costs	
	Aeration to add dissolved oxygen						
WQ-5	Mechanical aerators					Included in Treatment Facility Costs	
WQ-6	Passive aeration					Included in Treatment Facility Costs	
WQ-7	Salinity barrier in Blind River					Included in Treatment Facility Costs	Salinity not considered an issue in this part of the Blind River
SM	**Sediment Management**						
SM-1	Sediment diversion from Mississippi River	1,000 cfs	42,000,000	10,500,000	52,500,000		Impractical, too expensive, limited benefit and does not provide freshwater
SM-2	Reuse of excess construction materials beneficially					Considered in levee crossing	Ridge habitat, reuse material from levee cuts as available, already required, therefore not needed as a mgt measure
SM-3	Imported soil		79,000,000	0	79,000,000		Impractical, too expensive, limited benefit, and does not provide freshwater
SM-4	Sediment pumping from Miss. River (dredging or mining)	1,000 cfs	42,000,000	10,500,000	52,500,000		Impractical, too expensive, limited benefit, and does not provide freshwater
	NON-STRUCTURAL MANAGEMENT MEASURES						
WQ	**Water Quality Management**						
WQ-NA	No water quality management facilities (No Action)						covered above under no action

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
WQ-BAS	Extended diversion duration to freshen Blind River		0	250,000	250,000		Operational consideration, flush Blind River and also provide salinity benefits downstream (Lake Maurepas)
WQ-SAL	Extended diversion duration to counter salinity intrusions		0	250,000	250,000		Salinity not considered an issue in this part of the Blind River
SM	**Sediment Management**						
SM-NA	No sediment management facilities (No Action)						Covered above under no action
VM	**Vegetation Management**						
VM-1	Plant seedlings	1 acre	36,000	0	36,000		
VM-2	Salinity management	1/10 Year x Man Hour	6,000	3,200	9,200		This is a maintenance need
VM-2	Seed stock with soil	1 acre	36,000	0	36,000		Complement to structural sediment management measures that were screened-out
VM-3	Control hydroperiod and flooding levels		0	0	0		Not really a management measure
VM-4	Plant seedlings - Baldcypress - unit costs	1 acre	36,000	0	36,000		Part of WM-1 above
RA	**Recreational Access and Enhancements**						
RA-1	Consider recreational enhancements		315,000	10,000	325,000		Consider public safety, potential liability, and potential impacts to system operations from vandalism. Consider meandering transfer canal.
RA-1	Improved or additional access points		25,000	0	25,000		Part of management measure RA-1 above
RA-2	Improved access ways in swamp		15,000	0	15,000		Part of management measure RA-1 above
RA-3	Hiking and birding trails		85,000	0	85,000		Part of management measure RA-1 above
RA-4	Bird watching platform allowance		65,000	0	65,000		Part of management measure RA-1 above
RA-5	Boat ramps and access		125,000	0	125,000		Part of management measure RA-1 above. Limit boat access to dual use drainage network for water management and hydraulic needs

Code	Management Measure	Management Measure Size/Number	Capital Costs, $	Present Worth O&M Costs, $	Present Worth Life Cycle Costs, $	Comments	Additional Screening Comments
RE	**Real Estate (purchase and preservation)**						
RE-1	Real estate purchase	1,000 cfs	2,168,000	0	2,168,000		Required for the overall project - not a management measure
RE-2	Project specific easements	25% of Real Estate Purchase	539,500	0	539,500		Required for the overall project - not a management measure
RE-3	Conservation Easements	25% of Real Estate Purchase	539,500	0	539,500		
RE-4	Temporary construction easements	1,000 cfs	11,250	0	11,250		Required for the overall project - not a management measure
RE-5	Permits and approvals		62,609	0	62,609		Required for the overall project - not a management measure
RE-6	Inter-agency agreements	1,000 cfs	2,400,000	0	2,400,000		Required for the overall project - not a management measure
RE-7	Real estate purchase - Diversion Structure & Transfer Canal	1,000 cfs	45,000	0	45,000		Required for the overall project - not a management measure
RE-8	Temp. const. easements - Diversion Structure & Transfer Canal	25% of RE-7	11,250	0	11,250		Required for the overall project - not a management measure
M	**Monitoring**						
M-1	Monitoring	1,000 cfs	0	1,200,000	1,200,000	Includes equipment costs and operation/monitoring	Required for the overall program - not a management measure

Distribution System. A distribution system is needed to ensure that the water introduced into the swamp by diversion can be routed to the twenty-two (22) hydraulically distinct units within the study area. [Note: The twenty-two (22) units initially identified were later refined into twelve (12) larger units for ease of analysis.] Eleven management measures were initially identified under this category. Four measures were screened-out, three measures were added, and ten were retained for further analysis. DS-3c, DS-3d, and DS-3e were added to provide for the control of water into, through, and out of the swamp. DS-1, "no modifications", was screened-out because it duplicates NA-1, "no action", DS-5, "concrete-lined trapezoidal channel", DS-6, "gravity conduits", and DS-7, "pressure conduits and pump station", were screened out because they were not cost-effective when compared to DS-4, "earthen trapezoidal channels".

All of the remaining alternatives use the St. James Parish Drainage channels and any associated utility channels to distribute water to each of the distinct hydrologic units. The ability of the drainage canals to distribute water will be enhanced by installing water level control structures in the channels prior to their discharge to the Blind River. During diversions or during rainfall events the water surface elevation will be controlled to distribute water into the swamp either through or over control structures that will regulate the inflow to the swamp hydrologic units. Note that this method of distribution applies to the areas that are south and east of the Blind River. For areas north of the Blind River and the area between highway 61 and Interstate 10, the North Bridge diversion will need to be used to distribute flow to Highway 61 and under the highway to the north. Without this option the other feasible solutions would involve pumping water from the Blind River back into the swamp or diverting Conway Canal flows through the swamp for hydration of the hydrologic units.

Transmission System. A transmission system is needed to transfer the water removed from the Mississippi River to the swamp. Thirteen management measures were identified under this category. Four measures were screened-out and nine were retained for further analysis.TS-4, "concrete-lined trapezoidal channel with levees", and TS-5, "conduits (underground pipes or culverts)", were screened-out because they were not cost-effective when compared to TS-3, "earthen trapezoidal channel with levees", and TS-6, "earthen trapezoidal channel at grade". TS-9, "inverted siphons", was screened-out because it was considered impractical to maintain due to issues with sediments. TS-12, "bridge at railroad" was "screened-out" because it was considered impractical due to schedule delay for additional railroad coordination and permitting. In general, the railroads will only allow two days for track closures and this is insufficient for bridge construction[3].

[3] The railroad crossings will all require temporary relocations for construction. Culverts and a bridge may both be evaluated, but our analysis to date indicates that culverts will be more cost effective and bridges will not likely be acceptable to the railroads due to construction impacts.

Diversion System. A diversion system is needed to remove water from the Mississippi River and deliver it to the transmission system for transfer to the swamp. Ten management measures were initially identified under this category. Six measures were screened-out, one additional measure was added, and five were retained for further analysis. DV-11, "reverse cycle pumps", was added based on recommendations from the Value Engineering (VE) Team. The VE Team suggested that reverse cycle pumps would enhance ecosystem restoration potential and could result in incidental NED benefits. DV-1, "No diversion (No Action)", DV-2, "single diversion point", and DV-3, "multiple diversion points", were screened-out because they are covered by other management measures that will be carried forward for additional analysis. DV-8, "canals", DV-9, "pipes", and DV-10, "culverts", were screened-out because they are considered integral parts of management measures DV-4 through DV-7 and not separate management measures.

The diversion system selection is tied to the desired hydro period to meet the project objectives. The type of diversion will have flow delivery characteristics that are related to the stage in the Mississippi River. The design team is developing the relationships of flow to river stage for each of the diversion methods. Additional analysis of the hydraulics in the swamp will be required to determine the diversion systems which will match the flow requirements.

Diversion Location. A diversion location is needed to provide a construction footprint for the diversion system and transfer system. Seven individual diversion locations and four combinations of dual diversion location measures, for a total of 11, were initially identified. Five measures were screened-out and six were retained for further analysis. DA-1, "Mile 152.9 - Belmont crevasse", was screened out because it may impact three historic mounds and it is the least advantageous hydraulically. DA-2, "Mile 159.0 - Convent", was screened-out because it is a much longer route from the Mississippi River to the swamp without affording any benefit over other routes retained for further analysis. DA-6, "Mile 166.9 - South of the Highway 70 Bridge", was screened-out due to potential impacts to the historic Monroe Plantation and because it does not offer any advantages over DA-7, "Mile 168.9 - North of the Highway 70 Bridge". Alternatives DA-8, "Mile 152.9/168.9 - Belmont & North of The Highway 70 Bridge", and DA-10, "Mile 152.9/162.1 - Belmont & Romeville", were screened out because they include screened-out diversion locations.

Water Quality Management. Water quality management measures may be needed to: (1) provide the desired water quality and parameters in the freshwater delivered to, the swamp; and (2) to protect and possibly improve the water quality in the streams and waterbodies within and downstream of the study area. Seven management measures were identified under this category. One measure was screened-out and six were retained for further analysis. WQ-7, "salinity barrier in Blind River", was screened-out because salinity is not considered an issue in the Blind River within the study area.

Sediment Management. Sediment management measures were identified to directly introduce sediment into the swamp to assist with vertical accretion within the study area. Four management measures were identified under this category. All four measures were screened-out and none were retained for further analysis. SM-1, "sediment diversion from Mississippi River", SM-3, "imported soil", and SM-4, "Sediment pumping from the Mississippi River (dredging or mining)", were screened-out because they were considered impractical due to high cost and limited benefit and not because they are not consistent with the goal of delivering freshwater to the swamp. SM-2, "Reuse of excess construction materials beneficially", was screened-out because it is required and would be an integral component of any management measure included in the tentatively selected plan.

3.2.3.3 Non-Structural Management Measures (Activities)

Water Quality Management. Water quality management measures may be needed to: (1) provide the desired water quality and parameters in the freshwater delivered to, the swamp; and (2) to protect and improve the water quality in the streams and water bodies within and downstream of the study area. Three management measures were identified under this category. Two measures were screened-out and one was retained for further analysis. WQ-NA, "no water quality management facilities (No Action)", was screened-out because it is part of NA-1, "no action". WQ-SAL, "extended diversion duration to counter salinity intrusions", was screened out because although there are salinity issues in the portion of the Blind River outside of the study area, salinity is not an issue within the study area and does not warrant extended diversion durations.

Sediment Management. Sediment management measures were identified to directly introduce sediment into the swamp to assist with vertical accretion within the study area. One management measures was identified under this category. One measure was screened-out and none were retained for further analysis. SM-NA, "no sediment management facilities (No Action)", was screened-out because it is part of NA-1, "no action"

Vegetation Management. Vegetation management measures were identified to directly address the issue of regenerating vegetation within the swamp. Five management measures were identified under this category. Four measures were screened-out and one was retained for further analysis. WM-2, "*Salvinia* management", was screened-out because it is considered a maintenance item to be accomplished as needed as part of O&M and not a management measure. VM-3, "control hydro period and flooding levels", is considered to be an operational consideration and part of O&M and not a management measure. VM-4, "plant seedlings – Baldcypress – unit cost", was screened-out because it is part of VM-1, "plant seedlings". VM-1 was retained for further analysis on an as needed basis as part of the adaptive management plan.

Recreational Access and Enhancements. Recreation-related measures were identified to take advantage of the opportunity to improve recreation access and

enhance the recreational experience within the swamp consistent with public safety considerations and the overall objective of restoration of the degraded swamp ecosystem. Six management measures were identified under this category. Five measures were screened-out and one was retained for further analysis. RA-2, "improved or additional access points", RA-3, "improved access ways in swamp", RA-4, "hiking and hunting trails", "RA-5, "bird watching platforms-lookouts", and RA-6, "boat ramps and access", were screened-out because they are all part of RA-1, "consider recreational enhancements".

The study area supports a wide-range of recreational activities: fishing, hunting, camping, boating, sightseeing, hiking, bird watching, and trapping have all been common. Sporting game hunted in the project has historically included deer, raccoon, squirrel, rabbit, and waterfowl. Common sport fisheries pursued are largemouth bass, bream, perch, catfish, sac-a-lait (crappie), garfish, and choupique (bowfin). Additional recreational activities allowed annually in the WMA and in the study area are contract trapping for alligators and permit trapping for nutria. A project to reverse the trend of degradation in the swamp would have a positive influence on these recreational activities in the study area by improving the quality of the experience. The area is however fairly remote and accessible to only fairly skilled sportsmen. Accordingly no specific recreational facilities will be included in the final array of plans.

Real Estate. Eight management measures were identified under this category. All 8 real estate measures were screened-out because they are required for the overall project and will be developed for the TSP/Recommended Plan. There is not a need to consider them separately as management measures. RE-1, "real estate purchase", RE-2, "project-specific easements", RE-3, "conservation easements", RE-4, "temporary construction easements", RE-5, "permits and approvals", RE-6, "inter-agency agreements", RE-7, "real estate purchase," and RE-8, "temporary construction easements" are all project components that are integral to and included into a project as needed to make it a complete, functional project.

Monitoring. Monitoring was identified as a measure to verify the effectiveness of any plan selected for implementation. The measure (M-1) was screened-out at this level because it will be required for the overall project and will be developed for the TSP/Recommended Plan. There is not a need to consider monitoring separately as a management measure.

3.2.4 Management Measures not Carried Forward for Further Analysis

Management measured screened-out are discussed above and highlighted in pink on **Table 3-1.**

3.3 Preliminary Alternative Plans

3.3.1 Development of Preliminary Alternative Plans

As an initial step the screened list of management measures was evaluated based on benefits, constraints, and relative costs. The management measures were then grouped into an array of preliminary alternatives for further evaluation to achieve the overall project goals and objectives. The alternatives were formulated to consider different options for the diversion point, the diversion method, the transmission system, the distribution system, and the benefit area. The plans described below in terms of their constituent management measures. The plans are designated with a "P" for preliminary.

Early on in the study process a VE Study was conducted. A summary of the VE recommendations and how these recommendations were incorporated into the study is provided below. For additional information on the VE study see **Appendix H.**

During the week of May 18 to May 22, 2009 the VE team met to consider three LCA projects: Small Diversion at Convent Blind River, Amite River Diversion Canal Modification, and Medium Diversion at White Ditch. The results of the VE study were published in a report prepared by Value Management Strategies, Inc. dated June 2009.

For the Small Diversion at Convent Blind River the VE team identified three (3) items as key strategies to consider and three (3) additional items to also be considered. The key items and the follow up for how the item was covered in the final feasibility study development are included for each as follows.

- **CB-1 Provide method for transferring water under the railroad and US 61 to the north restoration area.**

  Response: The project Recommended Plan includes 4 culvert crossings under highway 61 which follows the recommendation of the VE study. During project development it was discovered that several existing openings are provided under the railroad so those culverts for connectivity are not required. The culverts provide the connectivity to the more northerly hydrologic units.

- **CB-2 Use the Blind River to distribute fresh water to the project area.**

  Response: The Blind River does divide the project area and receives all of the water diverted through the swamp. As the project was further developed, the concept of using additional berm gaps to distribute flow made the use of the Blind River for distribution a lower priority. In addition, further research on the Blind River designation as a scenic river in the State of Louisiana, greatly restricted any features that could be placed in the River. The advanced hydraulic calculations showed good distribution through the use of control

structures and berm gaps, so using the River for distribution was no longer required.

CB-3 Consider reversible pumping of proposed river siphons to facilitate low river stage diversion flow

Response: The project Recommended Plan does not use siphons. When the final hydraulics and cost estimates were completed the least costly diversion method was gated culverts. These culverts are located so that there will be flow diverted for most of the year with the exception of extreme low river stages.

The additional three items are as follows with how each item was treated in the final feasibility study:

CB-4 Construct "environmentally friendly" conveyance channels

Response: The transmission canal is designed with shallow 5:1 side slopes and the right of way was widened from 400 feet to 500 feet to allow a more environmentally friendly foot print which could be part of a recreation feature.

CB- 5 Define the hydrologic connectivity of project areas

Response: The later modeling in the study determined the amount of flow from the diversion, through the berm gaps and into the hydrologic units in the study area. These flows were also used in the WVA to determine the environmental benefits derived from the diverted flows.

CB-6 Obtain Total Maximum Daily Flow (TMDL) waiver for diversion into Blind River

Response: The diversion will force flow through the swamp area utilizing the berm gaps and the control structures. The swamp will have sufficient vegetation that the nutrients will be utilized and the flow into the Blind River should be relatively clean from both nutrients and sediment. It is anticipated the Blind River will environmentally benefit from the greater flows from the diversion.

The overall project has an extensive monitoring plan and includes costs for adaptive management to assure that the overall water quality in the Blind River is not degraded. The State agencies will work together to monitor the diversion operation to assist with the overall environmental improvement of the Blind River.

In addition to the six (6) Blind River specific recommendations there were ten (10) General and Plan Formulation recommendations. The following is a list of

those recommendations and how they were addressed specifically in the Blind River report.

G-1 Develop plan strategies that account for rise in sea level

Response: This project prepared a complete analysis of sea level rise scenarios and the results are made part of the report.

G-2 Provide clarification and address the WRDA 2007 regarding specified authorized funding limits and the extent of planning development of LCA projects

Response: The Blind River project reviewed the WRDA language and the proposed Recommended Plan is within the WRDA funding limits.

G-3 Define plan alternatives that can be optimized within project authorization

Response: The Blind River project is within the authorization and was optimized at a flow of 3000 cubic feet per second diversion rate.

G-4 Amend project authorizations to include additional federal funding for "first phase" adaptive management measures.

Response: The Blind River cost estimate includes the costs for monitoring and adaptive management for the first 10 years of the project.

G-5 Establish permanent trust fund for project maintainability

Response: The project is proposed to be maintained by the State of Louisiana. The State will have adequate funds for long term maintenance and operation.

G-6 Identify impacts of multiple diversion structures on the Mississippi River and fresh water and sediment requirement of project areas

Response: The State of Louisiana and the Corps of Engineers are conducting parallel studies on the Mississippi River and the Lake Maurepas areas to determine the long term effects of the combination of diversions and other coastal restoration efforts.

3.3.2 Description of Preliminary Alternative Plans

The 12 preliminary plans, plus the no action are described below:

Alternative P-0 - No Action Alternative – This alternative is the future expected without any project. This future without condition is the basis for comparison with project alternatives.

The No Action Alternative will continue the following conditions which will lead to eventual degradation of the swamp area: Local drainage occurs in episodic events and sends large quantities of water to the Blind River and the swamp. This local drainage can contain significant pollutants in terms of sediment, nutrients, pesticides and herbicides. Without the natural assimilation capacity of the swamp, these pollutants can cause stresses on the aquatic life in the Blind River.

Without adequate flow of water through the swamp and with issues relating to subsidence from relative sea level rise and ponding and drainage from pipeline channels, the hydroperiod of the swamp is not conducive to the health and regeneration of several natural tree species, including baldcypress and water tupelo. The swamp has been traversed with many man-made features including railroad embankments and channels which have disrupted the normally anticipated hydroperiod of the swamp and limited the vertical accretion that would occur from prolific vegetation growth from the Mississippi River nutrient input.

The result of the No Action Alternative is failure to meet the objectives of the project.

Alternative P-1 – Water management enhancements in the swamp and redirection of local hydrology. The benefit area would be up to 34 square miles. This would include potential regrading, berm cuts, and other flow improvement enhancements to increase distribution of flow from existing rainfall into and through the Blind River wetlands without a Mississippi River diversion. As an example, there are more than 40 miles of existing berms and spoil banks throughout the wetland that would be potentially gapped (cut) at regular intervals to allow a more distributed flow pattern in the wetland. There are also existing gaps that have not been maintained and need improvement. This alternative could also include 5 to 10 culverts under Highway 61 to reconnect the hydrology of the swamp across that man-made feature. To redirect surface drainage into the swamp variable control structures at the two St. James Parish outfall channels or at either US-61, I-10 or both can be used to manage water surface elevations to support regulation of the hydroperiod in the swamp. This alternative could potentially help the water quality of the Blind River by changing the runoff patterns into the River and develop a more constant water flow by using the swamp as both a water quality and quantity buffer.

The principal features of this alternative would raise the water surface elevation of the St. James Parish drainage system during normal rainfall events to direct local

drainage through the swamp for additional detention and treatment. The additional advantage is the short duration rain events that currently drain to the Blind River unimpeded would be detained in the swamp where the outflow would result in a higher quality and more constant flow. Combining this feature with flow distribution in the swamp would enhance the ability to adjust the hydroperiod to improve baldcypress and tupelo germination and sapling survival and contribute to a higher rate of vertical accretion in the swamp.

The ability to direct water across Highway 61 may be limited due to the hydraulic gradient, but modeling of the system will determine the feasibility to hydrate the areas north of Highway 61 and the area north of the Blind River and south of Highway 61.

Alternative P-2 – Diversion at Romeville by a Siphon. The benefit area would be up to 18 square miles. Water management in the swamp would be similar to Alternative P-1. The diversion from the Mississippi River would be a multi-barrel siphon with a capacity of up to 2,500 cfs. More barrels can be added to increase the flow to 5,000 cfs, but an analysis is currently underway to determine if culverts may be more cost effective once a higher rate of flow is required.

The transmission system would be primarily an earthen channel and modified existing drainage channels from River Road (LA44) to LA 3125 and to the St. James Parish drainage canal system. River Road would be elevated over the transmission system siphon connection. Culverts would be used at the Canadian Northern Railroad and LA 3125 crossings.

The distribution system would consist of up to six variable control weirs without navigation access at the ends of the existing drainage system to allow dual use for diverted flow distribution during dry weather while maintaining flood control level of service during wet weather events. The elevated water surface in the drainage channels created by the variable control weirs would allow the use of either fixed or variable flow weirs to distribute flow into the swamp along the periphery of the Parish drainage canals that border the swamp.

Alternative P-3 – Diversion North of the Highway 70 Bridge by a Siphon. The benefit area would be up to 34 square miles. Water management enhancements in the swamp would be similar to Alternative P-1. The transmission system would be earthen channels and modified drainage channels from River Road (LA 44) to LA 3125. This system would be extended to Highway 61 so flow can be distributed along Highway 61 and then across Highway 61 to the north and to the area bounded on the north by Interstate 10. River Road would be elevated over the transmission and siphon connection. Culverts would be used at the Canadian Northern Railroad and LA 3125 crossings. The distribution system would consist of 5 to 10 variable control weirs without navigation access at the ends of the St. James Parish existing drainage system to allow dual use for diverted flow distribution while maintaining flood control level of service. In addition a control structure would be used on the drainage system on the south side of Highway 61. This

channel would be hydraulically connected to the area north of Highway 61 by culverts beneath the roadway. Additional control structures may be required on the north side of Highway 61 to be sure flows are distributed north prior to exiting to the Blind River to the east. Depending on the culvert configuration it may be necessary to slightly elevate the current highway to allow for sufficient clearance for culvert installation.

Alternative P-4 – Diversion at Romeville by a Siphon plus Inline Treatment. This alternative is the same as Alternative P-2 with a wet detention treatment system located along the transmission system for sediment collection and treatment of excess nitrogen and other parameters. The in line treatment option will require additional right-of-way to allow for the additional volume for the detention time to be sufficient for sediment, metals, and nutrient assimilation. The standard width is estimated at 400 to 500 feet for a trapezoidal channel. With a meandering stream and small lakes to increase detention time, the right-of-way requirement could be 1000 to 1500 feet. The additional area could also allow for increased recreational benefits at minimal cost to the project

Alternative P-5 – Diversion North of the Highway 70 Bridge by a Siphon plus Inline Treatment. This alternative is the same as Alternative P-3 with a wet detention treatment system located along the transmission system for sediment collection and treatment of excess nitrogen and other parameters.

Alternative P-6 – Diversion at Romeville by a Gated Culvert System plus Inline Treatment. This alternative is the same as Alternative P-4 with a gated culvert system through the levee instead of the siphon. The gated culvert system is more cost effective for larger flows and for operation during longer periods of low Mississippi River stage.

The culvert system has several advantages over the siphon system. It is less operational concern since the adjustment of the flow is simplified by closing or opening a gate. The siphon system involves the use of electrical and mechanical vacuum pumps which must be used each time the siphon is restarted. The culverts would be able to operate over a wider operating river stage range. This would allow for longer periods of diversion when the River is low compared to the siphon which must have a minimum river stage to operate.

Alternative P-7 – Diversion North of the Highway 70 Bridge by a Gated Culvert System plus Inline Treatment. This alternative is the same as Alternative P-5 with a gated culvert system through the levee instead of the siphon. The gated culvert system is more cost effective for larger flows and for operation during longer periods of low Mississippi River stage.

Alternative P-8 – Diversion at Romeville by a Pumped Diversion System plus Inline Treatment. This alternative is the same as Alternatives P-4 and P-6 with a pumped system over the levee instead of the siphon or the culverts. The pumped system may have an advantage if designed with an option to pump storm

water from the back side of the levee into the River during flood events to assist with local drainage issues.

Alternative P-9 – Diversion North of the Highway 70 Bridge by a Pumped Diversion System plus Inline Treatment. This alternative is the same as Alternatives P-5 and P-7 with a pumped system over the levee instead of the siphon or the culverts. The pumped system may have an advantage if designed with an option to pump storm water from the back side of the levee into the River during flood events to assist with local drainage issues.

Alternative P-10 – Diversion at Nita Crevasse by a Siphon plus Inline Treatment. This alternative is the same as Alternative P-4 except the diversion location is downstream of Romeville by about 1500 feet in an area that was historically know as the Nita Crevasse. This area is slightly lower in elevation than Romeville, but there are two industrial complexes that will make the routing more difficult.

Alternative P-11 – Diversion at Nucor Steel Mill Site by a Siphon plus Inline Treatment. This alternative is the same as Alternative P-4 with a siphon over the levee at the proposed Nucor Steel Mill site. This option has the same characteristics as Romeville, but the cost of the channel can be shared with Nucor as an environmental enhancement of their property and a source of water supply.

Alternative P-12 – Diversions at Romeville and North of the Highway 70 Bridge by a Siphon plus Inline Treatment. This alternative is the same as Alternative P-4 with siphons over the levee at both Romeville and North of the Highway 70 Bridge. This alternative has the advantage of keeping the size of each siphon small while still having the location and volume to serve the whole 34 square-mile (88 square-kilometer) distribution area.

3.3.3 Screening / Evaluation of Preliminary Alternative Plans

The preliminary array of twelve alternatives plus the no action were developed as the reasonable range of alternatives to address the specific problems, needs and objectives of the study as described in Chapter 2. The alternative in the preliminary array underwent an initial screening process to develop the intermediate array of alternatives. The screening process analyzed the specific components or features that were included in the alternatives. Diversion Location, Diversion Flow Rates and Diversion Methods were analyzed.

Analysis of Diversion Locations. An initial evaluation of the preliminary alternatives determined that diversion location is an important factor in the benefits associated with each alternative. In total 11 diversion locations were identified through the plan formulation process and were considered for the diversion, five in the vicinity of Romeville and six in the vicinity of the Sunshine Bridge. The siting of these potential diversion locations are shown in **Figure 3-1** below. Preliminary conclusions are that a diversion in the vicinity of Romeville is a

hydraulically efficient[4] location from which to provide freshwater, nutrients, and sediments to that portion of the benefit area south of the Blind River; a diversion in the vicinity of the Sunshine Bridge is a hydraulically efficient location from which to provide freshwater, nutrients, and sediments to that portion of the benefit area north of the Blind River; and that diversions at both locations are hydraulically efficient locations from which to provide freshwater, nutrients, and sediments to the entire benefit area. The screening rationale associated with each of these diversion locations is provided in **Table 3-2** below. The Romeville and the South Bridge alignments were retained for further analysis along with the possibility of a two diversion alternative with diversions at both locations.

Analysis of Diversion Flow Rates. Two separate analyses were conducted to analyze various sizes for a diversion into southeastern Maurepas Swamp. The diversion at Convent/Blind River was authorized by WRDA 2007 as a small diversion. Small diversions are for a maximum diversion rate of 5,000 cubic feet per second (cfs). As part of the planning process public input was taken and several members of the public expressed interest in higher diversion rates of as much as 25,000 cfs. This input was included for consideration in the intermediate array of alternatives.

As a first step in this process to refine and screen the diversion flow rates, higher diversion rates of 10,000 and 25,000 cfs were analyzed. The results of this analysis concluded that:

- The St. James drainage canals have limited capacity with 2,000 cfs about the maximum flow they can accommodate without overtopping into the swamp. If we accept the overtopping as a desired effect, the Blind River will have a capacity that is only about 5,000 cfs (the current authorized maximum flow rate). Flows in excess of 5,000 cfs will be difficult to control without major modifications to the drainage channels and possible alterations to the Blind River.
- The Mississippi River nutrient loading at these flow rates would exceed the assimilation capacity of the swamp by factors of 20 to 50. These excessive loading rates would have the effect of passing high levels of nutrients to the Blind River and Lake Maurepas.
- Flow rates higher than the 5,000 cfs currently authorized for this study would not improve the objectives of the study and may cause additional problems with soil erosion and nutrient loading downstream of the distribution area. One of the problems identified is the inability of the swamp to properly drain so as to assist in tree propagation. Higher flows

[4] The term "hydraulically efficient" means that the level of the river and the distance between the river and the swamp are matched so the diversion water can be delivered with a high starting head (upstream on the Mississippi) and minimize friction loses (shorten the transmission distance) to the swamp so the application water head is as high as possible. An explanation has been added to the report.

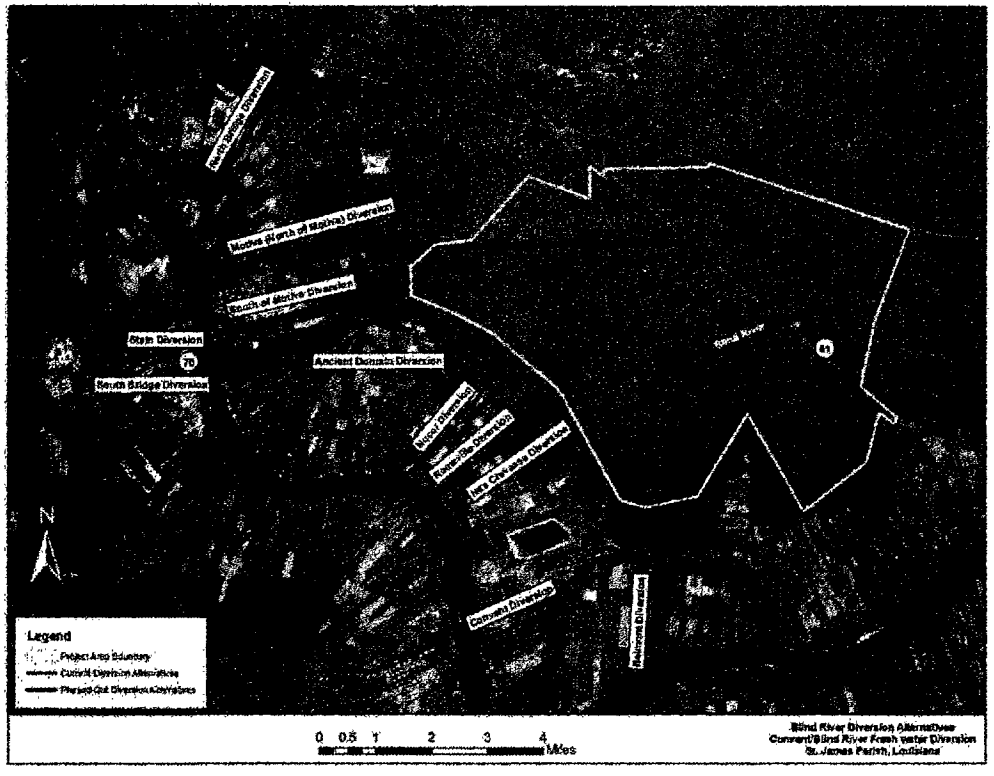


Figure 3-1: Location of screened diversion routes.

Table 3-2: Diversion Locations

Vicinity of Romeville	
Belmont	Screened out. May impact three historic mounds, least advantageous hydraulically
Convent	Screened out. Long route. More costly than Romeville without additional advantage
Nita Crevasse	Screened out. Higher wetland impacts than Romeville with essentially the same output. This site also has some difficult routing issues through existing industrial facilities
Romeville	Retained for further analysis
Nucor	Screened out. Would seriously interfere with Nucor's future development of the property, does not serve the total 35-mile study area and for the area it can serve it is at least as expensive as the Romeville alignment and does not provide any greater benefit.
Vicinity of Sunshine Bridge	
Ancient Domain	Screened out. Grain elevator currently under construction at this location
South Bridge	Retained for further analysis
Stein	Screened out. Impacts a barge fleeting area and alignment is too narrow
South of Motiva	There are significant HTRW problems associated with the Motiva Refinery property
Motiva	Screened out. Significant HTRW problems associated with the Motiva Refinery property
North Bridge	Screened out. Discharges to Conway canal and the Conway Canal has insufficient capacity to receive discharged flows and would be very expensive due to long transmission channel and need to cross I-10 compared to the South Bridge alignment

- would make it more difficult to adjust hydroperiods to allow for greater tree propagation.

Based on this analysis, alternatives greater than 5,000 cfs were eliminated from further consideration. See **Appendix L** for further description.

As a second step in this process to refine and screen the diversion flow rates, flow rates less than 5,000 cfs were modeled and analyzed to determine how the hydroperiod would respond to the different diversion flow rates. The amount of flow diverted (re-introduced) to the swamp depends on the amount of flow, sediments,

and nutrients needed for swamp restoration and improvement, with consideration of the extensive amount of backflow from Lake Maurepas.

Diversion capacity was incrementally increased in successive simulation analyses (from 1,000 cfs to 5,000 cfs capacities). Water was diverted only when the average water level in the swamp was below the Lake level. Diversions were discontinued when the average water level in the swamp exceeded the Lake level, or when the lake dropped below 0.5-feet NAVD (to accommodate potential dry-out conditions).

In addition to tracking the total volume of diverted water, five other hydrologic metrics were tracked over the 16-year analysis period for comparative purposes:

- Average annual freshwater inflow (includes runoff and diversions)
- Frequency at which the average swamp water level exceeds Lake Maurepas water level (to help prevent backflow)
- Frequency at or above certain water depths in the swamp
- Long-term average depth of water in the swamp
- Annual average Total Suspended Solids (TSS) into the swamp (using data from the USGS NWISWeb database, Station 07374000: Mississippi River at Baton Rouge).

Figure 3-2 illustrates the results of the sensitivity analysis, as the diversion capacity was increased from 1,000 cfs to 5,000 cfs. The graphs illustrate two important findings. First, no substantial change in the response of the system to the introduction of diversions occurs until a capacity of at least 1,000 cfs is provided. At this "point of departure," many of the hydrologic metrics outlined above begin to respond dramatically to increased diversion capacity. Second, once diversion capacity exceeds 3,000 cfs, the hydrologic metrics for those areas of the swamp that are most substantially affected generally become much less sensitive to increased diversion capacity. That is, above 3,000 cfs, there would be diminishing returns on further increases in capacity with respect to hydrologic sensitivity. This is due in part to the fact that additional capacity may not always be needed to help keep the swamp above the lake elevation. These findings were confirmed (and refined) with the HEC-RAS hydraulic model, which suggested that a minimum capacity of 1,500 cfs would be required to substantively reduce backflow potential, and that 3,000 – 4,000 cfs would be required to practically guard against it completely (using 2003 conditions). Some of the areas that receive little to no impact do begin to show modest hydrologic changes above 3,000 cfs, but they are generally small with respect to the much more substantial effects in the most heavily impacted areas. Impacts to these areas were examined in greater detail with subsequent modeling once the screening of the most effective flow range was accomplished.

It was not the goal of the screening-level analysis to completely characterize the hydrologic impacts to each area of the study area with precision. Rather, the goal was to identify the range of diversion capacities that would be successful in

achieving the overall project objective to reverse the trend of deterioration of southeast Maurepas Swamp and Blind River. For these reasons, a minimum diversion capacity of 1,500 cfs was established for the alternatives, and a maximum capacity of 3,000 cfs was established.

The 16 year period was used because that was the limit of available historic data that was considered reliable. The primary concern with the diversion is how it reacts within the swamp which is the primary objective of the project. The swamp has the ability to receive a limited amount of water and nutrients based on the statistical characteristics o f the Mississippi River water. In addition there needs to be a drying period in the swamp for the germination a propagation of new bald cypress trees. There are also hydraulic restrictions in the existing drainage canals which would have been more detrimental to the swamp to be able to transmit higher volumes. The 3,000 cfs is a nominal flow and there may be opportunities using the current configuration to deliver much more water, if it is determined to be needed in the future. In many cases the flow will be lowered to allow the swamp to drain but still maintain a flow in the Blind River. The project as currently configured has a great deal of operational flexibility.

The results of the sensitivity analysis were confirmed for each of the alternative locations, and the same trends were observed. That is, whether the diversion site was Romeville, South Bridge, or a division of the total capacity between the two, the response patterns of the hydrologic parameters was very similar. Additionally, all three alternatives for the diversion location yielded substantive hydrologic effects.

Analysis of Diversion Methods.

Diversion by siphons over the Mississippi River Levee and gated culverts through the Mississippi River Levee were considered. An analysis of construction costs indicates that siphons are more cost effective for flow rates below 1,000 cfs and gated culvert systems are more cost effective for flow rates greater than 1,000 cfs. Accordingly, siphons are used as the diversion method for flows less than 1,000 cfs and gated culvert systems are used for flows greater than 2,000 cfs in formulating a final array of alternatives. This information is presented graphically in **Figure 3-3** below.

Preliminary Alternative Plans Screened due to Analysis of Diversion Methods and Effectiveness and Completeness Considerations

Alternative P-1 – Water management enhancements in the swamp and redirection of local hydrology – This alternative was found to improve swamp drainage during periods of low flow, but to increase drainage times during high flow periods when the water level in the swamp was lower than the water level in Lake Maurepas. Accordingly this alternative was eliminated as a standalone alternative, but incorporated into each diversion alternative as defined below.

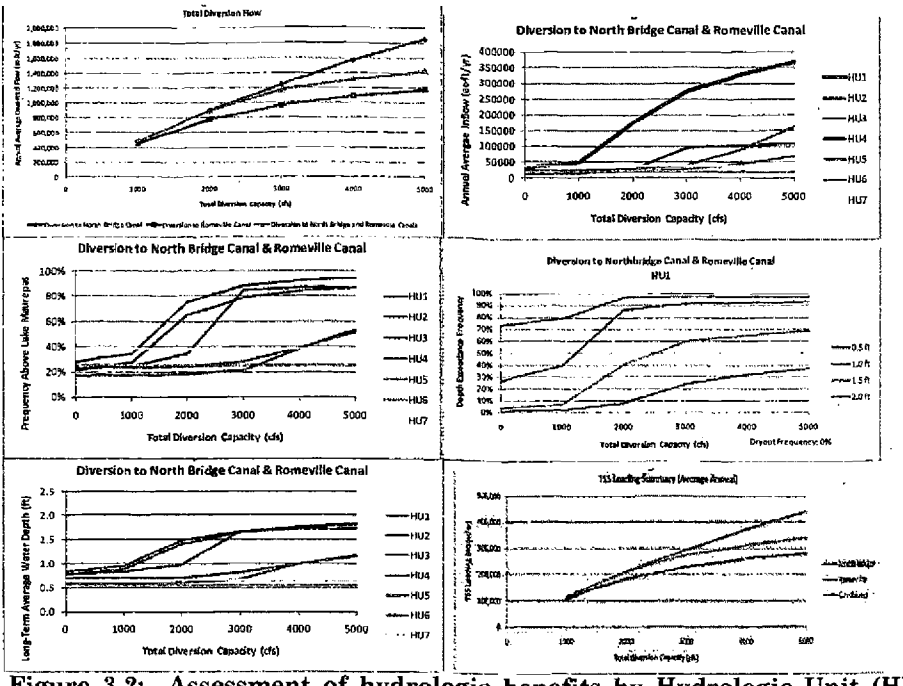


Figure 3-2: Assessment of hydrologic benefits by Hydrologic Unit (HU) received in relation to flow rate[5]

Alternative P-2 – Diversion at Romeville by a Siphon – Alternative P-2 was eliminated from further consideration because it does not include provisions for sediment collection and treatment of excess nitrogen and other parameters. Water quality and sediment management measures may be needed for proper function of the project consistent with applicable water quality requirements. Positive control of the heavy sediment load will reduce the long term maintenance costs for the project by reducing the requirements for dredging.

Alternative P-3 – Diversion North of the Highway 70 Bridge by a Siphon – Alternative P-3 was eliminated from further consideration because it does not include provisions for sediment collection and treatment of excess nitrogen and other parameters. Water quality and sediment management measures may be needed for proper function of the project consistent with applicable water quality

[5] Results represent the introduction of water at both locations simultaneously, with the capacity divided equally between the two. Trends are similar with respect to individual locations for water introduction to the swamp.

requirements. Positive control of the heavy sediment load will reduce the long term maintenance costs for the project by reducing the requirements for dredging.

Alternative P-8 – Diversion at Romeville by a Pumped Diversion System plus Inline Treatment – Alternative P-8 was eliminated because the purpose of a pump system is to allow pumping during periods of low flow in the Mississippi River. Historically when the swamp flooded it was when the Mississippi River was high and overflowed its banks. Additionally, pumped diversion systems have a very high operating cost and the gated culverts provide essential the same flows without the added maintenance and operating costs. Accordingly, pumping is eliminated because it is not considered necessary for the restoration goal for this project.

Alternative P-9 – Diversion North of the Highway 70 Bridge by a Pumped Diversion System plus Inline Treatment – Alternative P-9 was eliminated because the purpose of a pump system is to allow pumping during periods of low flow in the Mississippi River. Historically when the swamp flooded it was when the River was high and overflowed its banks. Additionally, pumped diversion systems have a very high operating cost and the gated culverts provide essential the same flows without the added maintenance and operating costs. Accordingly, pumping is eliminated because it is not considered necessary for the restoration goal for this project.

Alternative P-10 – Diversion at Nita Crevasse by a Siphon plus Inline Treatment – Alternative P-10 was eliminated because this alternative has higher wetland impacts that Alternative P-4 with essentially the same output. This site also has some difficult routing issues through existing industrial facilities.

Alternative P-11 – Diversion at Nucor Steel Mill Site by a Siphon plus Inline Treatment – Alternative P-11 was eliminated because this alternative would seriously interfere with Nucor's future development of the property, does not serve the total 34 square-mile benefit area, and, for the area it can serve, it is at least as expensive as the Romeville alignment and does not provide any greater benefit.

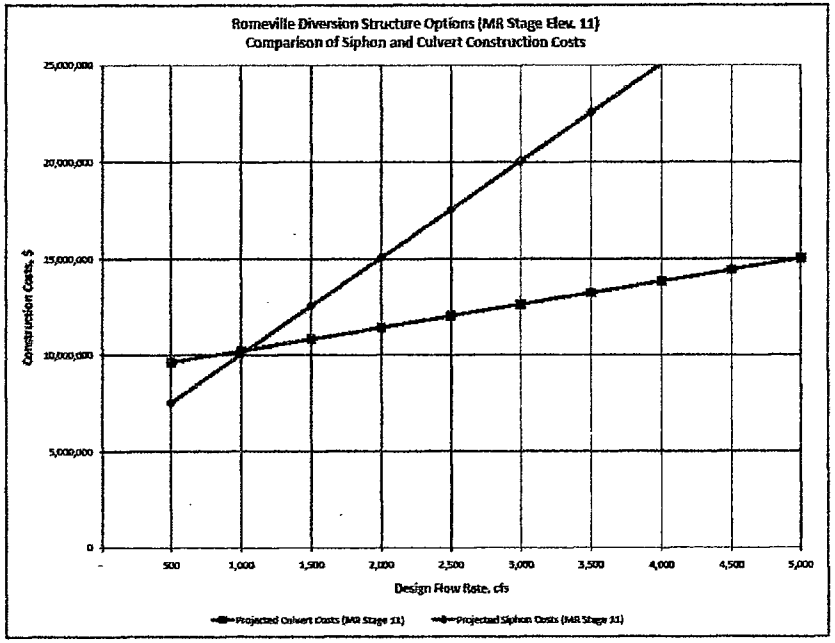


Figure 3-3: Comparison of Romeville structure options based on price and desired flow rate (cfs) [6]

[6] All costs are in October 2009 prices

3.3.4 Intermediate Array of Alternative Plans

The alternatives remaining after the screening of preliminary alternative plans were further developed into the following eight intermediate alternatives (designated as No Action and Alternatives 1 through 6 and 4B). These 8 alternatives were subjected to a more detailed analysis and screening to arrive at a final array of alternatives.

- No Action
- Alternative 1 – 1,500 cfs Romeville Diversion (Siphons)
- Alternative 2 – 3,000 cfs Romeville Diversion (Gated Culvert System)
- Alternative 3 – 1,500 cfs South Bridge Diversion (Siphons)
- Alternative 4 – 3,000 cfs South Bridge Diversion (Gated Culvert System)
- Alternative 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
- Alternative 5 – 1,500 cfs diversion split equally between Romeville & South Bridge (Siphons)
- Alternative 6 – 3,000 cfs diversion split equally between Romeville & South Bridge (Siphons)

An analysis of the data used to create the figures in **Figure 3-2** indicates that the system responds to diversions between 1,500 and 3,000 cfs with the response steepening at 1,500 cfs and then starting to flatten out at 3,000 cfs. The 1,500 cfs flow range is the minimum amount of flow that has the potential to provide substantive prevention of saline backflow and inundation from Lake Maurepas; but only to a limited benefit area.

An additional analysis of the availability of water from the Mississippi River indicates that stage conditions could diminish the diversion capacity during certain months (generally August – November) to varying degrees, based on total head differential across the swamp system. This, in turn, would effectively reduce the total average capacity of each alternative. For the 1,500 cfs alternatives, this was a concern, since our analysis suggested that this capacity was at or near the lower end of prospective capacities capable of providing substantive hydrologic effects. Reduction in the 3,000 cfs capacity was less of a concern, since many of the sensitivity curves actually began to exhibit diminishing hydrologic effects at capacity levels below 3,000 cfs.

Each of the alternatives was also analyzed with respect to features (berm gaps and control structures) that would maximize the flexibility of operations based on understanding of the dynamics of the Blind River/Maurepas Swamp system. More detailed operational analysis was completed for the final array of alternatives discussed in the Section 3.4, and is presented in **Appendix L2.10.**

After considering the hydrologic factors discussed above, the 1,500 cfs diversion alternatives were analyzed in terms of their capacity to contribute to the planning objectives. See **Table 3-3** below. As can be seen the 1,500 cfs alternatives are not effective in substantially contributing to the planning objectives. Accordingly alternatives 1, 3, and 5 (1,500 cfs) will not be considered further.

Table 3-3: Contribution of 1,500 cfs Diversion Alternatives to the Planning Objectives

Objective	Contribution to Objectives
Promote water distribution in the swamp to increase the area of freshwater inundation for low to average flood events by 10 to 25% from existing conditions to increase swamp productivity and wetland assimilation.	Effective when Stages in Lake Maurepas are lower than in the swamp. Ineffective in providing enough freshwater to the swamp when Lake Maurepas tailwater elevations are higher than the swamp.
Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing swamp productivity, as described above and by increasing sediment input by up to 1,000 grams per square meter per year in order to decrease the annual subsidence rate 50 to 100% in the swamp.	Ineffective because the amount of flow would affect a limited benefit area. In addition there would be limited effectiveness when Lake Maurepas stages are high, and not enough water available when Mississippi River stages are low.
Establish hydroperiod fluctuation in the swamp to improve baldcypress and tupelo productivity and their seeding germination and survival by decreasing flood duration in the swamp by 10 to 25% for high flood events, increasing the length of dry periods in the swamp (no standing water) by 10 to 25%, and by increasing the number of baldcypress and tupelo saplings per acre by 25 to 50% from existing conditions.	Ineffective because the amount of flow would affect a limited benefit area. In addition there would be limited effectiveness when Lake Maurepas stages are high, and not enough water available when Mississippi River stages are low.
Improve fish and wildlife habitat in the swamp and in Blind River by increasing the existing Wetland Value Assessment (WVA) Habitat Suitability Index (HSI) in the swamp by 10 to 25% five years after project implementation and by a 5 to 10% increase in the average dissolved oxygen in Blind River from existing conditions.	Effective when Stages in Lake Maurepas are lower than in the swamp. Ineffective in providing enough freshwater to the swamp when Lake Maurepas tailwater elevations are higher than the swamp.

3.4 Final Array of Alternatives (Alternative Studied in Detail)

Based on the analysis discussed above, it was determined that 3,000 cfs is the flow needed to provide both prevention of saline backflow and inundation from Lake Maurepas and also achieve the overall goal of reversing the trend of degradation in the swamp. The following five alternatives were identified for further consideration and inclusion in the Final Array are:

- No Action (required to establish baseline conditions and the need for a diversion)
- Alternative 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
- Alternative 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
- Alternative 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
- Alternative 6 – Two 1,500 cfs Diversions at Romeville and South Bridge (Siphons)

No Action (Future without Project Conditions)

The No Action Alternative will - lead to the eventual degradation of the swamp in the distribution area. Local drainage occurs in episodic events and sends large quantities of water to the Blind River and the swamp. This local drainage can contain significant pollutants in terms of sediment, nutrients, pesticides and herbicides. Without the natural assimilation capacity of the swamp, these pollutants can cause stresses on the aquatic life in the Blind River.

Without adequate flow of water through the swamp and with issues relating to subsidence, and - relative sea level rise as well as - ponding and drainage from pipeline channels, the hydro period of the swamp is not conducive to the health and regeneration of several native tree species, including baldcypress and water tupelo. The swamp has been traversed with many man-made features including railroad embankments and channels, which have disrupted the natural hydro period of the swamp and limited the vertical accretion that would occur from sediment input and prolific vegetation growth from the nutrient input from the Mississippi River.

Alternative 2 – A 3,000 cfs Diversion at Romeville

This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Alternative 4 – A 3,000 cfs Diversion at South Bridge

This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

Alternative 4B – A 3,000 cfs Split Diversion at South Bridge

This alternative adds a gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp, and adds 3 new culverts at 4 locations under U.S. HWY 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year

Alternative 6 – A 3,000 cfs Dual Diversion at Romeville and South Bridge

This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61. The purpose of the diversion is to bring freshwater, sediment, and nutrients to the swamp at strategic times during the year.

3.5 Comparison of Alternative Plans

The four alternatives in the final array plus the no action were compared based on preliminary costs, benefits, and impacts. The first cost and annual costs (annualized for 50 years) for the final four alternatives are shown in **Table 3-4** and **Figure 3-4** and **3-5** below. Alternative 2 is the least expensive with a preliminary first cost of about $102 million with Alternative 6 being the most expensive at over $155 million. Alternatives 4 and 4B are slightly less expensive than Alternative 6 at $152.2 million and $146.9 million, respectively. A summary comparison of the final array of alternatives with respect to environmental consequences and plan impacts is provided in **Table 3-5.**

Table 3-4: Preliminary Cost (millions of dollars) of alternatives in the final array.[7,8]

Item	Cost (millions of dollars) Alt. 2	Alt. 4	Alt. 4B	Alt 6
Construction Subtotal	$73.5	$110.7	$106.8	$111.2
Engineering & Design (E&D)	$3.7	$5.5	$5.3	$5.6
Supervision & Administration (S&A)	$2.2	$3.3	$3.2	$3.3
Real Estate	$2.2	$2.2	$2.2	$4.4
Subtotal	$81.6	$121.8	$117.5	$124.5
Contingencies @ 25%	$20.4	$30.4	$29.4	$31.1
Total First Cost	$102.0	$152.2	$146.9	$155.6
Annualized First Cost	$5.06	$7.55	$7.28	$7.72
Annual O&M Costs	$0.59	$0.59	$0.67	$0.74
Total Annual Cost	$5.65	$8.14	$7.95	$8.46
Life Cycle Cost	$114.0	$164.2	$160.4	$170.6

Please note the costs in the above table are preliminary costs used for planning purposes only and in the IWR analysis. They do not represent a fully funded cost estimate.

[7] All costs are in October 2009 prices

[8] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

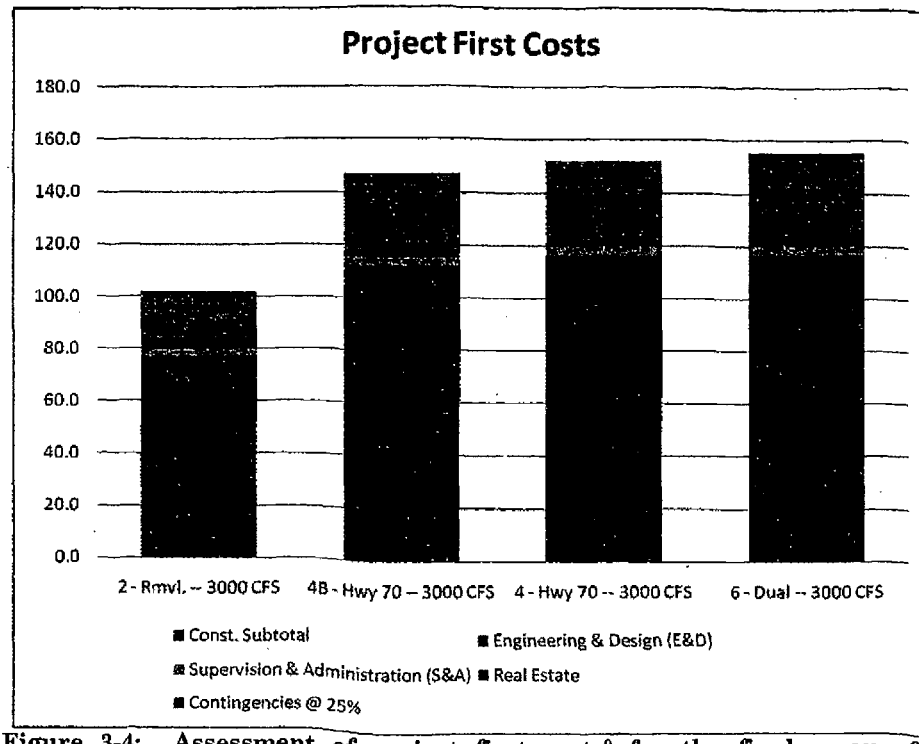


Figure 3-4: Assessment of project first costs[9] for the final array of alternatives.

[9] All costs are in October 2009 prices

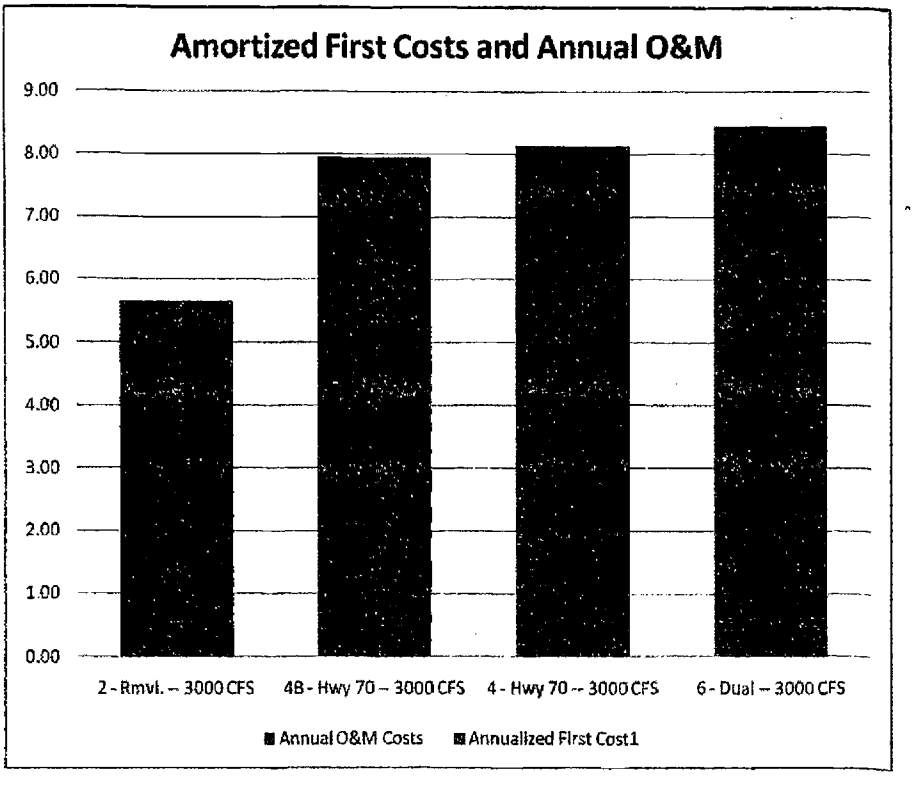


Figure 3-5: Amortized first costs and annual operation and maintenance for the final array of alternatives[10],[11].

Direct benefits and impacts to swamp habitat associated with the final array of alternatives were quantified by acreage and habitat quality (i.e., average annual habitat units or AAHUs).

[10] All costs are in October 2009 prices
[11] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

Table 3-5:

	No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
1. PLAN DESCRIPTION	No Action/Without Project Condition	Gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61.	Gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61.	Gated culvert system and transfer canal along the Romeville alignment and a gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds 6 control structures at strategic locations in the swamp and adds 3 new culverts at 4 locations under U.S. HWY 61	Gated culvert system and transfer canal along the Cox alignment south of the U.S. HWY 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds 6 control structures at strategic locations in the swamp, and adds 3 new culverts at 4 locations under U.S. HWY 61.
2. IMPACT ASSESSMENT					
A. NER					

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	1) Total Project Cost[12]	$0	$102,000,000	$152,200,000	$155,600,000	$146,900,000
	2) Annual Cost (not fully funded)[13]	$0	$5,650,000	$8,140,000	$8,460,000	$7,950,000
	3) Annual Net Benefits (AAHU)	0	6,421	6,124	7,114	7,103
	4) Cost Effective (yes/no/best buy)		Best Buy	No	Best Buy	Best Buy
	B. Environmental Resources					
	1) Soils and Water Bottoms	Continued advanced degradation of soils within the SA and increase in acreage of water bottoms.	Increased delivery of sediment to the SA and prevention of conversion of swamp to fresh and marsh open water.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	2)Hydrology: Flows and Water Levels	Persistence of existing conditions including a limited ability to drain and persistent flooding that conflict with historic drying cycles in the swamp, ponding and stagnant waters in some areas, and	Increased hydrologic connectivity that will allow water to flow out of the swamp more easily during periods when Lake Maurepas is low. Increased delivery of freshwater to the	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

[12] All costs are in October 2009 prices
[13] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		minimal contribution and circulation of nutrients and sediments in the swamp.	SA will provide nutrients and sediments to the swamp that will enhance productivity and accretion.			
	3) Hydrology: Sedimentation and Erosion	Continued lack of sediment inputs into SA.	Increased delivery of freshwater to the swamp will deliver nutrients and sediments to the swamp that will enhance productivity and accretion.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	4) Hydrology: Groundwater	Nearby human populations and industry continue to increase resulting in increased groundwater demands and decrease in groundwater resources. Continued decreasing swamp habitat no longer functions as	Minor variations in groundwater seepage due to head gradients created by the diversion and improved drainage of Maurepas Swamp. Restoration of swamp acts as natural water quality filtration system to the	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		effectively as natural water quality filtration system to aquifers.	aquifers.			
	5) Water Quality	Conversion of swamp vegetation to fresh marsh and open water reduces natural water quality filtration.	Temporary negative impacts (e.g., increased turbidity, decreased dissolved oxygen) during construction. Restoration of the swamp contributes to improvements in water quality.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	6) Water Quality: Salinity	Continued increases in salinity in Blind River, Maurepas Swamp, and Lake Maurepas.	Decreases in salinity in Blind River, Maurepas Swamp, and Lake Maurepas due to the fresh water inputs.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	7) Air Quality	Air quality in the study area continues to decline due to: continued population growth, further commercialization and industrialization, increased numbers of motor vehicles, and increased emissions from various engines.	Temporary impacts to air quality associated with construction. Overall improvement of air quality through restoration of Maurepas swamp.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	8) Noise	Limited increases in noise due to limited transportation, development, and navigation in the SA.	Temporary increases in noise levels during construction activities. Buffering of noise levels in the swamp due to increases in productivity and canopy cover.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	9) Vegetation Resources	Continued loss of vegetated wetland habitats, including; loss of baldcypress-tupelo and bottomland hardwood resources, increased saltwater intrusion, increased flood duration and impoundment, and increased herbivory.	Benefits to vegetation resources including swamp building (accretion), increased baldcypress and water tupelo seedling survival, recruitment, and forest stability. Forest productivity would also increase.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	10) Wildlife	Continued decline in quality of wildlife habitat adversely impacts wetland dependent wildlife populations.	Temporary impacts to wildlife due to construction activities. Improvement and creation of habitat for wetland dependent wildlife. Increases in populations of wildlife dependent on swamp habitat.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	11) Fisheries	Persistence of existing conditions including low oxygen that could lead to fish kills and	Localized and temporary impacts to fisheries during construction. Overall increases	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

123

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		low species diversity in the SA. Loss of wetland habitats used by fish species for shelter, feeding, and life cycle requirements.	in productivity and fisheries populations in the SA. Displacement of some fish species due to changes in salinity.			
	12) Aquatic Resources	A shift in plankton and benthic populations to species assemblages that prefer open water habitats as swamp conversion continues.	Localized and temporary impacts to aquatic resources during construction. Increases in populations due to increases in productivity in the swamp.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	13) Essential Fish Habitat (EFH)	Potential shift in EFH in Lake Maurepas due to salinity changes. Potential decrease in habitat for juvenile stages of red drum and white shrimp.	No EFH located within the SA. Potential shift in EFH in Lake Maurepas. Potential increase in habitat for juvenile stages of red drum and white shrimp.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	14) Threatened and Endangered Species	Continued degradation, conversion, and eventual loss of important wetland habitats used by threatened and endangered species.	Potential entrainment of pallid sturgeon in the intake structures. Potential creation of structures beneficial to pallid sturgeon. Possible displacement of manatee during construction activities.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2 with additional impacts associated with two intake locations.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	15) Cultural Resources	No impacts to cultural resources should occur within the SA as a result of the No-Action Alternative.	No impacts to cultural resources should occur within the SA as a result of this alternative. Potential protection of cultural resources due to deposition of sediment and restoration of swamp.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	16) Aesthetics	Continued swamp degradation and conversion of existing wetlands to fresh marsh and open water habitats resulting in decreased structural complexity and habitat diversity.	Improvement of the visual aesthetics of the SA through restoration of the forested swamp where it has been deteriorating.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

126

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	17) Recreation	Continued degradation of existing wetlands would diminish the wildlife habitat of the area, which in turn would adversely impact the recreational opportunities of the SA. Decreasing annual dollar revenues.	Localized and temporary impacts to recreation during construction. Overall, this alternative would serve to maintain and improve natural habitat, thereby maintaining and increasing recreational opportunities within the SA and leading to a substantial increase in recreational economic value. $35,000 annual dollar revenues based on unit day values.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2. $36,400 annual dollar revenues based on unit day values.	Impacts similar to Alternative 2.

127

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	19) Socioeconomics: Displacement of Population and Housing	There would be no impacts to populations or housing under the No Action Alternative.	There would be no impacts to populations or housing under Alternative 2.	Potential displacement of at most three houses and their inhabitants along the South Bridge transmission canal.	Impacts similar to Alternative 4.	Impacts similar to Alternative 4.
	20) Socioeconomics: Employment, Business, and Industrial Activity	Continued natural habitat degradation would have localized impacts on fishery- and wildlife-related employment and industries.	Potential for temporary employment in construction of proposed action. Overall, economic activities dependent upon the natural habitats in the SA would be maintained and possibly increased.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	21) Socioeconomics: Availability of Public Facilities and Services	No impacts to the availability of public facilities and	No impacts to the availability of public facilities and	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		services should occur within the SA as a result of the No-Action Alternative.	services should occur within the SA as a result of the proposed action.			
	22) Socioeconomics: Transportation	Continued wetland degradation would diminish the ease of travel within the SA.	Impacts on transportation resources would include temporary increase in demand of the transportation network during construction.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	23)) Socioeconomics: Disruption of Desirable Community and Regional Growth (including Community Cohesion)	Continued natural habitat degradation would have localized impacts on fishery- and wildlife-related employment and industries, which could impede community and regional growth.	Economic activities dependent upon the natural habitats in the SA would be maintained and possibly increased, which in turn could enable positive community and regional growth.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	24) Socioeconomics: Tax Revenues and Property Values	The continued natural habitat degradation could potentially cause the property value of the	The proposed action would protect and enhance the visual aesthetic of the SA,	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

129

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		private land within the SA to decline, thereby decreasing tax revenue.	which could potentially increase the property value of the privately-owned parcels within the SA.			
	25) Socioeconomics: Infrastructure	Continued wetland degradation, including coastal land loss, would impact infrastructure along *and leading to the* coastline, affecting both relocations and maintenance.	The proposed action would preserve and enhance the existing land, thereby reducing the need for *increased* maintenance and/or relocation of the infrastructure within the SA.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	26) Socioeconomics: Environmental Justice	Continued natural habitat degradation would have localized impacts on fishery- and wildlife-related employment and industries, which could lead to a rise of lower-income residents within the SA.	Economic development dependent upon the fish and wildlife within the SA would be maintained and possibly increased due to the protection and enhancement of the natural habitat.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
			Thereby, boosting the income of those employed in this sector.			
	27) Socioeconomics: Navigation	There will be no impacts to navigation as a result of the No Action alternative.	Potential impacts to navigation in St. James Parish canals when control structures are in use. No impacts to navigation on the Mississippi River or Blind River.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	28) Socioeconomics: Agriculture	There will be no impacts to agriculture as a result of the No Action alternative	A small loss of agricultural land in production due to the construction of the transmission canal.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2 with the additional loss of agricultural land associated with the construction two transmission canals.	Impacts similar to Alternative 2.
	29) Socioeconomics: Forestry	Continued degradation of the swamp greatly reducing the potential for forestry activities.	Wetland preservation and increased productivity that would benefit forest resources in the SA. A small	Wetland preservation and increased productivity that would benefit forest resources in the SA. The loss	Wetland preservation and increased productivity that would benefit forest resources in the SA. The	Impacts similar to Alternative 4.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
			loss of forested swamp associated with construction activities.	of forested wetland due to the construction of the South Bridge diversion would be more extensive than Alternative 2 due to the longer length of the transmission canal.	impacts of this alternative would be similar to those described for Alternative 2 with the additive direct impacts of Alternative 4.	
	30) Socioeconomics: Public Lands	Continued loss of public land and access resulting from swamp degradation and conversion to fresh marsh open water.	Preservation of public lands due to the diversion slowing or reversing the trend of swamp degradation and habitat conversion in the SA.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	31) Socioeconomics: Water Use and Supply	Continued increases in the salinity of Lake Maurepas and Lake Pontchartrain, which may render this minor water supply source unsuitable for water uptake.	Decreases in salinity of Lake Maurepas would benefit this minor water supply source.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	32) Socioeconomics: Oil, Gas, and Utilities	The effects of land loss and degradation could lead to increased costs for maintaining and repairing existing oil, gas, and utilities in the SA.	Prevention of the deterioration of substrate upon which oil, gas, and utilities are constructed associated with sediment inputs from the diversion.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	33) Socioeconomics: Flood Control and Hurricane Protection	Continued degradation of forested wetlands that provide some unknown level of hurricane and tropical storm abatement (USACE 2009). Consequently, there could be an increase in storm surge and risk of flooding due to coastal land loss.	Restoration of Maurepas Swamp would provide some level of buffering against future storm surge.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	34) Socioeconomics: Commercial Fisheries	Persistence of existing conditions including the continued conversion of existing wetlands to	Overall increases in fisheries productivity due to increased nutrient inputs and wetland building processes.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
		open water habitats, restricted water circulation, and decreased water quality that could result in declines in commercial fisheries.	The potential short term displacement of some commercial fisheries.			
	35) Socioeconomics: Oyster Leases	There would be no impacts to oyster leases from the No Action Alternative.	There would be no impacts to oyster leases from Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.	Impacts similar to Alternative 2.
	36) HTRW	An HTRW Phase I ESA was performed on the study area, and identified a low probability of encountering contaminants of concern. Increasing human populations, development, industry, and other activities in adjacent areas could increase potential for HTRW in SA.	Potential for impacts to the SA from implementation of Alternative 2 is low and would likely continue to be low into the future.	Potential for impacts to the SA from implementation of Alternative 4 is low and would likely continue to be low into the future. One underground storage tank was identified near the South Bridge transmission canal route.	Potential for impacts to the SA from implementation of Alternative 6 is low and would likely continue to be low into the future. One underground storage tank was identified near the South Bridge transmission canal route.	Potential for impacts to the SA from implementation of Alternative 4B is low and would likely continue to be low into the future. One underground storage tank was identified near the South Bridge transmission canal route.
3. Plan Evaluation	**A. Contribution to Planning Objectives**					

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	1) Promote water distribution in the swamp.	0	2	2	2	2
	2) Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise.	0	2	2	2	2
	3) Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seeding germination and survival.	0	2	2	2	2
	4) Improve fish and wildlife habitat in the swamp and in Blind River.	0	2	2	2	2
	B. Planning Constraints					
	1) Minimize impact for the ability of the Mississippi River & Tributaries flood control project to continue to fulfill its authorized purposes.	2	2	2	2	2

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	2) Minimize impact for the ability of authorized navigation projects to continue to fulfill their purpose.	2	2	2	2	2
	3) Do not violate limitations imposed by the designation of the Blind River as a scenic river by the LDWF. (e.g. do not include structures in the Blind River).	2	2	2	2	2
	4) The project will have to be constructed and operated so it would not conflict with the Wildlife Management Area in the study area.	2	2	2	2	2
	5) The operation of the project is constrained by the availability of freshwater, nutrients, and sediments from the Mississippi River. The Mississippi River annual high water (spring) and low water (summer) cycle will impact the hydraulic design of the diversion structure, transmission channel and swamp distribution system. The annual cycle could	2	2	2	2	2

		No Action	Alternative 2	Alternative 4	Alternative 6	Alternative 4B
	also reduce the ability to intercept a significant sediment load and to control the nutrient level received by the swamp.					
	6) The operation of the project will be constrained by Lake Maurepas tail water conditions (i.e. The Lake Maurepas tailwater is of the higher than the water level in Maurepas Swamp).	2	2	2	2	2
	7) Do not violate water quality standards as administered by the Louisiana regulatory agency.	2	2	2	2	2
	C. Response to Evaluation Criteria					
	1) Completeness	0	2	2	2	2
	2) Effectiveness	0	2	2	2	2
	3) Efficiency	0	2	2	2	2
	4) Acceptability	0	2	2	2	2

Note: Response to Evaluation Criteria

0 = Does Not Meet

1= Partially Meets Criteria

2=Meets Criteria

3.5.1 Alternatives Hydraulic and Water Quality Modeling

The engineering calculations and hydraulic modeling for each of the four alternatives are fully covered in the engineering **Appendix L in Section L2.10.** This section shows how the flow from the diversion is distributed through each of the hydrologic units using a finite element model analysis. From the modeling work, a general flow diagram with magnitudes was developed and is shown graphically in Figure L2.10.1-3. The model produced this diagram for all of the alternatives and the results by hydrographic unit are shown in Figures L2.10.5-1 through L2.10.5-4. These modeling results were derived from the alternative layouts showing key features in Figures L2.10.1-1, L2.10.2-1, L2.10.3-1 and L2.10.4-1.

The hydraulic analysis for each of the alternatives including water quality was factored into the WVA by hydrographic units as discussed below in Section 3.5.2. Once the appropriate cost and benefit information was derived to rank alternatives, more detailed information was prepared on Alternative 2. The detailed information on Alternative 2 is also contained in the tables and graphics in Appendix L Section 2.10.

3.5.2 Wetland Value Assessment

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Wetland Value Assessment (WVA) methodology was used to quantify the benefits and impacts on swamp habitat. The WVA is used to evaluate coastal restoration projects, and is similar to the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity (acreage) are measured for baseline conditions, and predicted for future without-project and future with-project conditions. For each habitat type, the model defines an assemblage of variables considered important to the suitability of an area to support a diversity of fish and wildlife species. As with HEP, the WVA provides a quantitative estimate of project-related impacts to fish and wildlife resources; however, the WVA uses separate models for fresh/intermediate marsh, brackish marsh, saline marsh, and swamp habitat.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each wetland type. Each model consists of: 1) a list of variables that are considered important in characterizing community-level fish and wildlife habitat values; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Index) and different variable values; and, 3) a mathematical formula that combines the Suitability Indices for each variable into a

single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

Each community model (WVA) contains a set of variables which is important in characterizing the habitat quality of several coastal wetland habitat types relative to the fish and wildlife communities dependent on those environments. The final list of variables for the swamp WVA model developed by the CWPPRA Environmental Work Group (2001) includes: 1) stand structure, 2) stand maturity, 3) water regime, and 4) mean high salinity during the growing season. Baseline values are determined for each of those variables to describe existing conditions in the study area. Future values for those variables are projected to describe conditions in the area without the project and with the project.

Variable V_1 - Stand structure. Most swamp tree species do not produce hard mast; consequently, wildlife foods predominantly consist of soft mast, other edible seeds, invertebrates, and vegetation. Because most swamp tree species produce some soft mast or other edible seeds, the actual tree species composition is not usually a limiting factor. More limiting is the presence of stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy and preferably as a combination of all three.

This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.

Variable V_2 - Stand maturity. Because of man's historical conversion of swamp, the loss of swamp to saltwater intrusion, historical and ongoing timber harvesting, and a reduced tree growth rate in the subsiding coastal zone, swamps with mature sizeable trees are a unique but ecologically important feature. Older trees provide important wildlife requisites such as snags and nesting cavities and the medium for invertebrate production. Additionally, as the stronger trees establish themselves in the canopy, weaker trees are out-competed and eventually die, forming additional snags and downed treetops that would not be present in younger stands. The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important consideration for this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp

ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, and average DBH only, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically a suitable number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Variable V_3 - Water regime. This variable considers the duration and amount of water flow/exchange. Four flow/exchange and four flooding duration categories are described to characterize the water regime. The optimal water regime is assumed to be seasonal flooding with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. In addition, abundant and consistent input and water flow-through is optimal, because under that regime the full functions and values of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable. Habitat suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be the least desirable (SI=0.1). Those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production.

Variable V_4 - Mean high salinity during the growing season. Mean high salinity during the growing season (March 1 to October 31) is defined as the average of the upper 33 percent of salinity measurements taken during the specified period of record. Although baldcypress is able to tolerate higher salinities than other swamp species, species such as tupelogum and many herbaceous species are salinity-sensitive. Optimal conditions are assumed to occur at mean high salinities less than 1.0 ppt. Habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

Field data, monitoring reports, scientific literature, preliminary hydrologic modeling data, previous WVAs within the basin, and academic expertise were used to compute baseline HSI values and to predict HSIs for each target year (TY). Target years were established when future significant changes in habitat quality or quantity were expected under future with-project and future without-project conditions.

The product of an HSI value and the acreage of available habitat for a given target year is the Habitat Unit (HU), which is the basic unit for measuring project effects on fish and wildlife habitat. HUs are annualized over the project life (i.e., 50 years)

to determine the Average Annual Habitat Units (AAHUs) available for each habitat type. The AAHUs are calculated by summing the HUs over the period of analysis (50 years) and dividing the total by the number of years in the life of the project.

AAHUs are calculated by summing the HU's over the period of analysis (50 years) and dividing the total (cumulative HUs) by the number of years in the life of the project. This method accounts for prestart changes in the analysis using the following equation.

$$\text{Cumulative HU's} = (T_2 - T_1)\left[\frac{(A_1H_1 + A_2H_2)}{3} + \frac{(A_2H_1 + A_1H_2)}{6}\right]$$

Where T1 = first target year of time interval

T2 = last target year of time interval

A1 = area of available habitat at beginning of time interval

A2 = area of available habitat at end of time interval

H1 = HIS at beginning of time interval

H2 = HIS at end of time interval

The time intervals used for the WVA calculation were 0, 1, 20, 30, and 50 years. The change (i.e., increase or decrease) in AAHUs for each future with-project scenario, compared to future without-project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the fish and wildlife community within that habitat type; a net loss of AAHUs indicates that the project would adversely impact fish and wildlife resources. Figure 3-6 depicts the HU over time for alternative 2. The benefit evaluation period for the project is 2015-2065.

The WVA analysis was run for each alternative within the final array to determine the quantitative benefits for each alternative including the areas impacted by the construction. Further explanation of how impacts/benefits are assessed with the WVA and an explanation of the assumptions affecting HSI (i.e., quality) values for each target year for benefits/impacts to swamp habitat are available for review at the Service's Lafayette, Louisiana, field office, and provided in **Appendix K**.

For planning and hydrologic modeling purposes, the project area was divided into three benefit areas (i.e., benefit area 1, 2, and 3) and within those benefit areas are several sub-basins. Benefit areas and sub-basins are defined by topographic high areas (e.g., spoil banks, relict railroad grade, road embankments) or channels, natural or artificial (e.g., rivers, canals, channels, intermittent tributaries) that would serve to impede or intercept hydrologic flows. The area south and southwest of Blind River is defined as benefit area 1 (i.e., 100 sub-basin series). The area

north of Blind River and west of U.S. Highway 61 is benefit area 2 (i.e., 200 sub-basin series), and the area north of Blind River and east of U.S. Highway 61 is benefit area 3 (i.e., 300 sub-basin series). For the purposes of the Wetland Value Assessment (WVA) the sub-basins are grouped into hydrologic units (**Figure 3-7**), or units that are considered to be under the same hydrological influences.

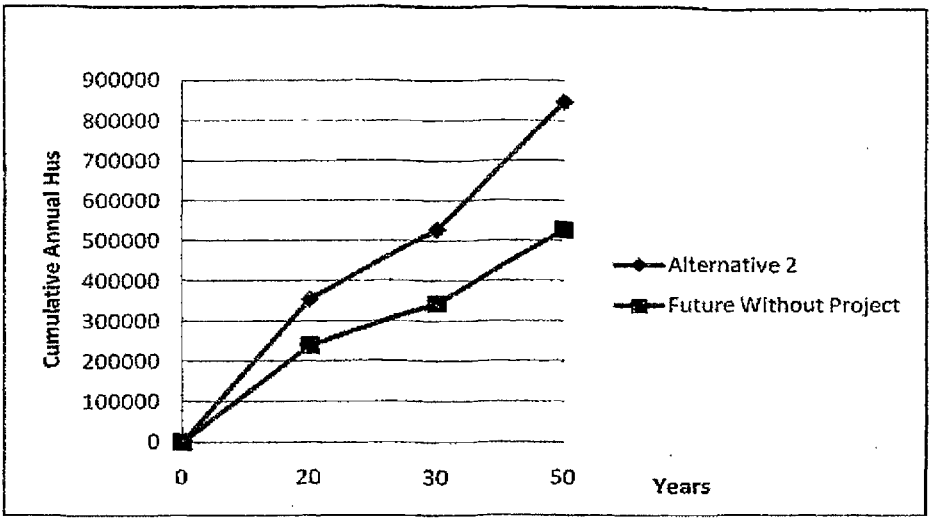


Figure 3-6 Annual Habitat Units

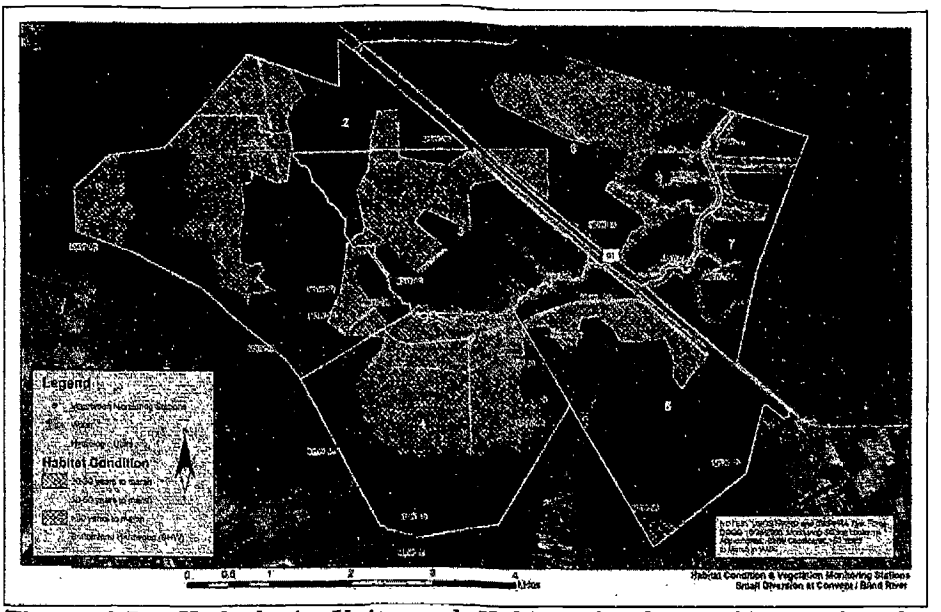


Figure 3-7. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.

WVA Model Certification. The WVA model is completing model certification in accordance with EC 1105-2-407, May 2005 Planning Models Improvement Program: Model Certification. The model has undergone external review which is documented in the July 8, 2009, Draft Model Certification Review Report for the Wetland Value Assessment Models prepared by the Battelle Memorial Institute for the US Army Corps of Engineers, Ecosystem Planning Center of Expertise. The WVA revision documentation and spreadsheets have been submitted to the ECO-PCX. The ECO-PCX has reviewed the revisions and will forward a recommendation to certify the model for use in the LCA projects.

Since the WVA was still in the process of being certified, the projects using the WVA model were required to respond to specific comments related to the ongoing certification process and the use of WVA on the specific project. The specific comments and responses for the WVA as it relates to the project can be found in **Appendix K.** Based on satisfactory responses to these comments Planning Center of Expertise for Ecosystem Restoration has cleared the WVA model for use in evaluating the alternatives considered in this report.

Relative Sea level Rise. Relative sea level rise refers to the difference between the change in eustatic sea level and the change in land elevation. The combination of subsidence and eustatic sea level rise would likely cause the landward movement of

marine conditions into estuaries, coastal wetlands and fringing uplands (Day and Templet, 1989). Relative sea level rise has been measured in the Mississippi Delta at rates as high as 10 mm/yr (Snedden et al., 2007). Based on guidance in EC-1165-2-211, it was determined that a low estimate for relative sea level rise over for the 50-year period of analysis (2061) is 1.5 ft (0.46 m); an intermediate estimate is 1.9 ft (0.58 m); and a high estimate is 3.2 ft (0.97 m). The WVA initial analysis was completed for the intermediate sea level rise scenario. The WVA analysis was also run on the low and high RSLR scenarios for the NER and Recommended Plan see Section 3.8.1.

3.5.3 Cost-effectiveness/Incremental Cost Analysis

The habitat values identified above, along with preliminary engineering costs, were used as inputs for the IWR Planning Suite to compare the alternatives in terms of outputs and costs as further described below.

Cost effectiveness and incremental cost analyses (CE/ICA) reveal information about good financial investments given the dollar costs and non-dollar outputs ("benefits") of alternative investment choices. The analyses are conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen-out those that do not. US Army Corps of Engineer (USACE) Regulation 1105-2-100 requires cost effectiveness and incremental cost analyses to support recommendations for ecosystem restoration through implementation of the IWR Planning Suite (IWR). IWR takes user-defined solutions to planning problems and externally-generated estimates of each solution's effects and can formulate all possible combinations of those solutions, considering user-defined relationships between solutions. IWR will then identify which combinations are the best financial investments through cost effectiveness and incremental cost analyses. Each combination of solutions is an alternative plan and the use of IWR assists in identifying which plans are the best investments.

Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of output considered. The resulting least cost alternative plans are then compared to identify those that would produce greater levels of output at the same cost, or at a lesser cost, as other alternative plans. Details of the project cost development are provided in **Appendix L, Annex L-1**. Alternative plans identified through this comparison are the cost effective alternative plans. Next, the cost effective alternative plans are compared to identify the most economically efficient alternative plans, that is, the "Best Buy" alternative plans that would produce the "biggest bang for the buck." Finally, the additional costs for the additional amounts of output ("incremental cost") produced by the Best Buy alternative plans are calculated. The results of all the calculations and comparisons of costs and outputs provide a basis for addressing

the decision question "Is it worth it?" i.e., are the additional outputs worth the costs incurred to achieve them?

In practice, USACE ecosystem restoration studies typically measure the ecosystem benefits of alternative plans in terms of physical dimensions (number of acres of wetlands, for example), or population counts (number of wading birds, for example), or various habitat-based scores ("habitat units" based on the U.S. Fish & Wildlife Service's *Habitat Evaluation Procedures*, or "HEP", or Wetland Value Assessment "WVA" for example).

The performance measures evaluated and selected for this project were habitat units (HUs). Habitat units are the metric that best integrate information regarding the quality and quantity of improved habitat for various representative species and/ or communities within the project benefit area. Cost and HU output comparisons are summarized and illustrated in **Figure 3-8** below:

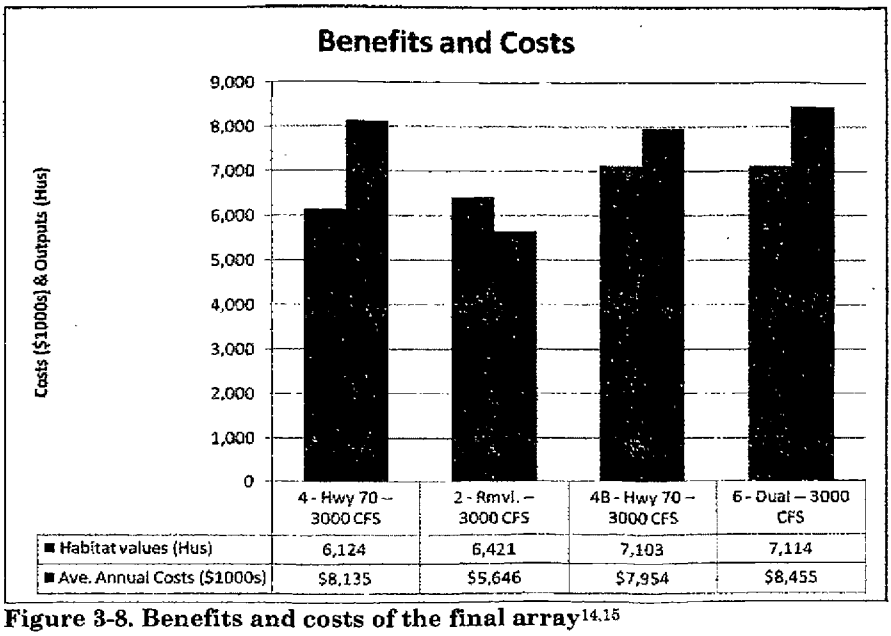


Figure 3-8. Benefits and costs of the final array[14,15]

The cost-effectiveness of the alternatives is presented in **Table 3-6** and **Figure 3-9**. The analysis indicates that Alternative 4 has lower benefits and higher preliminary costs than alternative 2 and is not a cost-effective solution. Therefore Alternative 4

[14] All costs are in October 2009 prices

[15] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

will not be considered further. Alternates 2, 4B, and 6 are all cost-effective and are also best buy alternatives and will be considered further through an incremental cost analysis. However, it should be pointed out that Alternative 6 produced significant AAHUs at an extreme cost per habitat unit when compared to the other two alternatives. This is explained further in the following paragraphs.

Table 3-7 and **Figure 3-10** summarize the incremental analysis of the cost-effective alternative plans. Of the three alternatives, Alternative 2 provides the lowest increase in average annual habitat units when compared to the future without-project condition. By delivering 3,000 cfs of freshwater, sediments, and nutrients to the Southeast portion of the Maurepas Swamp drainage in the swamp would improve, there would be more dry periods to promote seed germination and sapling survival, and there would be a decrease in persistent inundation, short circuiting drainage patterns, and ponding and stagnation. Nutrients and sediment diverted and pulsed to the swamp will be more widely distributed in the swamp and that would result in increased nutrient assimilation and vegetative productivity as well as improved water quality in Blind River. Implementation of Alternative 2 would reverse the existing trend of swamp deterioration. The sediment diverted to the swamp and the increased productivity will increase accretion (soil building) and offset subsidence and sea level rise and reduce the decrease in the ground surface elevation in the swamp and reduce persistent inundation. Because of this strong contribution to the planning objectives, the $5,646,000 annual cost for Alternative 2 to produce 6421 average annual habitat units at a per unit cost of $880 is considered justified. The increment from Plan 2 to Plan 4b produces an additional 682 average annual habitat units at a cost of $2,309,000 or $3,384 per average annual habitat unit and the increment from Plan 4b to Plan 6 produces an additional 11 habitat units at a cost of $501,000 or $45,530 per average annual habitat unit. Alternative 2 provides over 90 percent of the benefits for about 67% of the cost of Alternative 6, the cost per AAHU is much lower for Alternative 2 that for the other two alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Due to the high incremental cost per habitat unit for the increments above Alternative 2 these increments are not considered to be justified. Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the National Ecosystem Restoration Plan.

Table 3-6. Cost-effectiveness analysis of the final array[16,17]

	Alternative 4 South Bridge, 3000 cfs	Alternative 2 Romeville, 3000 cfs	Alternative 4B South Bridge (split flow)	Alternative 6 Dual Diversion
HUs	6124	6421	7103	7114
Cost ($1,000s)	$8,135	$5,646	$7,954	$8,455
Cost-effective	No	Yes	Yes	No
Best Buy	No	Yes	Yes	Yes

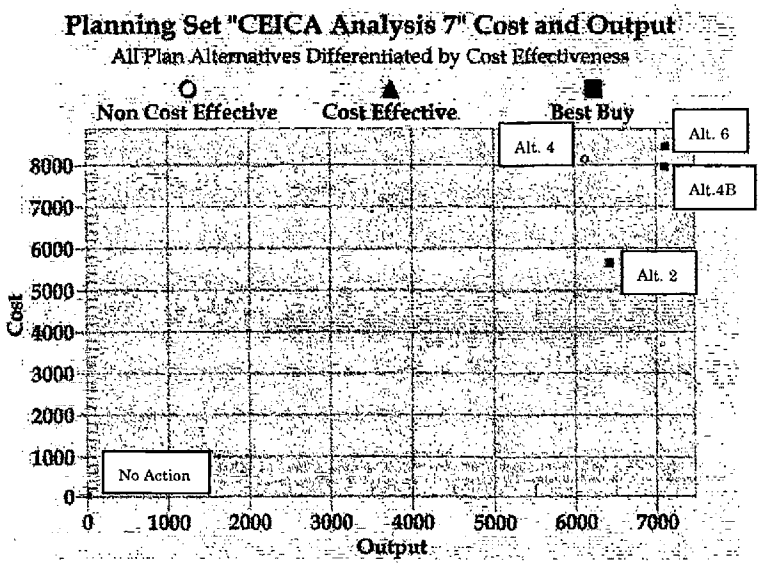


Figure 3-9. Cost-effectiveness of analysis of the final array

[16] All costs are in October 2009 prices

[17] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

Table 3-7. Incremental cost analysis of the final array[18,19]

	Alt. 2 – Romeville	Alt. 4B 0 South Bridge (Split flows)	Alt. 6 – Dual Diversion
AAHUs	6,421	7,103	7,114
AA Cost ($1,000s)	$5,646	$7,954	$8,455
			Yes
Δ AAHU	6,421	682	11
Δ AA Cost ($1000s)	$5,646	$2,309	$501
ΔAA Cost/AAHUs ($1000s)	$0.88	$3.39	$45.53

Please note the costs in the above table are preliminary costs used for planning purposes only and in the IWR analysis. They do not represent a fully funded cost estimate.

3.6 The National Ecosystem Restoration (NER) Plan

The National Ecosystem Restoration (NER) Plan is the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective. Based on the comparison of alternatives above, Alternative 2, a 3,000 cfs diversion at Romeville is designated as the NER Plan

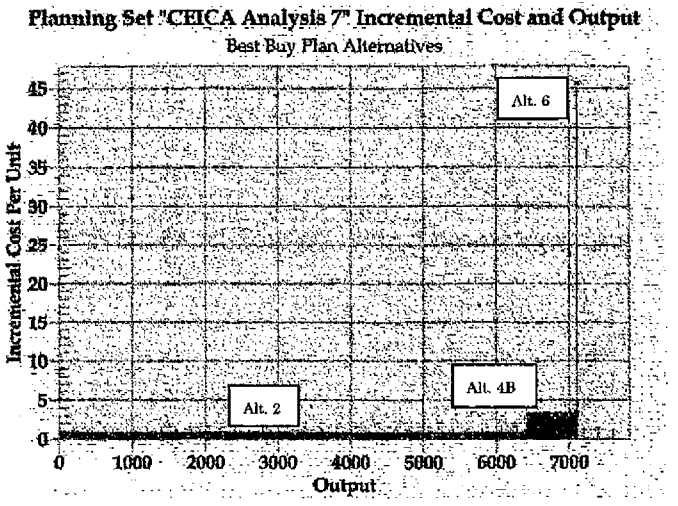


Figure 3-10. Incremental cost analysis of the final array[20,21]

[18] All costs are in October 2009 prices

[19] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

3.7 Plan Selection – Tentatively Selected Plan/ Recommended Plan

After comparing the four alternative plans carried over for detailed analysis and the No Action Alternative, The NER Plan, Alternative 2, a 3,000 cfs diversion at Romeville was selected, as the TSP and was later confirmed as the Recommended Plan. Plan 2 best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the - southeast part of the Maurepas Swamp. The Recommended Plan would improve a total of 21,369 acres (8,648 ha) of baldcypress-tupelo swamp that are in various stages of deterioration. The Recommended Plan would improve 3,295 acres (1,333 ha) of baldcypress-tupelo swamp that would become marsh in 20 to 30 years without project implementation, 7,934 acres (3,211 ha) of baldcypress-tupelo swamp that would become marsh in 30 to 50 years without project implementation, and 10,140 acres (4,104 ha) of baldcypress-tupelo swamp that would become marsh in greater than 50 years without project implementation.

The selected Recommended Plan is in within the scope and cost of the current authorization. According to the MCACES cost estimate, the total fully funded costs of constructing the Recommended Plan is $123,140,000, this is under the cost authorized by WRDA 2007. See Table 3.8.

Table 3.8- Maximum Cost Including Inflation through Construction

Authorized cost in WRDA 2007 Title VII, Section 7006 (e)(3)(A):	$88,000,000
* Cost Index Used EM 1110-2-1304 (Revised 31 Mar 2010)	CWBS- Features Codes 15 Floodway Control & Diversion Structure
Cost Index Ratio 1Q FY07 to 2Q FY14	1.14
** Current Project Cost Estimate (Inflation applied from 10/2006 to 1/2014)	$100,729,295
20% of Authorized Cost:	$17,600,000

[20] All costs are in October 2009 prices

[21] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

*** Monitoring & Adaptive Management: (per WRDA 2007 Section 2039)	$6,620,000- $717,000 = $5,903,000
Maximum Cost Limited by Section 902:	$100,729,295+ $17,600,000+ $5,903,000 **= $124,230,000**
Recommended Plan cost****	**$123,140,000**

*Notes: * The cost index applied is derived from: EM 1110-2-1304, 31 Mar 10, Civil Works Construction Cost Index System (CWCCIS).** For the purposes of applying the Cost Index to the WRDA Authorized Cost, each project was adjusted for inflation from the October 2006 price levels through the mid-point of construction. *** The cost of any modifications required by law. This is derived from section 8.0 of each projects Monitoring and Adaptive Management Plan minus the project monitoring cost found on the LCA Cost Summary. ****Fully Funded Cost includes interest during construction.* ***Bolded numbers are rounded.***

3.7.1 Significance of Outputs

The Recommended Plan meets both 2004 and 2010 planning objectives. The Recommended Plan will restore the southeastern Maurepas Swamp to ensure its ability to provide hydrologic and habitat form and function for the 50 year period of analysis. Hydroperiods, water quality, and interior marsh habitat for fish and wildlife species will be restored, mimicking as closely as possible, conditions which occurred naturally in the area. The alternatives were designed to work with the natural, fluid, soft environment of coastal Louisiana. Without this project, the southeastern Maurepas Swamp will continue to deteriorate with eventual conversion to open water; the baldcypress-tupelo habitat characteristic of the swamp would be lost.

This plan, by increasing the flow-through of freshwater and nutrient inputs into a stagnant or starved system, would let the ecosystem recover and contribute to the objective of Civil Works ecosystem restoration "...to restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition". With the plan, partial restoration may be possible, with significant and valuable improvement made to degraded ecological resources." The southeastern Maurepas Swamp provides important geomorphic, hydrologic, and habitat functions in the Pontchartrain Basin. Loss of these functions would have impacts beyond the project study area.

The Maurepas Swamp is a significant ecosystem within the Pontchartrain Basin in Southern Louisiana. The ecosystem outputs from the Maurepas swamp play an

important role in the overall health of the southern Louisiana ecosystem. The outputs are institutionally recognized. The study area is almost wholly located within the Maurepas Wildlife Management Area, and the Blind River is a state-designated Scenic River. This project is listed in the Louisiana State Master Plan and it is designated as a critical near term feature in the LCA Ecosystem Restoration Study. There is public support in Louisiana for this project, with specific emphasis on beginning construction as soon as possible. The area is utilized for boating, fishing, hunting, and bird watching. Commercial and recreational fishing are culturally significant to many south Louisiana residents.

The outputs are technically recognized. Examples of technical significance are:

- Scarcity: Louisiana's coastline represents 90% of the wetlands in the contiguous United States and is currently disappearing at an alarming rate. This unique and scarce habitat has high fish and wildlife values.

- Representativeness: The project footprint is uninhabited. The Recommended Plan will restore the hydrologic and habitat of the swamp.

- Status and Trends: The project areas are declining and imperiled. While the project cannot stop the natural processes of sea level rise, subsidence and storm caused erosion, the project can greatly slow down the disappearance of these landforms and supported habitats by increasing the amount of freshwater, nutrients, and sediment in the swamp system.

- Connectivity: The Maurepas Swamp serves as a buffer between open water areas of Lake Maurepas and Lake Pontchartrain and developed areas along I-10/Airline Highway and it is one of the largest continuous tracts of baldcypress-tupelo on the coast, supporting fish and wildlife habitats. The swamp is also a valuable stopover habitat for migratory birds.

- Limiting Habitat: Much of the southeastern Maurepas Swamp is considered important habitat for nesting Bald Eagles and other migratory birds. The swamp provides necessary habitat for a variety of small mammals including deer, alligators, and fish species.

The Recommended Plan meets the four evaluation criteria specified in the P&G.

- Acceptability: The Recommended Plan is acceptable to the State and the Federal Agencies. The Recommended Plan was selected by an interagency and interdisciplinary team. There is broad based public support for the plan. The agencies' and public's greatest concern is beginning construction as soon as possible.

- Completeness: The plan provides and accounts for all necessary investments and actions to ensure the realization of the planned restoration outputs specified in the Recommended Plan. The plan prevents the

conversion/disappearance of baldcypress-tupelo habitat for the 50 year period of analysis as stated in the project objectives. Consequently, the project improves the potential for long term survival of the swamp system.

- Efficient: The Recommended Plan was identified as cost effective solution and it has been designated as the National Ecosystem Restoration plan.

- Effectiveness: The plan makes a significant contribution to addressing the specific restoration problems. The Recommended Plan will prevent the loss of baldcypress- tupelo habitat, and conversion of the swamp to open water for the period of analysis, reducing land loss and providing essential habitat for wildlife. By maintaining the hydrologic and habitat form and function of a swamp system, salinity impacts on the wetland interiors will be lessened.

The Significance of specific resources within the project study area is summarized in the following **Table 3-9**.

Table 3-9 Significance of specific resources within the project study

Resource	Institutional Significance	Technical Significance	Public Significance
Soils	Soil resources are institutionally significant under the following statutes and memoranda: the Council on Environmental Quality (CEQ) memorandum of August 11, 1980, entitled "Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act (NEPA)"; Executive Order 11990 – Protection of Wetlands; and Agriculture and Food Act of 1981 (Public Law 97-98), which includes the Farmland Protection Policy Act (Public Law 97-98; U.S.C. 4201 *et seq.*).	This resource is technically significant because it is a critical element of coastal habitats and supports vegetative growth and open-water benthic productivity.	This resource is publicly significant because of the high value the public places on agricultural production, wildlife and fisheries supported by the soils in the area.
Water Bottoms	These resources are institutionally significant because of the national Environmental Policy Act of 1969; the Coastal Zone Management Act; and the Estuary Protection Act. Louisiana Revised Statute 41:1701 defines state water bottoms as "[t]he beds and bottoms of all navigable waters and the banks or shores of bays, arms of the sea, the Gulf of Mexico, and navigable lakes" and establishes the management and protection of the resources.	These resources are technically significant because the bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a benthic effect.	

Resource	Institutional Significance	Technical Significance	Public Significance
Hydrology	This resource is institutionally significant because of the National Environmental Policy Act of 1969; Clean Water Act; Flood Control Act of 1944; Coastal Barrier Resources Act; Rivers and Harbors Act of 1899; River and Harbor and Flood Control Act of 1970; Watershed Protection and Flood Prevention Act; Submerged Land Act; Coastal Zone Management Act; Safe Drinking Water Act; Estuary Protection Act; Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Executive Order 11988 Floodplain Management.	This resource is technically significant because Civil Works water resources development projects typically impact (positively or negatively) the interrelationships and interactions between water and its environment.	This resource is publicly significant because the public demands clean water, hazard-free navigation, and protection of estuaries and floodplains.
Water Quality	This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Clean Water Act; the Coastal Zone Management Act; and the Estuary Protection Act.	This resource is technically significant because the water quality supports most physical, chemical, geological, and biological processes throughout the entire estuarine system.	This resource is publicly significant because the public demands clean water and healthy wildlife and fisheries for recreational and commercial use.
Air Quality	This resource is institutionally significant because of the Clean Air Act of 1963, as amended, and the Louisiana Environmental Quality Act of 1983, as amended.	Air quality is technically significant because of the status of regional ambient air quality in relation to the National Ambient Air Quality Standards (NAAQS).	

Resource	Institutional Significance	Technical Significance	Public Significance
Wildlife and Habitat	This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Coastal Zone Management Act; Estuary Protection Act; the Fish and Wildlife Coordination Act of 1958, as amended; the Migratory Bird Conservation Act of 1929, as amended; the Migratory Bird Treaty Act of 1918; the Endangered Species Act of 1973 (ESA), as amended; the Fish and Wildlife Conservation Act of 1980; the North American Wetlands Conservation Act; Executive Order 13186 Migratory Bird Habitat Protection; Migratory Bird Conservation Act; and the Marine Mammal Protection Act	Wildlife resources are technically significant because they are a critical element of the coastal ecosystem, they are an important indicator of the health of coastal habitats, and many wildlife species are important recreational and commercial resources.	Wildlife resources are publicly significant because of the high priority that the public places on their aesthetic, recreational, and commercial value.
Benthic Resource	These resources are institutionally significant because of the NEPA of 1969; the Coastal Zone Management Act; and the Estuary Protection Act.	These resources are technically significant because the bottom of an estuary regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system through what is called a "benthic effect." Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries (Day et al. 1989).	Benthic resources are publicly significant because members of the epibenthic community (e.g., oysters, mussels, etc.) provide commercial and recreational fisheries as well as creating oyster reef habitats used by many marine and estuarine organisms.
Fisheries	Fishery resources are institutionally significant because of the Fish and Wildlife Coordination	Fishery resources are technically significant because they are a critical	Fishery resources are publicly significant because of the high priority

Resource	Institutional Significance	Technical Significance	Public Significance
	Act of 1958, as amended; the Endangered Species Act of 1973; the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (Magnuson-Stevens Act); the Magnuson-Stevens Act Reauthorization of 2006; the Coastal Zone Management Act; and the Estuary Protection Act.	element of many valuable freshwater and marine habitats; they are indicators of the health of various freshwater and marine habitats; and many species are commercially important.	placed on their aesthetic, recreational, and commercial value. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the fisheries resources provided in the LCA PEIS (2004) is hereby incorporated by reference.
Threatened and Endangered Species	This resource is institutionally significant because of the Endangered Species Act of 1973, as amended, and the Marine Mammal Protection Act of 1972.	Endangered (E) and threatened (T) species are technically significant because of the role these species play in maintaining ecosystems and, because of which, these species serve as indicators of overall ecosystem health.	These species are publicly significant because of the public desire to protect these species and their habitat.
Cultural and Historic Resources	This resource is institutionally significant based on State Historic and Preservation Office regulations, requirements, and policy to protect and preserve artifacts and remnants from our cultural past.	The technical significance of this resource is in providing knowledge of past cultures.	The public significance of this resource is in providing knowledge of past cultures.
Aesthetics	This resource's institutional significance is derived from laws and policies that affect visual resources, most notably the National Environmental Policy Act of 1969, the National Scenic Byway program, the Louisiana Scenic Rivers Act (1988).	This resource is technically significant because of the visual accessibility to unique geological and botanical features that are an asset to the study area.	Public significance is based on expressed public perceptions and professional evaluation. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the aesthetics resources provided in the LCA PEIS (2004) is hereby incorporated by reference.

156

Resource	Institutional Significance	Technical Significance	Public Significance
Recreation	This resource is institutionally significant because of the Federal Water Project Recreation Act of 1965, as amended, and the Land and Water Conservation Fund Act of 1965, as amended.	Recreational resources are technically significant because of the high economic value of recreational activities and their contribution to local, state, and national economies.	Recreational resources are publicly significant because of the high value that the public places on fishing, hunting, and boating, as measured by the large number of fishing and hunting licenses sold in Louisiana, and the large per-capita number of recreational boat registrations in Louisiana.
Socioeconomics and Human	This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Estuary Protection Act; the Clean Water Act; the River and Harbors Acts; the Watershed Protection and Flood Protection Act; and the Water Resources Development Acts. Of particular relevance is the degree to which the proposed action affects public health, safety, and economic well-being; and the quality of the human environment.	This resource is technically significant because the social and economic welfare of the nation may be positively or adversely impacted by the proposed action.	This resource is publicly significant because of the public's concern for health, welfare, and economic and social well-being from water resources projects.

3.7.2 Sustainability of Significant Resources

With the project in place the greatest risk to significant resources is related to relative sea level rise. USACE estimates for 50-year eustatic sea level rise (without the relative impacts of subsidence or accretion) range from 0.28 feet to 2.00 feet. This is a very broad range, as it coincides generally with the magnitude of normal water level fluctuations in the swamp. Future conditions for this project used the intermediate eustatic sea level rise estimate of 0.67 feet. Future subsidence rates used in this project, per USACE guidance, were 7.5 mm per year. This corresponds to 1.23 feet over a 50-year period. Coupled with the intermediate value of sea level rise, this yields a relative sea level rise of 1.90 feet over a 50-year period. However, the range of 50-year relative sea level rise estimates when subsidence is included is still very broad: 1.51 – 3.23 feet.

The form and function of the various significant resources within the study area are interdependent. Their viability is also dependent on the uncertainty of external forces including sea level rise and subsidence. A future without the project will consist of conditions that are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover will persist below 33 percent. Habitat disappearance and habitat switching are likely to occur as marsh converts increasingly to open water encouraging greater connectivity and influence from Lake Maurepas, and resulting in a greater potential for storm surge further inland.

Hydrologic and hydraulic analysis performed, using intermediate sea level rise values from available regional estimates of each contributing factor (eustatic sea level rise, subsidence, and accretion) suggest that over the effectiveness of the project over the 50-year project planning period will not be compromised by relative sea level rise. In other words, accretion effects expected with the project will at least, and in all likelihood, exceed the loss of elevation in the swamp expected without a project in place.

The analyses has considered a portion of this range of combined effects, looking primarily at future estimates of relative sea level rise accounting for subsidence, but hydraulic modeling was not completed with explicit representation of accretion and sedimentation (in order to offer conservative "worst case" estimates). The relative rise has been applied in the modeling analysis at the downstream boundary condition, specifically the water level in Lake Maurepas, and the primary impact it has on model results is increased backflow of Lake water into the swamp, and a greater need for diverted water in future years to overcome the backflow.

However, it is conceivable that the water levels in the Mississippi River (upstream boundary condition and flow input for this project) could also be affected by combined effects of eustatic sea level rise and changes in sediment load. This is

important because the flow rating curves developed for the gravity-based diversion structure are based on the differential head across the system, not just on the water level in the Mississippi River. If downstream water level rises in Lake Maurepas but Mississippi River water levels are largely unchanged, the physical ability to divert water could be diminished.

Specific forecasts of future water elevation trends in the Mississippi River near the study area are not readily available, so the analysis presented should be evaluated with the following considerations:

- If the Mississippi River water level does not change appreciably in the future, total diversion capacity could be diminished based on the assumptions guiding the application of sea level rise estimates to Lake Maurepas (less differential head across the system, and correspondingly lower diversion flows). As stated elsewhere, if intermediate projections for all contributing factors to relative sea level rise are applied together, the net effect could be almost negligible (counterbalancing effects). Hence, while there is the potential that rising relative sea level coupled with stationary river level could reduce diversion throughput, there is some uncertainty with these projections.
- If the Mississippi River water levels rise in future decades, it should improve the ability to divert water to the Blind River system when compared to stationary water levels in the river.

It is uncertain which of these scenarios is more likely to occur, and to what degree. Therefore, the project team has evaluated the effects of the different phenomena in sensitivity analyses. The worst case for diversion project performance would be higher levels in Lake Maurepas that do not appreciably affect the Mississippi River. This case would effectively reduce the gravity head gradient from the diversion to the Maurepas Swamp system and increase the need for more diverted flow to provide equal swamp restoration and flushing benefits.

The following two factors were used in deciding how to estimate the design level upstream boundary conditions in future decades:

- Intermediate (medium) projections of relative sea level rise, accounting for eustatic changes, subsidence, and accretion, suggest that the relative rise could be practically negligible.
- If relative sea level does change appreciably, it might be inferred that backwater elevations in the Mississippi River could also increase, if not in direct proportion, somewhat commensurately.

For these reasons, neither the historic water surface elevations in the Mississippi River (used in the hydrologic and hydraulic analysis) nor the flow rating curves for the diversion structure (in which the Mississippi River water level is the independent variable) were adjusted for the analysis of sea level rise in future decades.

Analysis results were developed for the Recommended Plan with low, medium and high projections of sea level rise. The trends of the results for low and high relative sea level projections are consistent with the results for medium sea level rise and confirm the likelihood of the sustainability of the swamp under with-project conditions over the 50-year project planning period. Additional detail and graphics to support these analyses are included in **Appendix L.**

3.7.3 Components

Alternative 2, a 3,000 cfs diversion at Romeville, has six major components: a diversion structure, a transmission canal, control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along U.S. highway 61 and instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. **Figure 3-11** illustrates Recommended Plan features that are described in detail in the following paragraphs.

Diversion Structure. The diversion culvert facility will divert freshwater from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal. The primary hydraulic elements of the diversion culvert facility are as follows:

- 3 – 10' x 10' multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44
- 3 – 10'x10' cast iron sluice gates with motor operators on the culvert inlets
- Trash racks near the culvert inlet
- Inlet canal across the batture from the Mississippi River to the culvert inlet
- LA 44 (River Road) is adjacent to the levee, and the box culvert will be extended under the road and discharge into the transmission canal approximately 100 feet east of the road. Erosion protection will be provided as needed at locations with higher flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance, and at the culvert outlet.
- Ancillary elements at the diversion culvert facility include a gate tower to raise the sluice gate operators and operator access above the Mississippi River flood stage, a steel sheet pile cut-off wall in the levee to reduce the potential for seepage and piping (loss of fines), and stop logs both upstream and downstream of the sluice gates to isolate them for maintenance. The diversion site will include an access driveway, a site road for access to the top of the levee, fence, drainage, lighting, a security system, and a control building. Additionally, a bar screen structure will be included to stop large debris and large fish and aquatic life from entering the diversion canal.

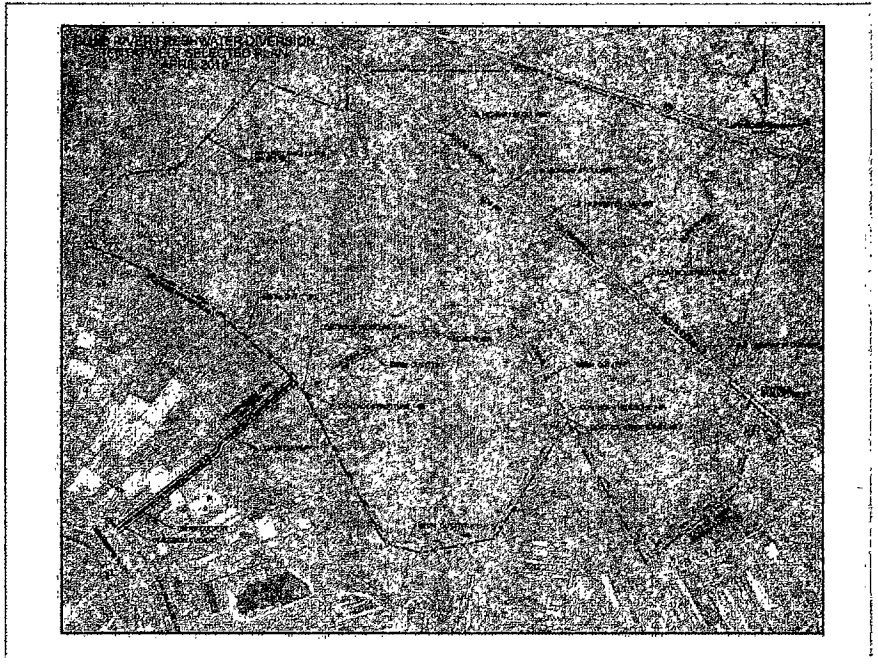


Figure 3-11: Recommended Plan design features

Transmission Canal. The transmission canal will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The transmission canal will be designed with a 25 percent factor of safety for the flow rate to avoid overtopping the berms. This is in anticipation that as the Mississippi River stage varies, the diversion control system will not control the flow rate to the precise design value. For the 3,000 cfs diversion, the transmission canal will be designed for 3,750 cfs.
The canal will be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2-foot freeboard. The top width will be approximately 250 feet. The hydraulic grade line will be above natural ground for most of the route. Therefore, embankments or berms with 12-foot wide tops will be constructed on both sides of the canal. During the PED process the borrow soils will be examined to determine if any additional modifications will be required to reduce the potential for seepage through the guide berms. The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125, a local highway. Both crossings will consist of 8 – 12' x 8' reinforced concrete box culverts across the full right-of-way.

Control Structures. The project will use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp. The hydraulic grade line, or water surface elevation, will need to be raised above the existing levels and controlled to force the diverted water out of the drainage channels into the swamp. Control structures will be installed at key locations in the existing channels to perform this function.

For the feasibility level design, downward opening crest gates were used as the basis for design of structures and for cost estimating purposes. This is one of the more expensive options to keep our estimates of cost conservative and type of structure has a good track record of success on other projects, so there was a high level of confidence in their success. During PED other options on the control structures will be considered. There may be operationally equivalent devices to control the flow of water that can be installed at a lower initial cost and possibly have lower operating and maintenance costs. Final design of the control structures will be coordinated with the natural resource agencies to ensure that the design considers aspects of fish and wildlife conservation. The selection of other control technologies will have no bearing on the ranking of alternatives or the level of benefits derived from the project.

Berm Gaps. When the existing drainage channels were excavated in the swamp, the excavated material was cast to one side of the channel forming spoil banks. The size of the spoil banks vary, with the top elevations ranging from Elev. 4 to Elev. 12 (NAVD 88). From field observations and the hydro-dynamic modeling, it has been determined that the spoil banks currently block flow circulation into and out of the swamp, resulting in stagnant areas and poor circulation of water through the

hydrologic units. In the current configuration, the spoil banks would continue to prevent the diverted water from easily entering and flowing through the swamp. Therefore, new 500-foot wide berm gaps will be excavated in the spoil banks at an approximate spacing of 2,500 feet on center. The gaps will be excavated to the elevation of the adjacent swamp natural ground elevations, and the spoil will be disposed behind the existing spoil banks. The spoil will be placed up to Elev. 6 (NAVD 88) to provide additional refuge areas for wildlife during flood events in the swamp. It should be noted that during the PED process additional hydraulic modeling will be performed to optimize the width and spacing of the gaps to provide an optimal distribution of diverted flows. The optimization was not done as part of the feasibility study because the outcome of the optimization will not significantly change the cost of the gaps nor will it significantly change the benefits derived from the gap optimization. The gap optimization will be included with the swamp distribution operating plan which will also include the optimization of the control structures and the operating plan. While all of these actions will improve the final system, the outcome will not change the ranking of the alternatives based on either cost adjustments or benefits adjustments due to the optimization.

Cross Culverts at the Highway 61 Corridor. The hydrodynamic modeling of the swamp study area indicated that the KCS RR and the U.S. HWY 61 embankments disrupt the natural flow and circulation of water through the swamp. This resulted in hydrologic units east and west of the KCS RR/Hwy 61 corridor having stagnant water, poor drainage, and lack of sources of freshwater input. New culvert crossings will be added under the KCS RR and U.S. HWY 61 at four locations. Each installation will consist of 3 – 3' x 4' reinforced concrete box culverts. Note that there may be sufficient cross drainage openings at the KCS RR, and additional culverts may not be required. Earthen channels (large ditches) will be excavated across the 500-foot space between the KCS RR and U.S. HWY 61 to interconnect the drainage capacity at the railroad with the new culverts at U.S. HWY 61.

Instrumentation. Instrumentation will be required to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. Real-time data is required from the system components to allow the operator to control and adjust the system flow rates. Satellite communication will be provided at each control structure in the U.S. HWY 61 corridor to communicate to the control building via a satellite at the diversion facility. Typically, flow rates and water levels will be measured and the feedback data will be used to adjust gate positions to control the desired parameters at the diversion culvert and the control structures. The monitoring and control data will be collected, analyzed, and transmitted to and from a control building on the diversion culvert site. Following are the main instrumentation for data collection and control at each component:

Diversion Culvert – The flow control at the diversion culvert will establish the flow rate for the project. The diversion flow rate will likely be set manually

by an operator, with adjustments as necessary. The diversion culvert will have instrumentation for water levels at the culvert entrance and exit, for flow measurement, and for sluice gate positions. The control system at the diversion structure will be designed to automatically adjust the sluice gate openings as the Mississippi River stage varies to maintain a constant flow rate.

Control Structures – The control structures will require water level and water flow measurements on both sides. The control structures will likely have manually set positions, with occasional adjustments based on feedback from system monitoring.

Transmission Canal –The transmission canal will have level monitors at several locations to ensure that the berms are not overtopped.

Additional instrumentation may be required as part of monitoring and adaptive management.

Table 3-10 below provides a summary description of the Recommended Plan components.

Table 3-10: Recommended Plan Components

Item	Description
Diversion Culvert	3,000 cfs
Box Culverts[22]	3 – 10' x 10' reinforced concrete, multi-cell box culvert
Sluice Gates	3 – 10' x 10' cast iron gates with motor operators
Trash Racks	Coarse grid
Inlet Canal	Earthen channel – 40' bottom width, 4:1 SS, 27' deep
Transmission Canal	3,750 cfs (1.25x diversion flow rate)
Earthen Canal	155' bottom width, 4:1 SS, 12' deep
Berms	Earthen embankments, 12' top width, 3:1 SS (exterior)
Culverts at CN RR	8 – 12'x8' reinforced concrete multi-cell box culverts
Culverts at LA 3125	8 – 12'x8' reinforced concrete multi-cell box culverts
Control Structures	
Control Structure	Large concrete structure in existing channel
Control Building	Housing for instrumentation, HPU, generator

[22] Box culvert dimensions are horizontal x vertical inside dimensions.

Berm Gaps	
500-foot Wide Gaps	Excavate gaps at 2,500-foot spacing in spoil banks
Cross Culverts at Hwy 61	
Box Culverts	3 – 3'x4' Box Culverts at 4 locations
Instrumentation	
Local instrumentation	Monitoring and control at diversion and control structures
Stream Stage Monitors	Monitoring in Blind River and drainage channels
Communication	Remote satellites for communication to control building

3.7.4 Design, Environmental, and Construction Considerations

The purpose of the Blind River diversion project is to divert freshwater into the Maurepas Swamp to freshen the swamp, provide nutrients and sediment, and counter potential backflow of water from Lake Maurepas containing elevated levels of salinity. The hydraulic, hydro-dynamic, and environmental analyses of the swamp indicated that re-introducing freshwater from the Mississippi River back into the swamp and correcting the internal drainage and circulation problems could revitalize the target areas in the swamp. This is consistent with scientific research in the area that has indicated that once hydraulic connection is restored within a degraded freshwater swamp, tree vigor and stand productivity will increase (Shaffer *et al.* 2009). The hydraulic and the hydro-dynamic analyses identified means to divert the freshwater from the Mississippi River, deliver it to the swamp, and distribute it within the swamp to accomplish the environmental goals. The hydro-dynamic analysis identified specific actions necessary to improve the distribution and circulation of the water into and within the swamp. These included opening large gaps in the existing spoil banks along the existing drainage channels and adding cross culverts at the KCS RR and U.S. HWY 61 corridor to improve drainage and circulation between the hydrologic units in that area.

The major project components are primarily hydraulic conveyance and control structures designed to divert freshwater from the Mississippi River, transfer it to the Maurepas Swamp, and distribute and direct the diverted water into and through the swamp. Typically, the hydraulic designs were established through iterative processes that included the hydraulic needs, the hydraulic grade line of the overall system, component sizes, and costs.

The project will be constructed in two very different settings – upland areas where normal construction techniques apply, and the Maurepas Swamp where special

techniques and approaches will be required. Construction considerations include existing site conditions, access, construction techniques, temporary construction facilities, detours for transportation facilities, construction sequences, dewatering and surface water control, storm water pollution prevention plans, and balancing earthwork volumes. All of these items can impact the design and the cost estimates of the components. Based on HTRW research in the study area the potential to encounter HTRW is low in most of the study area, nevertheless if any solid or hazardous wastes, or soils and/or groundwater contaminate with hazardous constituents are encountered during the project LDEQ will be notified. Additional details for design and construction are presented in **Appendix L, Section 11**.

3.7.5 Real Estate Requirements

The real estate requirements are in two categories: permanent and temporary construction. The permanent real estate primarily is for the transmission channel between the Mississippi River at River Mile 162.1 and the St. James Parish drainage canal. This easement will be 500 feet (150 meters) in width and will be 15,500 feet (4,700 meters) in length. This total area will be approximately 180 acres (75 hectares). In order to provide a 100 foot (30 meter) offset temporary detour for LA 44, the Canadian National Railroad, and LA 3125, an additional 10 acres (4 hectares) of temporary easement will be required during the construction of crossing culverts and bridges.

The other real estate requirement is a dual use easement for the diversion structure at the levee where the diversion will be co-located in the easement for the flood control levee.

Another area for real estate consideration is the use of Louisiana state land in the Wildlife Management Area for the six (6) control structures and berm gap construction. This will require that surveys and agreements for construction in the Wildlife Management Area be obtained from the Louisiana Department of Wildlife and Fisheries (LDWF), but no costs for easements are anticipated.

The last real estate consideration is to obtain permits to construct the bridges and culvert on state highway right of ways. These will require the project to maintain traffic lanes open at all times due to the importance of the roadways as hurricane evacuation routes. The Canadian National Railroad will also require a permit to construct a bridge across the transmission canal. The Real Estate Plan for the project study area is presented in **Appendix J**.

3.7.6 Operations and Maintenance Considerations

Operations and maintenance considerations have to be addressed on the diversion structures, transmission canal, berm gaps, control structures, and U.S. Highway 61 Cross Culverts.

Diversion Structure:

- **Operations** – An operator would set the flow rate into the swamp and Blind River. The gates would be automatically controlled to maintain the flow based on river stage and downstream water surface conditions.
- **Maintenance** – Maintenance would include the computerized control and monitoring system, the diversion gates and inspection and cleaning of the inlet trash grates. General maintenance of the control building and landscaping would also be required.

Transmission Canal:

- **Operations** – The transmission canal would be self operating with monitoring of flow and stage transmitted to the control building for processing. An automatic diversion gate closure would be initiated if the freeboard in the channel is less than 1.0. The sediment level in the channel would be periodically monitored, and the canal crossing would be inspected at annual intervals.
- **Maintenance** – The transmission channel right of way would be mowed and maintained, and the sediment deposited in the channel would be monitored and removed by dredging annually. Any erosion of internal or external slopes would be repaired as required. Planned maintenance excavation within the transmission canal will be coordinated with state and Federal resource agencies.

Control Structures:

- **Operations** – The gates on the controls structures would be positioned to provide flow through the swamp as required for flow, sediment and nutrient distribution. The gates would be lowered in the anticipation of heavy rain events. Due to the slow drainage time for the channels, the gates would be lowered 24 hours in advance of rain events greater than 1 inch.
- **Maintenance** – The control structures would have hydraulically operated gates with electric motors on the hydraulic pumps and generators providing power to the motors. General maintenance of pumps, motors and generators would be required. The units would be inspected and maintained monthly.

Berm Gaps:

- **Operations** – The berm gaps would have no operating features.
- **Maintenance** – The gaps would need to be inspected twice each year and debris cleared from the gaps as required. Should the gaps silt in there may need to be limited dredging that would be accomplished when the drainage channel dredging is accomplished.

- **U.S. Highway 61 Cross Culverts:**
- **Operations** – The culverts would have no operating features.

- **Maintenance** – Culverts would be submerged and would need to be desilted on an annual basis to assure that flow openings are maintained.

The operating plan will be to divert the water from the Mississippi River at 3,000 cfs for 6 to 9 months each year. The remaining 3 to 6 months will most likely be at a lower flow to allow the swamp to drain and for the cypress seeds to germinate and produce saplings of sufficient height to provide for survival once the swamp is then hydrated with the diversion. The exact flow rates will be determined once all of the parameters of the system can be determined and the final configurations of all the elements are designed. The following elements will be revised as part of the actual operating plan:

- Level of the downstream water surface in Lake Maurepas and the Blind River based on average tide elevations. The tide is influenced by time of year and is greatly influenced by prevailing wind speed and direction.
- Level of water in the swamp will be higher when nutrients are delivered to the vegetation in the early spring and summer. As late fall arrives the swamp will be drained to allow the seeds from the cypress trees to germinate. The drying period does not need to be annual, but should occur at least every three years to be sure sufficient new trees are propagated.
- Nutrient values will be monitored to assure that the swamp is assimilating the nutrients to a level that does not adversely affect the Blind River and more importantly Lake Maurepas. The calculations of nutrient uptake indicate the eutrophication of the lake should not be an issue. Monitoring of River nutrient levels and blind River levels will indicate how the nutrient removal process is performing. There is also considerable local nutrient addition from agricultural practices that will be improved by allowing the local drainage to filter through the swamp prior to discharge to the Blind River.
- The sediment load is mostly deposited in the transmission canal and distribution drainage canals and will need to be removed at periodic intervals. The drainage canals will be dredged as they are currently by the parish. The transmission canal will be dredged and the material directed into the swamp for disposal in low areas to help with soil building.
- The water quality in the Blind River will be monitored at several locations to assure that diverted water is keeping appositive velocity in the River and providing sufficient flows to prevent stagnation and low dissolved oxygen levels that are currently experienced.

The operating plan can accommodate the manipulation of all of these elements due to the flexibility in the volume of diversion that can be controlled and the height of the water in the distribution channels that can be controlled by the control structures. The exact operating plan will change from season to season and year to year based on the varying elements of the system. The operating plan is designed to mimic the natural system before the man made elements were created and to

also counter the effects of subsidence and sea level changes. Additional operation and maintenance detail is presented in **Appendix L, Section 12.**

3.7.7 Monitoring Plan and Adaptive Management

A feasibility level monitoring and adaptive management (AM) plan have been developed for the Louisiana Coastal Areas (LCA) Small Diversion at Convent/Blind River project (**Appendix I**). The monitoring and AM plan for this project was developed with assistance from the LCA AM Formulation Team. The feasibility level monitoring and AM plan was developed to include a sufficient description of the proposed monitoring and adaptive management activities to identify the nature of proposed AM activities and to estimate the costs and duration of the monitoring and AM plan.

The project monitoring and AM plan describes and justifies adaptive management in relation to the proposed project management alternatives identified in the Feasibility Study. The plan also identifies how adaptive management will be conducted for the diversion at Convent/Blind River and who will be responsible for this specific AM program. The results of this project-specific AM program will be used to adaptively manage the project, including specification of conditions that will qualify project success and terminate the AM program. Status of the project as it is implemented and managed will be documented in a report by the managing agency approximately every three years.

The monitoring and AM plan identifies the restoration goals and objectives identified for the diversion at Convent/Blind River; outlines management actions that can be undertaken to achieve the project goals and objectives; presents a conceptual ecological model that relates management actions to desired project outcomes; and lists sources of uncertainty that recommend the project for adaptive management. Monitoring, assessment, decision making, and data management are also addressed in the monitoring and AM plan.

The level of detail in the monitoring and AM plan is based on currently available data and information from the FS/SEIS. Uncertainties remain as to the exact project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were estimated based on the currently available information. Uncertainties will be addressed in preconstruction, engineering, and design (PED), and a detailed monitoring and adaptive management plan, including a detailed cost breakdown, will be drafted at that time.

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes in the face of uncertainty. All projects face uncertainties with the principal sources of uncertainty including (1) incomplete description and understanding of relevant ecosystem structure and function, (2) imprecise relationships between project management actions and corresponding outcomes, (3) engineering challenges in implementing

project alternatives, and (4) incoherent management and decision-making processes.

Independent of adaptive management, an effective monitoring program is required to determine if the project outcomes are consistent with original project goals and objectives. The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management. A carefully designed monitoring program is central to the Convent/Blind River AM program. For each project objective the monitoring program indicates performance measures, the desired outcome, and the monitoring design. Adaptive management triggers will be determined later in the AM process.

The plan identifies performance measures along with desired outcomes and monitoring designs in relation to specific project goals and objectives. Additional monitoring is identified under supporting information needs to help further understand and corroborate project effects.

Objective 1: Promote water distribution in the southeast portion of Maurepas Swamp to move stagnant water out of the system

Performance Measure: Area of swamp inundated with diverted water during operational events

Desired Outcome: Increase from pre-project conditions area of swamp inundated for low flow to high flow events. Specific targets are:

- Increase the area of freshwater inundation for low to average flood events by 10 to 25 percent
- Increase swamp productivity as measured by a 5 to 10 percent annual increase in the diameter at breast height (dbh) of baldcypress and tupelo
- Decrease average total nitrogen in Blind River by 10 to 25 percent
- Decrease average total phosphorous in Blind River by 10 to 25 percent
- Increase average dissolved oxygen in Blind River by 5 to 10 percent

Monitoring Design: Synoptic hydrologic surveys, using salinity, temperature, dissolved oxygen, conductivity, turbidity, pH, and velocity as tracers, will be conducted during selected low flow and high flow operational events to track distribution of freshwater.

Objective 2: Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.

Performance Measure 2a: Sediment accretion and elevation

Desired Outcome: Accretion rate equals or exceeds subsidence rate after five years. The specific target is to increase sediment input by up to 1,000 grams per square meter per year.

Monitoring Design: Sediment erosion tables (SET) will serve as an elevation benchmark and marker horizons or sediment traps will be used to assess accretion.
Supporting Information Need: Total suspended sediment will be collected to help understand how sediment contributions through the diversion may enhance swamp productivity and land building.

Performance Measure 2b: Swamp production and extent
Desired Outcome: Increase in basal area increment of bald cypress & tupelo in the swamp from existing conditions, that is, existing conditions defined from preconstruction measurements from CRMS-Wetlands stations and Southeastern Louisiana University (SLU) historic monitoring
Monitoring Design: Diameter at breast height and overstory tree cover will be measured to estimate production.

Performance Measure 2c: Annual sediment discharge

Desired Outcome: Deliver 86,480 M tons of sediment through the Convent/Blind River diversion each year.

Monitoring Design: Hourly turbidity recorders will be deployed in the outfall channel and at hydrologic sites and correlated to TSS to investigate this measure.

Objective 3: Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seed germination and survival, by increasing the length of dry periods in the swamp.
Performance Measure 3a: Depth, duration and frequency of flooding in the swamp.
Desired Outcome: A statistically significant decrease from pre-project condition average flood durations (existing conditions defined from pre-construction measurements from CRMS stations). The project will be operated to facilitate dry periods. These dry periods should be targeted every year if possible.
Desired Outcome: Maintain dry periods (moist soils) in the swamp for a minimum 7-35 days during summer and early fall for seed germination and maintain water levels below seedling height to promote seedling survival.
Monitoring Design: Hourly hydrologic recorders will be deployed to investigate this measure.
Performance Measure 3b: Number of bald cypress and tupelo saplings
Desired Outcome: 25% increase in the number of bald cypress and tupelo saplings per acre from pre-project conditions five years after project implementation and 50%increase after 10 years. Performance of this measure is dependent on achieving extended dry periods in the swamp. In addition:

- Decreased flood duration in the swamp by 10 to 25 percent for high flood events

- Increasing the length of dry periods in the swamp (no standing water) by 10 to 25 percent
- Increase the number of baldcypress and tupelo saplings per acre by 25 to 50 percent.

Monitoring Design: Understory vegetation (herbaceous, seedling and sapling) will be measured to assess regeneration and changes in cover classes.

Objective 4. Improve fish and wildlife habitat in the swamp and in Blind River

Performance Measure: No applicable performance measure

Desired Outcome: Swamp production, hydroperiod, and water quality measures will be used to assess this objective.

Monitoring Design: Fish and wildlife habitat is linked to the performance measures associated with objectives 1-3, focused on improving habitat. Therefore, no specific monitoring is proposed for this objective.

Risk Endpoint: Water quality impairment in Blind River and Lake Maurepas

Desired Outcome: Do not create or contribute to nitrate loading in Blind River that will result in a Louisiana 303 (d) listing. If listed, a total maximum daily load (TMDL) assessment will be considered in coordination with Louisiana Department of Environmental Quality (DEQ).

Monitoring Design: Nutrient sampling will be designed in coordination with Louisiana DEQ, if needed.

Feasibility level of detail cost estimates were calculated for implementation of adaptive management and monitoring. **Table 3-11** details these costs.

Table 3-11: Preliminary Cost Estimate for Implementation of a Monitoring Program

Category	Activities	2 yr PED Set up & Data Acquisition	5 yr Construction	10 yr Post Construction	Total
Monitoring: planning and management	Monitoring workgroup, drafting detailed monitoring plan, working on performance measures	$135,900	$53,200	$210,100	$399,200
Monitoring: data collection	Landrights, site construction, and surveying	$129,300			$129,300
	Vegetation	$64,900	$103,700	$409,600	$578,200
	Hydrology	$229,200	$366,600	$1,447,300	$2,043,100
	Sediment input	$37,400	$59,900	$236,300	$333,600

	Sediment accretion and elevation	$25,900	$41,500	$163,800	$231,200
	Water quality	$64,000	$102,400	$404,400	$570,800
Database management	Database development, management, and maintenance, webpage development for communication of data to stakeholders	$62,400	$99,800	$393,900	$556,100
TOTAL		**$749,000**	**$827,100**	**$3,265,400**	**$4,841,500**

3.7.8 Effectiveness of Recommended Plan in Meeting Goals and Objectives

The overall Small Diversion at Convent/Blind River project objective is to reverse the trend of deterioration of Maurepas Swamp (west) and Blind River.

The Specific Project Objectives are to:

- Promote water distribution in the swamp to increase the area of freshwater inundation for low to average flood events from existing conditions and to increase swamp productivity and wetland assimilation.
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise by increasing swamp productivity and sediment input.
- Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seedling germination and survival by decreasing flood duration and increasing the length of dry periods in the swamp, and
- Improve fish and wildlife habitat in the swamp and in Blind River.

The Recommended Plan would meet the overall and the specific project objectives. The diversion will bring nutrients, sediment and water to the swamp to increase productivity and accretion (swamp building). The construction of new gaps in berms, maintenance of existing gaps in the berms, and strategically placed control structures in the major conveyance channels, along with the diversion, will promote water distribution to increase productivity and accretion (swamp building). The operational flexibility provided in the Recommended Plan will allow establishment of hydroperiod fluctuations in the swamp to improve seedling germination and survival. Nutrient assimilation in the swamp of water diverted from the Mississippi River will improve water quality and thereby the fish and wildlife habitat in the swamp and in Blind River. These activities would reverse the trend of deterioration of Maurepas Swamp (west) and Blind River.

3.7.9 Effectiveness of Recommended Plan in Meeting Environmental Operating Principles

The Recommended Plan is effective in meeting the environmental operating principles. The Recommended Plan is environmentally sustainable as it minimizes operational activities to the extent possible while maintaining operational flexibility to restore a viable natural system. The Recommended Plan was developed to reverse deterioration of the swamp and Blind River by utilizing the natural swamp building and assimilation processes balanced with appropriate management activities while minimizing environmental consequences. The improvement of bald cypress-tupelo swamp provided by the Recommended Plan will mitigate for the unavoidable wetland impacts resulting from project implementation. Monitoring and adaptive management will provide knowledge on how to effectively implement small diversion projects to maintain and protect valuable swamp ecosystems. In addition, the Recommended Plan was developed with the inclusion of important stakeholder input.

3.7.10 Compensatory Mitigation Measures

Compensatory mitigation is not needed for this project. Wetland impacts were avoided and minimized to the extent possible in the preliminary design of the Recommended Plan. The Recommended Plan will impact 53 acres (21ha) of wetlands with construction of the Romeville diversion canal. The wetlands that will be impacted are not part of Maurepas Swamp that will be improved (as described above). The improvement of 21,369 acres (8,648 ha) of bald cypress-tupelo swamp, that are in various stages of deterioration, will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal.

3.8 Risk and Uncertainty

Risk and uncertainty will be discussed as relates to the ability of the proposed system to meet the project objectives. Risk is defined as the reliability of an estimated value. Uncertainty is a measure of imprecision of knowledge of parameters and functions used to describe aspects of a project plan, such as the hydrologic, environmental and engineering design, operational performance and maintenance needs, as well as construction and economics. The following assumptions are key to the success of the project:

- The Mississippi River has sufficient sediment and nutrients to improve the characteristics of the Maurepas Swamp and within the 50 year life cycle the supply of sediment and nutrients will not change significantly. This assumption is based on historic information and demand versus supply within the River.
- There will be no legal restrictions imposed on withdrawing 3000 cubic feet per second from the Mississippi River.
- The net effects of local subsidence and sea level rise will not deviate significantly from the numbers estimated for this study.

- The study area can receive sediments and nutrients at an appropriate frequency without restrictions from the State agencies controlling the Wildlife Management Area.

3.8.1 Hydrologic Uncertainties

The hydraulic and hydrologic modeling results presented in the analysis to date (**Appendix L, Section 2**) have been developed with the best available information on historical hydrology, existing topography, sea level rise, subsidence, and accretion, however, each of these factors, alone or in combination, is subject to uncertainties which could pose risks to the hydraulic and ecological functionality of the project. These hydrologic uncertainties can be reduced as additional data is collected and additional modeling is conducted as the project moves forward. The uncertainties are discussed below:

Topography: All modeling to date has been completed using best available topographic and bathymetric data, in combination with available engineering plans to define channel cross-sections, roadway culverts, and surface storage areas. The available topographic data coupled with field reconnaissance provided sound definition of major hydrologic and hydraulic features for use in the development models. The model calculations that rely on topographic input such as estimates of water depths, residence times, and propensity of water to flow in assumed directions are limited in their resolution.

Future hydrology: The period of record used for extended analysis covered the period from 1989 through 2004. During this period, it appears that extended dry conditions that would support cypress germination and sapling survival occurred only every 5 to 6 years. The frequency at which conditions in the future may support growth cannot be accurately forecasted based only on this available data record. What can be inferred from the analysis is that careful flow management within the system can facilitate periodic hydrologic conditions that would support tree re-growth, but favorable ecological factors will also need to be present for this desired outcome.

- **Relative Sea Level Rise:** The basis for estimating relative sea level rise and associated impacts to the project are based on multiple components that all contain some elements of uncertainty as discussed below: Relative sea level rise consists of eustatic sea level rise and subsidence.
    - **Eustatic Sea level rise:** USACE estimates for 50-year eustatic sea level rise (without the relative impacts of subsidence or accretion) range from 0.28 feet to 2.00 feet. This is a very broad range, as it coincides generally with the magnitude of normal water level fluctuations in the swamp. Future conditions for this project used the intermediate eustatic sea level rise estimate of 0.67 feet (coupled with subsidence for a relative rise of 1.90 feet).

- **Subsidence:** Future subsidence rates used in this project, per USACE guidance, were 7.5 mm per year. This corresponds to 1.23 feet over a 50-year period. This is based on the measured local increase in sea level over 50 years (9.20 mm/yr) minus the global eustatic rate of sea level rise (1.7 mm/yr). Coupled with the intermediate value of eustatic sea level rise, this yields a relative sea level rise of 1.90 feet over a 50-year period. However, the range of 50-year relative sea level rise estimates when subsidence is included is still very broad: 1.51 – 3.23 feet. Further uncertainty is introduced when considering the subsidence value alone. For example, the LCA Amite River Diversion Canal Modification (ARDCM) Project used a subsidence estimate of 7.5 mm/year, selected from an estimate range of 4 mm/yr to 20 mm/year based on projects and limited research available for the region. Shaffer et al. 1992 cited (Turner and Cahoon, 1987) and presented a subsidence rate of 7.5 mm/yr for the Atchafalaya Delta region.
- **Accretion:** Estimates of future accretion rates are not included in the projections of future relative sea level rise. The LCA ARDCM Project identified a range of 5 mm/year to 25 mm/year of accretion, with an intermediate estimate of 12 mm/year. Over a 50-year period, this range translates into 3.28 feet of uncertainty with respect to accretion alone. The intermediate rate of 12 mm/year translates into 1.97 feet over 50 years, which would roughly offset the relative sea level rise of 1.90 feet (eustatic sea level rise plus subsidence). Rybczyk et al. (2002) reported on the effects of adding nutrient-rich, secondarily treated wastewater to a subsiding, forested wetland at Thibodaux, Louisiana and indicate that accretion rates in the treatment wetland site were 1.1 cm/yr or 11.0 mm/yr. In evaluating diversion of water, nutrients and sediment into forested wetlands upstream of the Bonnet Carre Spillway, Day et al. (2007) indicate that based on the amount of water diverted, the deposition of mineral sediments, the relationship between vertical accretion and mineral sediment deposition, accretion is expected to be 22mm/yr. Therefore, an accretion rate with a diversion is expected to keep pace with rates of RSLR (9.2 mm/yr).
- **Combined Effects:** Using ranges applied to the Blind River project and also developed for the LCA Amite River Diversion Canal Modification project, the cumulative 50-year effects of uncertainty with respect to eustatic sea level rise, subsidence, and accretion are as follows, using combinations of extreme values:
  - **Highest Estimated Relative Sea Level Rise:**

    Maximum Eustatic Rise + Maximum Subsidence – Minimum Accretion

    2.00 ft + 3.28 ft – 0.82 ft = **4.46 feet**
  - **Lowest Estimated Relative Sea Level Rise:**

Minimum Eustatic Rise + Minimum Subsidence – Maximum Accretion

0.28 ft + 0.66 ft – 4.1 ft = **-3.16 feet**

The total range, then, of cumulative effects of land and sea changes is approximately 7.62 feet, which represents a large range of potential future conditions, especially considering that the range spans almost equally in opposing directions. Relative sea rise conditions that result in a relative sea level reduction will not pose risk to the project, while increases in relative sea level could impact project performance. The use of intermediate values for all factors produces an estimated relative sea level rise is -0.07 feet, representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise.

Using intermediate values from available regional estimates of each contributing factor (eustatic sea level rise, subsidence, and accretion) suggest that relative sea level rise over 50 years will not produce the adverse hydrologic impacts to project performance that were analyzed. Analysis results developed for Alternative 2 are presented in this report and utilized relative sea level rise for three projections; low, medium and high. The rates of sea level rise and the rate of accretion relative to the existing elevation of the swamp is depicted for reference **in Figure 3-12 and 3-13** below. A review of these graphs indicates that with project accretion will keep up with relative sea level rise under low and intermediate forecasts, but without project accretion will not be able to keep up with relative sea level rise for any of the three sea level rise forecasts.

Hydraulic modeling was not completed with explicit representation of accretion and sedimentation (in order to offer conservative "worst case" estimates). The relative rise has been applied in the modeling analysis at the downstream boundary condition, specifically the water level in Lake Maurepas, and the primary impact it has on model results is increased backflow of Lake water into the swamp, and a greater need for diverted water in future years to overcome the backflow.

However, it is conceivable that the water levels in the Mississippi River (upstream boundary condition and flow input for this project) could also be affected by combined effects of eustatic sea level rise and changes in sediment load. This is important because the flow rating curves developed for the gravity-based diversion structure are based on the differential head across the system, not just on the water level in the Mississippi River. If downstream water level rises in Lake Maurepas but Mississippi River water levels are largely unchanged, the physical ability to divert water could be diminished.

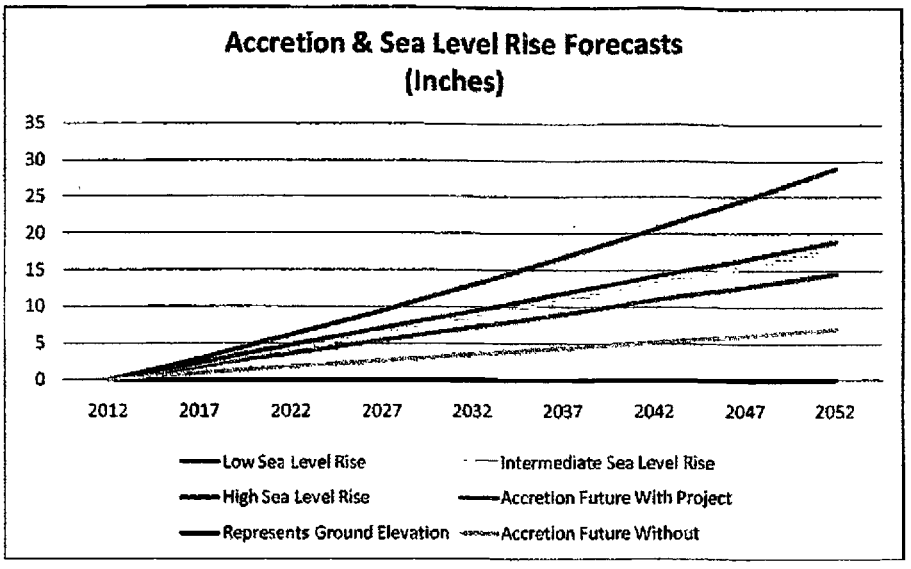


Figure 3-12. Accretion and Sea Level Rise Forecasts for the Recommended Plan

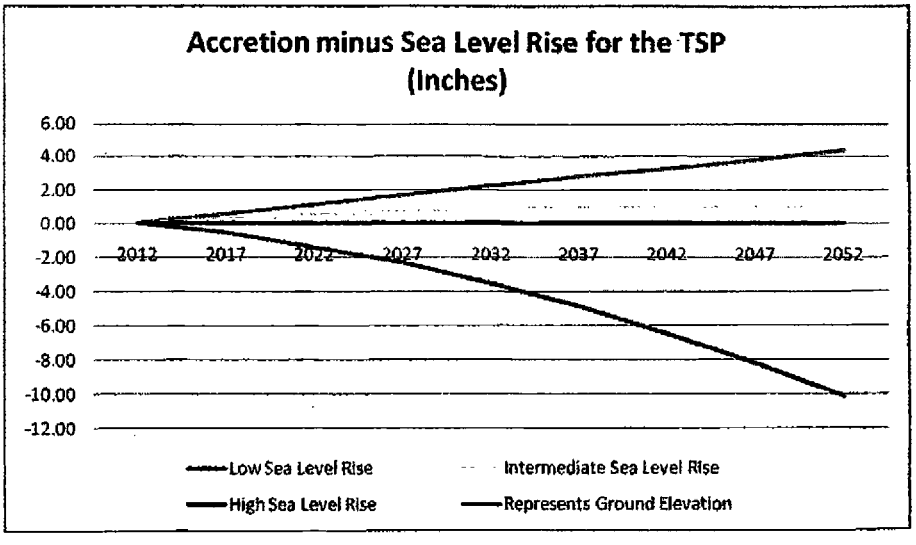


Figure 3-13. Accretion minus Sea Level Rise for the Recommended Plan

Specific forecasts of future water elevation trends in the Mississippi River near the study area are not readily available, so the analysis presented herein should be evaluated with the following considerations:

- If the Mississippi River water level does not change appreciably in the future, total diversion capacity could be diminished based on the assumptions guiding the application of sea level rise estimates to Lake Maurepas (less differential head across the system, and correspondingly lower diversion flows). As stated elsewhere, if intermediate projections for all contributing factors to relative sea level rise are applied together, the net effect could be almost negligible (counterbalancing effects). Hence, while there is the potential that rising relative sea level coupled with stationary river level could reduce diversion throughput, there is some uncertainty with these projections.
- If the Mississippi river water level rises in future decades, it should improve the ability to divert water to the Blind River system when compared to stationary water level in the river.

It is uncertain which of these scenarios is more likely to occur, and to what degree. Therefore, the project team has evaluated the effects of the different phenomena in sensitivity analyses. The worst case for diversion project performance would be higher levels in Lake Maurepas that do not appreciably affect the Mississippi River. This case would effectively reduce the gravity head gradient from the diversion to the Maurepas Swamp system and increase the need for more diverted flow to provide equal swamp restoration and flushing benefits.

The following two factors were used in deciding how to estimate the design level upstream boundary conditions in future decades:

- Intermediate (medium) projections of relative sea level rise, accounting for eustatic changes, subsidence, and accretion, suggest that the relative rise could be practically negligible.
- If relative sea level does change appreciably, it might be inferred that backwater elevations in the Mississippi River could also increase, if not in direct proportion, somewhat commensurately.

Significant uncertainty in each contributing factor provides the possibility for relative sea rise conditions that could affect the performance of the project. The sea level rise scenarios that were evaluated are considered to be conservative, since they account for eustatic rise and subsidence, but not for accretion. Uncertainty associated with relative sea level rise can be reduced with the collection and incorporation of additional information during subsequent project phases to better define local subsidence and probable accretion rates. In addition, adaptive management strategies should continue to be incorporated into the planned project in order to minimize potential impacts of relative sea and land elevations in the future. As additional information becomes available consideration of future

conditions will continue to be refined during project design and to facilitate adaptive management after construction.

In the analyses performed, the use of intermediate values for eustatic sea level rise, subsidence, and accretion produces an estimated relative sea level rise representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise. This suggests that that relative sea level rise will not produce adverse hydrologic impacts in project performance.

Hydraulics and Flood Levels: During the feasibility study phase of the Blind River project the hydraulic modeling was confined to the project area. During the PED phase the hydraulic modeling will be expanded to include several additional refinements to the results reported for the project for the feasibility phase. The areas where additional modeling will be conducted include downstream hydraulic benefits, effects of nutrients on downstream systems, water surface elevation control mechanisms as part of the operations system, optimization of flow through the berm gaps for both flooding and drainage of the swamp. The results of these additional investigations will be disclosed to the public. The additional work to refine the hydraulics during PED will optimize the Recommended Plan, but the ability to optimize the current plan will not make any of the previously considered alternatives more cost effective.

The level of hydraulics performed for the feasibility phase of the project leaves low levels of uncertainty that the existing plan is viable and will achieve the objectives and stated benefits of the project. The primary purpose of additional modeling will be to assist with better definition of the operations plan for the timing and control of diversions and for the adaptive management plan for in-swamp modifications to improve vegetation productivity. The key point is that the Maurepas swamp is a natural system and will be allowed to evolve naturally. As the ecological evolution of the swamp is monitored the project will have the flexibility to adapt to that evolution. The hydraulic modeling was adjusted over a wide range that indicates that the project can operate within those ranges and achieve the objectives and stated benefits. So while there are some hydraulic uncertainties, they can be accommodated within the operations plan of the system once it is optimized.

During PED there will be additional emphasis on how the operations system will work with the diversion optimization to control the amount of additional water surface level increase that would correspond to any adverse flooding effects. During the feasibility study the hydraulic calculations showed that the diversion flows presented no adverse impacts to water surfaces that were not already present due to rainfall and extreme tidal events. The entire area is subject to extreme tropical tidal surge events that far exceed the levels expected by the diversion of 3,000 cubic feet per second. There will be a need to coordinate the stopping of the diversion flows with high tidal and rainfall events so that the current level of flooding is not increased.

3.8.2 Environmental Uncertainties

Environmental uncertainties include the amount of water, sediment and nutrients needed to reverse swamp degradation, the affect of existing conditions on swamp degradation, and the level of future salinity impacts to the swamp. Less impoundment and greater throughput of water and an increase in hydro period fluctuation are needed to reverse swamp degradation, but the optimal target hydro period to maximize swamp productivity, accretion, nutrient assimilation, seed germination and sapling survival is unknown. Available information has been summarized regarding how swamps respond to a diversion or other applications of water, sediment and nutrients but the specific needs and the optimal target hydro period to reverse the degradation of this swamp will be determined through monitoring and adaptive management. These environmental uncertainties can, to some extent, be reduced in the future through adaptive management practices.

Water quality within the swamp and downstream of the swamp will likely change with diversion flow over time (refer to **Appendix L, Section L2.5.8.5**). The expectation is that water quality will improve in the swamp and the Blind River as freshwater, nutrients, and sediments from the Mississippi River are delivered to the project area by the project. The feasibility phase modeling of water flow and water quality used the best available data, however limited, to simulate existing conditions and estimate future change in water quality. While some uncertainty of change in water quality exists, water quality monitoring stations installed within the swamp and along Blind River as part of the feasibility phase will result in more substantial water quality and salinity data that will be used to refine water quality modeling during the PED phase. Additionally, as data and further analysis on other projects in the Maurepas Swamp area, such as Hope Canal, are available, the cumulative effects of all projects on water quality will be examined more fully. These additional data, analysis, and refined modeling results will be disclosed to the public prior to construction and a supplemental NEPA document prepared as appropriate.

3.8.2.1 WVA Results for Sea Level Rise Scenarios

In accordance with U.S. Army Corps of Engineers guidance outlined in EC 1165-2-211, project performance was assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. Using the relative sea level rise rate of 9.20 mm/yr (a historic rate representative of the project area based on the West End at Lake Pontchartrain gage-85625) a starting year of 2012, and a 50-year project life, the low relative sea level rise rate is 1.51 feet for the year 2062. The low relative sea level rise rate of 9.20 mm/yr includes both eustatic sea level rise and subsidence. Estimates of the intermediate and high relative sea level rise rates were determined from NRC curves I and III.

The diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the

existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp. Because in-swamp management is a feature of all alternatives there are considerable WVA benefits in the first 20 years as a result of those features, and the difference in AAHUs between alternatives is minimized.

The benefits of the Recommended Plan (Alternative 2) in terms of Average Annual Habitat Units (AAHUs) for low, intermediate, and high sea level rise estimates indicates 6,741, 6,421, and 5,459 AAHUs, respectively (Table 3 in **Appendix K**). A comparison of these values indicates that the low sea level rise AAHU value is 5% greater than the intermediate sea level rise AAHU value and the high sea level rise AAHU value is 15% less than the intermediate sea level rise AAHU value.

The WVA does not show a distinction (or change in suitability indices) between habitat classes and between FWP and FWOP for basal area because throughout most of the project area is considered to be within the optimal range for basal area to support wildlife habitat. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The project area is semi-permanently flooded and future-with-project modeling projections indicates that the flooding regime within most of the project area will return to pre-project conditions by target year 20 as a result of relative sea level rise. However, hydrologic flow will be improved and will provide additional benefits by increasing forest stand vigor, accretion, water quality and back flow prevention (Gary Shaffer, personal communication, October 2009).

Monitoring for adaptive management, including water levels, salinity, and accretion rates will provide data to better identify/quantify influence areas and how water, sediments and nutrients move through the system and within each hydrologic unit. These data as well additional topographic data in the swamp can be incorporated in to the hydrologic models in support of adaptive management activities and modification of the diversion operation plan (refer to the Monitoring and Adaptive Management Plan in **Appendix I**). As the project is further refined in the PED phase as well as through adaptive management thereafter, state and federal agency coordination will be continued to fully and adequately address any changes that could impact accretion rates, water quality, fish and wildlife, threatened or endangered species, essential fish habitat, bald eagles, and nesting bird colonies. Consultation with USFWS and NMFS will be reinitiated if and when warranted.

3.8.3 Construction and Economic Uncertainties

Construction and engineering design uncertainties include diversion flow control as a function of variability in the Mississippi River, amount of sedimentation in the transmission canal, the type and amount of contaminants in the diverted water, the

level of erosion control needed, structural and geotechnical issues related to berm improvement and placement of water control structures, high groundwater during construction, the need for special construction equipment and construction techniques in and near the swamp, and maintenance needs. These uncertainties will be addressed in final design. Uncertainties that will be considered during actual construction phase include identification/location of and avoidance of nesting bird colonies and bald eagle nests. Coordination with the appropriate regulating agencies will minimize disruption to area avifauna. Construction will also be subject to obtaining all necessary permits to work in the area and construction timing will consider migration and nesting seasons. Economic (cost) uncertainties include embankment quantities, geotechnical results (incomplete), detailed designs for control structures, pricing (including localized effects), price trends, and inflation. These uncertainties are accounted for through conservative design and cost estimating including contingencies coupled with a 25 percent project scope contingency. These construction and economic uncertainties can, to some extent, be reduced in the future through additional data collection and analysis and through adaptive management practices.

Because the project relies upon the St. James Parish drainage system to convey freshwater from the Mississippi River to the swamp the potential impacts of the project on flooding was analyzed. The results of the analysis determined that the construction of the gaps in the existing St. James drainage system will provide connectivity allowing flow to pass through the drainage system and into the swamp without increasing the risk of flooding. There are no inhabited structures in close proximity to the project influence area. According to modeling conducted during the study no flooding impacts are anticipated. A more extensive modeling effort and additional flow monitoring will be performed part of the PED process. The additional modeling and monitoring will provide additional data to determine the exact water surface elevations to verify and refine the operation plan of the diversion as necessary to assure that flood stages are not adversely affecting properties.

3.8.4 Real Estate Uncertainties

Some uncertainty exists with the ability to ensure that the projected project benefits are attained and maintained in the absence of further restrictions on land use within the project benefits areas. The portion of the Maurepas Swamp that is part of the project is owned by the Louisiana Department of Wildlife and Fisheries (LDWF). The LDWF has established procedures for granting permits for exploratory activities on its WMAs. Exploratory activities, if permitted, could have some localized adverse impacts on the project benefits area. However, it is our opinion that exploration would be highly unlikely given that there are no active wells within the project area and that the major mineral interest owner is a conservation foundation. Further risk assessment and analysis will be conducted

together with identification of approaches that may be appropriate to manage identified risks.

3.9 Implementation Requirements

3.9.1 Schedule

Table 3-12 presents the steps and milestones required to complete the feasibility report, obtain project approvals, authorization of construction, final design and construction. The TSP/NER plan can be implemented with existing authorities. Following completion of a report of the Chief of Engineers with a positive recommendation for the project, provided that the Chief completes his report before December 31, 2010, the project would be eligible for construction funding. The project is expected to begin Pre construction Engineering and Design in late 2010 and begin construction in 2012. See Table 3.12. The project would be considered for inclusion in the President's budget based on: national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to find its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the Corps and the non-Federal sponsor would enter into a project partnership agreement (PPA). The PPA would identify the Federal and non-Federal responsibilities for implementing, operating and maintaining the project. Project construction would begin following the certification of the real estate requirements. After construction, the Corps' acceptance from the contractor and notice of construction completion of the project (or a functional portion of the project) to the non-Federal sponsor would proceed or be concurrent with the delivery of an O&M manual and as-built drawings.

Table 3-12: Milestone Schedule

Milestones	Schedule
Final Report	August 2010
Division Engineer Notice	August 2010
Washington Level Review	August 2010
Execute Cost-Sharing Agreement for PED	September 2010
State and Agency Review	October 2010
Chief of Engineers Report	December 2010
Begin Preconstruction Engineering and Design	2010

ASA and OMB Review	2011
ASA Report to Congress	2011
Complete Design Documentation Report	2011
Complete Plans and Specifications	2011
Execute PPA	2011
Complete Real Estate Acquisition	2011
Advertise Construction	2012
Construction Start	2012
Complete Construction	2015
Turnover Project to Local Sponsor	2015
Initiate Monitoring and Adaptive Management	During PED
Complete Monitoring and Adaptive Management	2025

3.9.2 Implementation Responsibilities

The non-Federal sponsor shall, prior to implementation, agree to perform all of the local cooperation requirements and non-Federal obligations. Local cooperation requirements and non-Federal sponsor obligations include, but are not necessarily limited to:

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

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

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

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and

construct improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material that the Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;

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

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

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

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

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

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

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

h. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

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

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

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

l. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as would properly reflect total costs of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

m. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until

the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

n. Comply with all applicable Federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying, and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.); and

o. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

3.9.3 Cost Sharing

The State of Louisiana, acting through the Coastal Protection and Restoration Authority of Louisiana (CPRA), will be the non-Federal sponsor for the LCA Small Diversion at Convent/Blind River Project. In November 2008, the USACE and CPRA executed a single Feasibility Cost-Share Agreement covering six Louisiana Coastal Area near-term plan elements listed in Section 7006(e) of the Water Resources Development Act of 2007. The six features each underwent a separate feasibility analysis and environmental compliance analysis culminating in a single master feasibility document. The cost-share during the feasibility phase was 50% Federal and 50% non-Federal. However, the individual elements have been divided so that each entity had lead responsibility for preparing three of the six report components. At the end of the feasibility phase the total cost for all elements will have been shared on a 50/50 basis, yet for work on each individual element during the feasibility phase the ratio of funds expended by either the Federal or non-Federal sponsor will be higher depending upon their level of responsibility. CPRA had the technical planning lead for this particular LCA project element.

Following the feasibility phase, the cost share for the planning, design and construction of the project will be 65% Federal and 35% non-Federal. The CPRA

must provide all lands, easements, rights-of-way, utility or public facility relocations, and disposal areas (LERRDs) required for the project. Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) of the project would be a 100% CPRA responsibility.

Under current law, authority for the non-Federal sponsor to receive credit for construction activities is limited. Section 7007(a) of WRDA 2007 authorizes the Secretary to credit, "toward the non-Federal share of the cost of a study or project under this title the cost of work carried out in the coastal Louisiana ecosystem by the non-Federal interest for the project before the date of the execution of the partnership agreement for the study or project." In addition, section 7007(a) incorporates the requirement of section 221 of the Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) that the Government and non-Federal sponsor must enter into a separate agreement for any work that will be carried out prior to execution of the partnership agreement. In other words, work undertaken by the non-Federal sponsor prior to (but not after) execution of the project partnership agreement (PPA) is eligible for credit subject to execution of a separate agreement covering such work before it is undertaken. For design work that the non-Federal sponsor proposes to undertake, the Design Agreement will serve as the required separate agreement. For construction work that the non-Federal sponsor proposes to undertake, an In-Kind Memorandum of Understanding will be required. Opportunities to enter into an In-Kind MOU for construction activities will depend on the schedule for entering into the PPA for a project.

Section 7007(d) provides that credit afforded under section 7007 that is in "excess" of the non-Federal cost share for a study or project authorized in Title VII of the Water Resources Development Act of 2007 may be applied toward the non-Federal cost share of any other study or project under that title. "Excess" credit will be applied only toward another study or project involving the same sponsor. In addition, "excess" credit will be applied within project phases (i.e., study to study, design to design, and construction to construction). At this time, it is anticipated that that there are limited opportunities for the application of "excess credit" from other Title VII projects toward these projects.

Table 3-13 below provides the distribution of cost for the fully funded project cost estimated. The estimate includes contingencies based on a risk and uncertainty analysis using the Crystal Ball computer program, price escalation to October 2011, and inflation to the midpoint of construction. According to the MCACES cost estimate developed, the total costs of constructing the Recommended Plan is $123,140,000. The Federal cost-share for construction of the Recommended Plan would be $80,041,000 and the non- Federal cost share would be $43,099,000. Operation and maintenance costs will be $462,000 annually and the cost to dredge sediments from the transfer canal will be $2,200,000 annually.

Operation and maintenance activities will include (but are not limited to) starting and stopping the diversion(s), routine equipment and instrument maintenance, corrective equipment and instrument maintenance, and gap and culvert cleaning. The annual estimated cost for operation and maintenance activities is $462,000.

Annual maintenance dredging or de-silting is anticipated to remove sediments deposited in the Transmission Canal during operation of the diversion system. The Mississippi River carries a significant suspended solids load. It is expected that the flow diverted into the diversion operation will have the same characteristics, and will cause a reduction in Transmission Canal volume due to sediment accumulation.

The project is not anticipated to induce shoaling on the Mississippi River. However, if further analysis determines that the project increases maintenance dredging requirements for the Mississippi River, Baton Rouge to the Gulf of Mexico, Project by inducing shoaling, the incremental costs of any additional maintenance dredging would also be a 100-percent non-Federal responsibility.

Periodically major project components may have to be repaired, rehabilitated, or replaced. The annual cost for repair, rehabilitation, and replacement is $92,000.

The total annual cost for OMRR&R is $2,754,000. During the PED phase of the project there will be Value Engineering reviews to look at all aspects of the project to reduce the Operation and Maintenance costs along with capital costs to optimize the life cycle cost of the project.

Table 3-13: Cost Sharing

ITEM	FEDERAL	NON-FEDERAL	TOTAL (Rounded)
LERRDs to be acquired		$4,040,000	$4,040,000
Facility/Utility Relocation		$14,060,000	$14,060,000
Highway		$1,820,000	$1,820,000
Railroad		$2,090,000	$2,090,000
Subtotal Real Estate		$22,010,000	$22,010,000
Construction	$77,610,000		$77,610,000
Planning, Engineering, & Design	$5,812,500	$1,937,500	$7,750,000
Construction Management	$9,150,000		$9,150,000
Subtotal Construction	$94,510,000		$94,510,000
Adaptive Management	$6,620,000		$6,620,000

Subtotal 65/35 Cost Share	$99,192,500	$23,947,500	$123,140,00
Adjustment for 65/35 Cost	($19,151,500)	$19,151,500	
TOTAL FIRST COST*	$80,041,000	$43,099,000	$123,140,00
PERCENT OF FIRST COST	65%	35%	
Annual Operation & Maintenance	$0	$462,000	$462,000
Annual Repairs, Replacement and Renewal	$0	$92,000	$92,000
Annual maintenance dredging	$0	$2,200,000	$2,200,000

** Represents fully funded cost including interest during construction*

3.9.4 Environmental Commitments

A summary of the environmental and related commitments made during the planning process and incorporated into the proposed project plan is as follows. Mitigation measures are proposed to reduce or avoid impacts that would otherwise occur as a result of the implementation of the preferred alternative. These commitments would be implemented by construction contractors or management authorities. Some commitments, such as monitoring, would continue beyond completion of construction of facilities.

Throughout the planning process for the proposed project, efforts have been made to avoid impacts where practicable. If avoidance was not possible, then mitigation measures have been developed to reduce the level of impact. The Recommended Plan will impact 53 acres (21ha) of wetlands with construction of the Romeville diversion canal. The wetlands that will be impacted are not part of Maurepas Swamp that will be improved. The improvement of 21,369 acres (8,648 ha) of baldcypress-tupelo swamp that are in various stages of deterioration, will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal.

Other management practices would be employed during construction activities to minimize environmental effects and would be included in construction specifications. Many of these measures are required in order to comply with Federal, State, or local laws and regulations, regardless of whether they are specifically identified in this document. Project implementation will comply with all relevant Federal, State, and local laws, ordinances, regulations, and standards during the implementation of the preferred alternative. Implementation of the environmental commitments for the proposed project will be documented to track the completion of the environmental commitments.

Environmental Commitments:

- Ensure that construction contractors limit ground disturbance to the smallest feasible areas.
- Use accepted erosion control measures during construction.
- To minimize disturbance to bald eagles and other raptors nest searches will be conducted up to three-quarters of a mile of proposed activities prior to construction to avoid active nests. Appropriate protective measures will be implemented to avoid or minimize nest disturbance if active nests are found.
- Contact pipeline and gas well companies prior to construction activities to identify and avoid existing hazards.
- Construction contractors will use and implement measures contained in erosion control guidelines and BMPs to control soil erosion from construction areas.
- Construction contractors will implement measures to control fugitive dust during construction.
- Implement a program to compensate for losses of archaeological sites (if any) that would occur as a result of construction and operation of the proposed project.

Formal consultation was conducted on the pallid sturgeon in compliance with ESA of 1973. A Biological Opinion (**Appendix A**) was received on September 23, 2010 from the USFWS outlining the following Reasonable and Prudent Measures and Terms and Conditions:

> ***REASONABLE AND PRUDENT MEASURES***
> *The Service believes the following reasonable and prudent measures (RPMs) are necessary and* ***appropriate*** *to minimize the incidental take of pallid sturgeon by entrainment through the small diversion at Convent/Blind River.*
>
> > *1. Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).*
> > *2. Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.*
> > *3. Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.*

4. The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.
5. In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.
6. The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.
7. The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.
8. Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken .

TERMS AND CONDITIONS
In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.
2. Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.
3. Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.
4. Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type

should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.

Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

3.9.5 Financial Requirements

It is expected that the CPRA will have the capacity to provide the required local cooperation for the Recommended Plan. A project schedule and cost estimate will be provided to the CPRA so that it may develop a financing plan. A standard cost share percentage of 65% Federal and 35% non-Federal would be applied to the total first cost of the project, including the value of LERRDs, pre-construction engineering and design and construction features.

Section 7007(b) of WRDA 2007 provides that "The non-Federal interest may use, and the Secretary shall accept, funds provided by a Federal agency under any other Federal program, to satisfy, in whole or part, the non-Federal share of the cost of the study or project if the Federal agency that provides the funds determines that the funds are authorized to carry out the study or project." If the Mineral Management Services determines in writing that funds it provides to the non-Federal sponsor under the Energy Policy Act of 2005 (Coastal Impact Assistance Program - CIAP) and the Gulf of Mexico Energy Security Act of 2006 (GOMESA) are authorized to be used to carry out the Small Diversion at Blind River project, the non-Federal sponsor can use those funds toward satisfying its local cooperation for the project, including the non-Federal sponsor's acquisition of Lands, Easements, Relocations, Rights of-way and Disposals (LERRDs) required for the project.

By letters dated July 2, 2009 and December 18, 2009, the Minerals Management Service and the USACE established a process for the Minerals Management Service to provide its written determination regarding the acceptability of the use of CIAP funds for LCA studies, projects, and programs. That process provides that the Minerals Management Services' written determination for a specific study, project, or program will take the form of the grant award document for that activity.

3.9.6 Views of Non-Federal Sponsor

As demonstrated in its August 9, 2010 letter of support for the LCA WRDA Section7006 (e)(3) projects, the CPRA has expressed the desire to implement and

sponsor the LCA Small Diversion at Convent/Blind River project in accordance with the items of local cooperation that are set forth in Section 3.9.2 and subject to the discussion provided in Sections 3.9.3 and 3.9.5. In addition, CPRA supports the Recommended Plan (TSP/NER-Alternative 2) since this plan best meets the screening criteria; would accomplish the planning objectives, and goals; is cost-effective and is a best-buy, and would reverse the trend of deterioration in the southeast part of the Maurepas Swamp. Specifically, Alternative 2 would improve over 21,000 acres of baldcypress-tupelo swamp that are in various stages of deterioration.

The State of Louisiana fully supports the project. The state recognizes that the USACE's position is that section 7007 does not authorize credit for work carried out after the date of a partnership agreement. However, the state disagrees with the USACE position and intends to continue to seek a change in law that would allow in-kind contribution credit for work carried out after the date of a Project Partnership Agreement and that would allow for such in-kind contributions credit to carry over between LCA Program components (i.e., "excess" credit for work undertaken after signing of the project partnership agreement for one project may be carried over for credit to another project). Nevertheless, while the state is of the opinion that its view is consistent with the authority and Congressional intent under WRDA 2007, the state fully intends to proceed with the project under the Corps' interpretation of current law and to meet all non-Federal financial and other obligations outlined by the USACE in this report until such time as the law is changed.

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4.0 AFFECTED ENVIRONMENT*

This chapter describes the location, climate, geomorphic and physiographic setting, and historic and existing conditions for the following important resources: soils and water bottoms; hydrology [including flows and water levels, sedimentation and erosion, water quality, and groundwater]; vegetation resources; wildlife and habitat; fisheries; aquatic resources; EFH; threatened and endangered species; cultural and historic resources; aesthetics; recreation; and socioeconomic and human resources [including displacement of population and housing, employment, business, and industrial activities, availability of public facilities and services, transportation, infrastructure, environmental justice, water use and supply, navigation, land use socioeconomics (i.e. agriculture, forestry, and public lands), man-made resources (i.e., oil, gas, and utilities, and flood control and hurricane protection), and natural resources (i.e., commercial fisheries)]. In addition, the characterization of air quality, noise, and hazardous, toxic, and radioactive waste (HTRW) in the study area are presented.

A resource is considered important if it is recognized by statutory authorities including laws, regulations, Executive Orders (EO), policies, rules, or guidance; if it is recognized as important by some segment of the general public; or if it is determined to be important based on technical or scientific criteria. The following sections discuss historic and existing conditions of each important resource occurring within the study area, with the area of interest expanded to include Lake Maurepas where relevant.

More detailed descriptions of climate, geomorphic and physiographic setting and important resources is provided in the 2004 programmatic environmental impact statement for the Louisiana Coastal Area (LCA), Louisiana, Ecosystem Restoration Study (LCA PEIS 2004). Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 pertinent and applicable information from the LCA PEIS is incorporated by reference. The content of the material incorporated by reference will be briefly described for context.

4.1 Environmental Setting of Study Area

4.1.1 Location

The Study Area for this project is included as portions of the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Upper Sub-Basin of the Lake Pontchartrain Basin. Located approximately equidistant between Baton Rouge and New Orleans, Louisiana, St. James Parish contains most of the Study Area, but the northwest portion of the distribution area extends into Ascension Parish. With regards to ecological communities, the Study Area is within the Mississippi Alluvial Plain (Level III) Inland Swamp (73n) and Southern Holocene Meander Belts (73k) (Level IV) ecoregions (Daigle et al. 2006). The Study Area includes the proposed construction footprint (intake locations and transmission canals) and distribution area.

4.1.2 Climate

Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the climate provided in the LCA PEIS (2004) is hereby incorporated by reference. The climate of the Study Area is subtropical marine with long humid summers and short moderate winters. Long-term, daily precipitation data (1930-present) within the vicinity of the Study Area reveal an average annual rainfall of 60.49 inches (153.65 cm) with a low of 40.48 inches (102.82 cm) and a high of 93.15 inches (236.60 cm) (NOAA 2009: station id 2534). Across years, rainfall is relatively evenly split between months (NOAA 209) though the Study Area is subject to periods of both drought and flood, and the climate rarely seems to truly exhibit "average" conditions (MsCIP 2008).

The Study Area is susceptible to tropical waves, tropical depressions, tropical storms, and hurricanes. These weather systems can cause considerable property and environmental damage and loss of human life. Historical data from 1899 to 2008 indicate that 31 hurricanes and 41 tropical storms made landfall along the Louisiana coastline during this period (NOAA 2009). The 2005 hurricane season brought the most substantial hurricane damage to the Study Area in recent history, with the arrival of Katrina and Rita. Hurricane Gustav, while much smaller and less intense, brought additional damage to the region with landfall on September 1, 2008, that was further exacerbated by subsequent impacts from Hurricane Ike landfall on September 13, 2008.

Wetland loss as a result of Hurricanes Katrina and Rita was over one third of the total wetland losses predicted by the Coast 2050 Report to occur over the next half-century (LCWCRTF and WCRA 1999). Barras (2006) estimated a total of 217.0 square miles (562.1-km^2) of wetland loss from the 2005 hurricanes. Within the Pontchartrain Basin, about 12,160 acres (4,921 ha) of wetlands were converted to open water, with marshes incurring the greatest losses (Barras 2006). Inland, forested wetlands were least affected with negligible wetland losses detected for this region and, specifically, within the Study Area (Wicker 1980; Barras et al. 1994; Barras et al. 2003; Morton et al. 2005).

4.1.3 Geomorphic and Physiographic Setting

The geomorphic and physiographic setting is technically significant because geologic conditions can place constraints on the nature, design, and location of the proposed action, as well as influence the impacts that the proposed action would have on other important resources. Over long, geologic time scales and across an extended region, coastal processes have affected and continue to influence the Study Area. Riverine processes, occurring at smaller spatial scales and over shorter time periods, are the predominant contemporary forces that shape the geomorphic and physiographic setting of the Study Area. The co-occurrence of these processes has been further influenced by human modifications. A description of how these processes define the geomorphic and physiographic setting of the Study Area is included in the following sections. Consistent with 40 CFR Parts §§1500.4 (j) and

1502.21, description of the geomorphic and physiographic setting provided in the LCA PEIS (2004) is hereby incorporated by reference.

USGS Open File Report 02-206, Environmental Atlas of the Lake Pontchartrain Basin (Penland et al. 2002), describes the geomorphology and geologic history of the Lake Pontchartrain Basin and is herein referenced for the discussion that follows. Formation of the Lake Pontchartrain Basin began approximately 20,000 years before present in the late Wisconsin glaciation of the Pleistocene Epoch. Climatic warming and the subsequent melting of glaciers caused a rapid rise in sea level from its lowstand (18,000 years before present) to its highstand (3,000 to 4,000 years before present)—a period known as the Holocene Transgression. As sea level rose, incised river valleys eroded into and beveled the adjacent Pleistocene uplands. After sea level reached its highstand, a sequence of events occurred that was critical to the formation of the basin and the estuarine system present today: the development of the Pine Island barrier shoreline trend resulted in the creation of Lakes Pontchartrain and Maurepas; the St. Bernard delta complex built out from the alluvial valley onto the continental shelf and buried the Pine Island barrier trend; and the Mississippi River abandoned (2,000 years before present) the St. Bernard delta complex for the Lafourche and later returned to the Modern delta complex (1,000 years before present).

The Lake Pontchartrain Basin is divided into three distinct, geomorphic regions: the Pleistocene Terraces Region to the north of Lake Maurepas, Pontchartrain, and Borgne; the Mississippi River Deltaic Plain Region to the south of the lakes; and the Marginal Deltaic Basin Region, which includes the lakes and surrounding wetlands. The Study Area for the Small Diversion at Convent / Blind River project is within the Maurepas Swamp Area—the westernmost portion of the Marginal Deltaic Basin. Lake Maurepas and the surrounding wetlands compose this geographic area.

Further description of the St. Bernard delta complex, within which the Study Area lies, is provided by the USGS Open File Report 98-36 (1998). The St. Bernard delta complex, the oldest within the Mississippi Deltaic Plain Region, is a distinct physiographic unit that was formed by Mississippi River deposits between 700 and 4,700 years ago. The most prominent features are the vast expanses of fresh, intermediate, brackish, and salt marsh. The majority of the remaining surface features are comprised of inland swamp, tidal channels, shallow lakes and bays, natural levee ridges along active and abandoned distributaries, sandy barrier islands and beaches. The St. Bernard delta complex began receiving Mississippi River deltaic sediments from the middle to late Holocene. The first deltaic deposits to enter the area were homogenous prodelta clays. This was followed by the deposition of interdistributary bay deposits as the Mississippi River and its distributaries prograded. The deposits were finer sediments (silty clay and clay) that were transported away from the distributary channel and settled out of suspension as interdistributary deposits.

Depositional environments within the Study Area include point bar, natural levee, and inland swamp, in order of decreasing area. Point bars line the Mississippi River, forming the batture, and were developed through lateral channel migration of the river, cutbank formation and collapse, followed by the deposition of sand and silt on the opposite convex bank (Fisk, 1947; Flores et al. 1985; Galloway and Hobday, 1983). Floods historically deposited sand and silt adjacent to the river and formed natural levees along the Mississippi River that grade towards the inland swamp (Farrell, 1989; Flores et al. 1985; Galloway and Hobday, 1983). The distribution area, and thus most of the Study Area, consists of inland swamp described as low-lying, very flat, poorly drained areas bounded by natural levees or low terraces (Saucier, 1994).

4.1.3.1 Coastal and Riverine Processes

Disruption of the Deltaic Cycle

The geologic development of coastal Louisiana is closely related to shifting Mississippi River courses (Coleman et al. 1998). Description of the deltaic cycle including delta advancement and abandonment, deltaic geomorphology, and biologic diversity and delta switching is provided in the 2004 programmatic environmental impacts statement for the LCA Ecosystem Restoration Study (LCA PEIS; USACE 2004). In more recent geologic history, the Mississippi River has changed its course several times over the last 7,000 years, spurring the development of the Mississippi River Deltaic and Chenier Plains. Recognition that the Deltaic and Chenier Plains are formed by an orderly progression of events related to shifting Mississippi River courses led to the identification and characterization of the deltaic cycle. The deltaic cycle is a dynamic and episodic process alternating between periods of delta building and the subsequent landward retreat of deltaic headlands as deltas are abandoned, reworked, and submerged by marine waters.

Since European settlement of Louisiana in the eighteenth century, humans have exerted a major influence on many of the key elements controlling the deltaic cycle. Construction of levees along the Mississippi River's banks and other flood control and flow modifications, which culminated under the Mississippi River and Tributaries Project (1928), have channelized the river's path of flow. The prevention of overbank flooding from the Mississippi River into the study area reduced the introduction of nutrients and sediment, decreased primary productivity and accretion, and transitioned the deltaic cycle from delta advancement to abandonment (e.g., Kesel, 1989; Boesch et al. 1994; Day et al. 2000). Whereas riverine freshwater inflows dominate the regressive or constructional phase of the deltaic cycle, delta abandonment and degradation is dominated by marine processes (Roberts, 1997). Reduction of the natural delta-building processes allowed relative sea level rise (RSLR) and erosion to dominate the coastal Louisiana landscape. Other flood control (e.g., drainage canals) and infrastructure (e.g., roads, railways, and oil and gas pipelines) projects have altered the hydrology of coastal wetlands and exacerbated degradation processes.

Biological Diversity and Delta Switching

The deltaic cycle of growth, abandonment, and degradation is paralleled by the cycle of biological diversity and productivity, with a slight time lag in the latter **(Figure 4-1).** At the early degradation phase of delta development, the biodiversity/productivity cycle is at its highest, with an accompanying peak in primary plant productivity and fishery productivity. In this stage, ecosystems produce an excess of organic material, some of which is exported seaward where it sustains major energetic pathway, provides the basis for various trophic webs, and supports coastal fisheries (Odum, 1980; Day et al. 1989). As the delta degradation phase continues, biological diversity / productivity also eventually declines. The elimination of overbank flooding from the Mississippi River and flood control modifications within the study area have promoted the degradation of forested wetlands within this area. Apparent symptoms of degradation include extremely low rates of primary productivity and tree growth, as well as high rates of tree mortality (Shaffer et al., 2003).

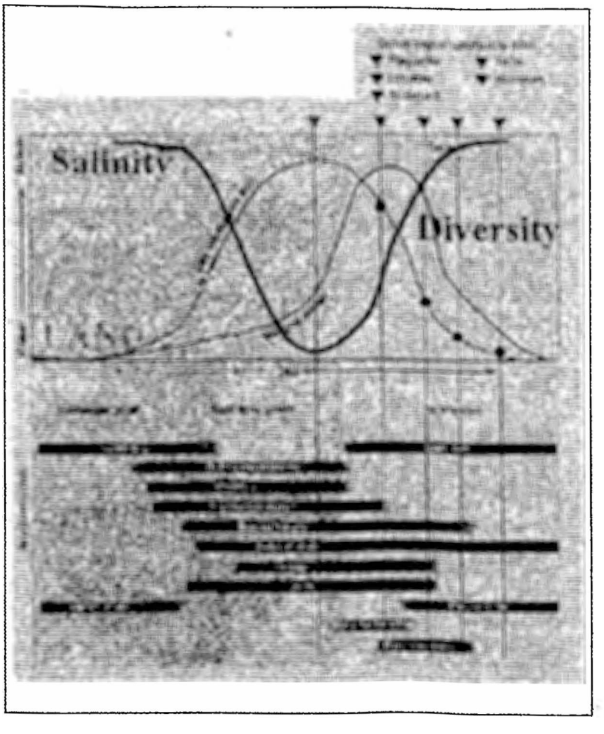


Figure 4-1. Relationship between the deltaic cycle and biological productivity and diversity (from LCA FPEIS, 2004).

Relative Sea Level Rise

The entire Louisiana coastal zone is experiencing relative sea level rise (RSLR). RSLR, or local mean sea level rise, is defined here as the net effect of numerous processes that result in the downward displacement of the land surface relative to sea level. Major processes contributing to RSLR in the study area include eustatic sea level rise, compaction of Holocene deposits (subsidence), and human modifications. The compaction of Holocene deposits is considered the primary contributor to RSLR in the Louisiana coastal plain, where regional rates are unprecedented elsewhere in the country (Terzaghi 1943; Roberts 1985).

Hydrologic Uncertainties

The hydraulic and hydrologic modeling results presented in the analysis to date have been developed with the best available information on historical hydrology, existing topography, sea level rise, subsidence, and accretion, however, each of these factors, alone or in combination, is subject to uncertainties which could pose risks to the hydraulic and ecological functionality of the project. The uncertainties are discussed below:

Topography: All modeling to date has been completed using best available topographic and bathymetric data, in combination with available engineering plans to define channel cross-sections, roadway culverts, and surface storage areas. The available topographic data coupled with field reconnaissance provided sound definition of major hydrologic and hydraulic features for use in the development models. The model calculations that rely on topographic input such as estimates of water depths, residence times, and propensity of water to flow in assumed directions are limited in their resolution.

Future hydrology: The period of record used for extended analysis covered the period from 1989 through 2004. During this period, it appears that extended dry conditions that would support cypress germination and sapling survival occurred only every 5 to 6 years. The frequency at which conditions in the future may support growth cannot be accurately forecasted based only on this available data record. What can be inferred from the analysis is that careful flow management within the system can facilitate periodic hydrologic conditions that would support tree re-growth, but favorable ecological factors will also need to be present for this desired outcome.

- **Relative Sea Level Rise:** The basis for estimating relative sea level rise and associated impacts to the project are based on multiple components that all contain some elements of uncertainty as discussed below: Relative sea level rise consists of eustatic sea level rise and subsidence.
    - **Eustatic Sea level rise:** USACE estimates for 50-year eustatic sea level rise (without the relative impacts of subsidence or accretion) range from 0.28 feet to 2.00 feet. This is a very broad range, as it coincides generally with the magnitude of normal water level

fluctuations in the swamp. Future conditions for this project used the intermediate eustatic sea level rise estimate of 0.67 feet (coupled with subsidence for a relative rise of 1.90 feet).

- **Subsidence:** Future subsidence rates used in this project, per USACE guidance, were 7.5 mm per year. This corresponds to 1.23 feet over a 50-year period. This is based on the measured local increase in sea level over 50 years (9.20 mm/yr) minus the global eustatic rate of sea level rise (1.7 mm/yr). Coupled with the intermediate value of eustatic sea level rise, this yields a relative sea level rise of 1.90 feet over a 50-year period. However, the range of 50-year relative sea level rise estimates when subsidence is included is still very broad: 1.51 – 3.23 feet. Further uncertainty is introduced when considering the subsidence value alone. For example, the Amite River Project used a subsidence estimate of 8.5 mm/year, selected from an estimate range of 4 mm/yr to 20 mm/year based on projects and limited research available for the region. Shaffer et al. 1992 cited (Turner and Cahoon, 1987) and presented a subsidence rate of 7.5 mm/yr for the Atchafalaya Delta region.
- **Accretion:** Estimates of future accretion rates are not included in the projections of future relative sea level rise. The Amite River Project identified a range of 5 mm/year to 25 mm/year of accretion, with an intermediate estimate of 12 mm/year. Over a 50-year period, this range translates into 3.28 feet of uncertainty with respect to accretion alone. The intermediate rate of 12 mm/year translates into 1.97 feet over 50 years, which would roughly offset the relative sea level rise of 1.90 feet (eustatic sea level rise plus subsidence).
- **Combined Effects:** Using ranges applied to the Blind River project and also developed for the Amite River project, the cumulative 50-year effects of uncertainty with respect to eustatic sea level rise, subsidence, and accretion are as follows, using combinations of extreme values:
  - **Highest Estimated Relative Sea Level Rise:**

    Maximum Eustatic Rise + Maximum Subsidence – Minimum Accretion

    2.00 ft + 3.28 ft – 0.82 ft = **4.46 feet**
  - **Lowest Estimated Relative Sea Level Rise:**

    Minimum Eustatic Rise + Minimum Subsidence – Maximum Accretion

    0.28 ft + 0.66 ft – 4.1 ft = **-3.16 feet**

  The total range, then, of cumulative effects of land and sea changes is approximately 7.62 feet, which represents a large range of potential future conditions, especially considering that the range spans almost

equally in opposing directions. Relative sea rise conditions that result in a relative sea level reduction will not pose risk to the project, while increases in relative sea level could impact project performance. The use of intermediate values for all factors produces an estimated relative sea level rise is -0.07 feet, representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise.

Using intermediate values from available regional estimates of each contributing factor (eustatic sea level rise, subsidence, and accretion) suggest that relative sea level rise over 50 years will not produce the adverse hydrologic impacts to project performance that were analyzed. Analysis results developed for Alternative 2 are presented in this report and utilized relative sea level rise for three projections; low, medium and high.

Hydraulic modeling was not completed with explicit representation of accretion and sedimentation (in order to offer conservative "worst case" estimates). The relative rise has been applied in the modeling analysis at the downstream boundary condition, specifically the water level in Lake Maurepas, and the primary impact it has on model results is increased backflow of Lake water into the swamp, and a greater need for diverted water in future years to overcome the backflow.

However, it is conceivable that the water levels in the Mississippi River (upstream boundary condition and flow input for this project) could also be affected by combined effects of eustatic sea level rise and changes in sediment load. This is important because the flow rating curves developed for the gravity-based diversion structure are based on the differential head across the system, not just on the water level in the Mississippi River. If downstream water level rises in Lake Maurepas but Mississippi River water levels are largely unchanged, the physical ability to divert water could be diminished.

Specific forecasts of future water elevation trends in the Mississippi River near the study area are not readily available, so the analysis presented herein should be evaluated with the following considerations:

- If the Mississippi River water level does not change appreciably in the future, total diversion capacity could be diminished based on the assumptions guiding the application of sea level rise estimates to Lake Maurepas (less differential head across the system, and correspondingly lower diversion flows). As stated elsewhere, if intermediate projections for all contributing factors to relative sea level rise are applied together, the net effect could be almost negligible (counterbalancing effects). Hence, while there is the potential that rising relative sea level coupled with stationary river level could reduce diversion throughput, there is some uncertainty with these projections.

- If the Mississippi river water level rises in future decades, it should improve the ability to divert water to the Blind River system when compared to stationary water level in the river.

It is uncertain which of these scenarios is more likely to occur, and to what degree. Therefore, the project team has evaluated the effects of the different phenomena in sensitivity analyses. The worst case for diversion project performance would be higher levels in Lake Maurepas that do not appreciably affect the Mississippi River. This case would effectively reduce the gravity head gradient from the diversion to the Maurepas Swamp system and increase the need for more diverted flow to provide equal swamp restoration and flushing benefits.

The following two factors were used in deciding how to estimate the design level upstream boundary conditions in future decades:

- Intermediate (medium) projections of relative sea level rise, accounting for eustatic changes, subsidence, and accretion, suggest that the relative rise could be practically negligible.
- If relative sea level does change appreciably, it might be inferred that backwater elevations in the Mississippi River could also increase, if not in direct proportion, somewhat commensurately.

Significant uncertainty in each contributing factor provides the possibility for relative sea rise conditions that could affect the performance of the project. The sea level rise scenarios that were evaluated are considered to be conservative, since they account for eustatic rise and subsidence, but not for accretion. Uncertainty associated with relative sea level rise can be reduced with the collection and incorporation of additional information during subsequent project phases to better define local subsidence and probable accretion rates. In addition, adaptive management strategies should continue to be incorporated into the planned project in order to minimize potential impacts of relative sea and land elevations in the future. As additional information becomes available consideration of future conditions will continue to be refined during project design and to facilitate adaptive management after construction.

In the analyses performed, the use of intermediate values for eustatic sea level rise, subsidence, and accretion produces an estimated relative sea level rise representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise. This suggests that that relative sea level rise will not produce adverse hydrologic impacts in project performance.

Human modifications to hydraulics and hydrology can substantially influence relative sea level (White and Tremlay, 1995; Fielding et al. 1998; Morton et al. 2002; Turner, 2004 Morton et al. 2005; Gonzáles and Törnqvist, 2006). An important anthropogenic contributor to RSLR is the drainage of wetlands for agriculture, flood protection, and development (Turner, 2004). Forced drainage lowers the groundwater table, which accelerates the compaction and oxidation of organic

material. Recent studies have suggested that subsurface fluid withdrawals (e.g., oil and gas extraction) also promote RSLR, but the magnitude of its contribution is not well understood (Fielding et al. 1998; Morton et al., 2002; Morton et al., 2005). Within the study area, the elimination of freshwater, sediment, and nutrient inputs from the Mississippi River have significantly contributed to RSLR by decreasing accretion rates (primary productivity and sediment input) and soil strength (Shaffer et al. 2003). An increased duration and depth of flooding further decreases primary productivity and accelerates the rate of RSLR. With sediment inputs and organic accumulation from high primary productivity, coastal wetlands can maintain their surface elevation despite sea level rise (Baumann et al. 1984; Delaune et al. 2004).

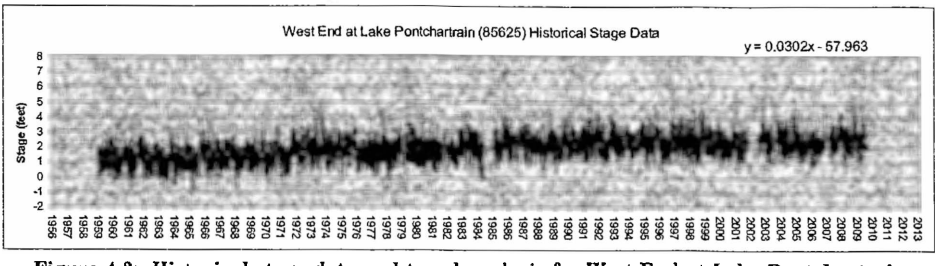


Figure 4-2: Historical stage data and trend analysis for West End at Lake Pontchartrain gauge.

4.2 Significant Resources

4.2.1 Soils and Waterbottoms

4.2.1.1 Soils

Soil resources are institutionally significant under the following statutes and memoranda: the Council on Environmental Quality (CEQ) memorandum of August 11, 1980, entitled "Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing the National Environmental Policy Act (NEPA)"; Executive Order 11990 – Protection of Wetlands; and Agriculture and Food Act of 1981 (Public Law 97-98), which includes the Farmland Protection Policy Act (Public Law 97-98; U.S.C. 4201 *et seq.*). This resource is technically significant because it is a critical element of coastal habitats and supports vegetative growth and open-water benthic productivity. This resource is publicly significant because of the high value the public places on agricultural production, wildlife and fisheries supported by the soils in the area.

Historic Conditions

Within coastal areas, soils construct a critical abiotic component of ecosystems, affecting biogeochemical processes, species composition, productivity, and other factors essential to ecosystem integrity and functioning (Brady and Weil, 2002; Anderson and Lockaby, 2007). Pedogenesis, the development of soil, is dependent

on the interaction of soil forming factors: the five factors include parent material, climate, topography or landscape position, biological factors, and time (Jenny 1994). Existing soil types in the study area are associated with depositional events from historic deltaic processes (USACE, 2009). From 1932 to 1990, the Coast 2050 reports the loss of approximately 1,600 acres of soil resources through shoreline erosion and direct removal in the Amite / Blind River Mapping Unit (LCWCRTF and WCRA, 1999).

Existing Conditions

Soil resources within the Study Area include both hydric and non-hydric soils (NRCS, 2007). Hydric soils are characteristic of wetlands, and as such are predominant. The accumulation of organic material in the surficial soil horizon is evident across most of the Study Area due to slow decomposition under anaerobic, water saturated conditions. Shaffer et al. (2003) noted atypically low soil bulk densities for Maurepas Swamp (0.05-0.15 g/cm3), that are more typical of fresh and intermediate marshes (e.g., Hatton, 1981). Interstitial soil pH was slightly acidic, typical of organic soils with low bulk densities, and higher bulk densities were found in areas receiving agricultural and other runoff (Shaffer et al. 2003). Low bulk densities and high organic matter content likely result from insufficient sediment input since the leveeing of the Mississippi River.

According to the Natural Resources Conservation Service (NRCS), most of the Study Area consists of mucky clay / muck of the Barbary association soil series. Adjacent pedons that extend into the distribution area from the landward periphery include the Mhoon silty clay loam, the Schriever clay, and the Schriever association frequently flooded soil series, in decreasing order respectively.

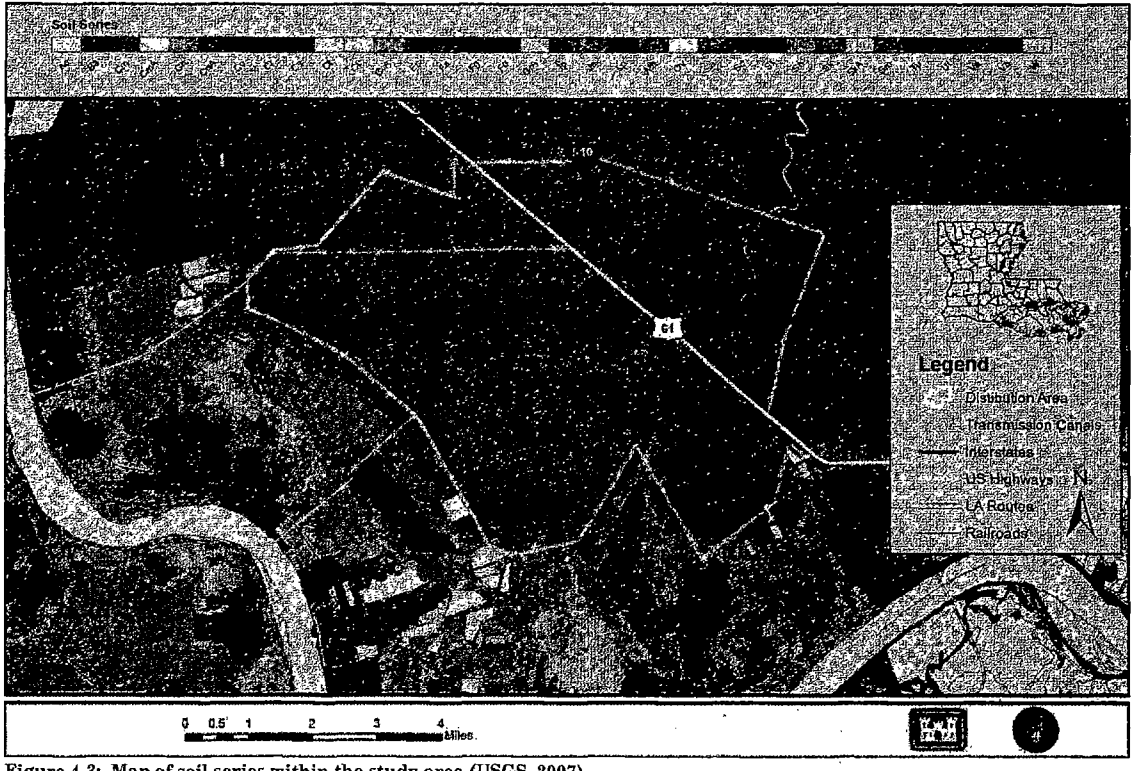


Figure 4-3: Map of soil series within the study area (USGS, 2007).

208

Table 4-1: Soil series characteristics within the project distribution area as described by the NRCS (2007).

BLIND RIVER STUDY AREA SOIL RESOURCES

Parameter		Barbary association (Ba)		Mhoon silty clay loam (Mh)		Schriever clay (Sk)		Schriever association frequently flooded (Sm)		Cancienne silt loam (Cm)			Cancienne silty clay loam (Cn)			Carville fine sandy loam, sandy variant (Co)	Schriever silty clay loam (Sb)		Vacherie fine sandy loam, sandy variant (Va)		Vacherie silt loam (Vh)	
Area	Outfall	22.057.7 (97.85%)		14.1 ac (0.06 %)		12.7 ac (0.06 %)		181.2 ac (0.80 %)		0.5 ac (<0.01 %)			..			..	..		..		..	
	T1	22.7 ac (15.65 %)		7.7 ac (5.32 %)		32.1 ac (22.16 %)		8.7 ac (6.00 %)		5.5 ac (3.81 %)			7.3 ac (5.06 %)			33.3 ac (23.02 %)	10.7 ac (7.37 %)		10.3 ac (7.13 %)		..	
	T2	14.5 ac (7.80 %)		..		62.8 ac (33.67 %)		48.4 ac (25.97 %)		10.0 ac (5.34 %)			..			..	17.5 ac (9.36 %)		..		31.4 ac (16.83 %)	
Depth (in)		0-10	10-80	0-14	14-60	0-6	6-60	0-6	6-60	0-12	12-52	52-80	0-12	12-52	52-80	0-60	0-6	6-54	0-27	27-60	0-20	20-60
Sand		1-3 %	1-3 %	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Silt		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Clay		..	60-95	27-45	14 39	40-60	60-90	40-60	60-90	14-27	14-39	14-41	27-39	14-39	14-41	0-18	27-35	60-90	4-17	40-65	10-18	40-65
Organic Matter		30-70 %	2.0-2.5 %	0.5-2.0 %	0.0-0.5 %	0.5-4.0 %	0.0-0.5 %	0.5-4.0 %	0.0-0.5 %	0.5-4.0	0.5-1.0	0.5-1.0	0.5-4.0	0.5-1.0	0.5-1.0	0.5-3.0	0.5-4.0	0.0-0.5	0.5-2.0	0.0-0.5	0.5-2.0	0.0-0.5
Texture		Mucky clay, muck	Clay, mucky clay	Silty clay loam	Clay loam, silty clay loam, silt loam	Clay	Clay	Clay	Clay	Silt loam	Loam, silty clay loam, silt loam	Stratified very fine sandy loam to silty clay	Silty clay loam	Loam, silty clay loam, silt loam	Stratified very fine sandy loam to silty clay	Fine sandy loam	Silty clay loam	Clay	Fine sandy loam	Clay, silty clay	Silt loam	Clay, silty clay
Shrink / Swell Potential		low		moderate		very high		very high		moderate			moderate			low	very high		very high		very high	
Water Regime	Drainage	very poor		poor		poor		poor		somewhat poor			somewhat poor			somewhat poor	poor		somewhat poor		somewhat poor	
	Flooded	frequently		no		rarely		frequently		no			no			no	rarely		no		no	
	Ponded	frequently		no		no		no		no			no			no	no		no		no	
	Hydric Soil	yes		yes		yes		yes		no			no			no	yes		no		no	
Slope		0-1 %		0-1 %		0-1 %		0-1 %		0-1 %			0-1 %			0 1 %	0-1 %		0-3 %		0-1 %	
Landform		swamps		Flood plains		Backswamps		Backswamps		Natural levees			Natural levees			Natural levees	Backswamps		Natural levees		Natural levees	
Taxonomy		Very-fine, smectitic, nonacid,hyperthermi -c Typic Hydraquents		Fine-silty, mixed, superactive, nonacid, thermic Fluvaquentic Endoaquepts		Very fine, smectitic, hyperthermic Chromic Epiaquerts		Very-fine, smectitic, hyperthermic Chromic Epiaquerts		Fine-silty, mixed, superactive, nonacid, hyperthermic Fluvaquentic Epiaquepts			Fine-silty, mixed, superactive, nonacid, hyperthermic Fluvaquentic Epiaquepts			Coarse-silty, mixed, superactive, calcareous, hyperthermic Fluventic Endoaquepts	Very fine, smectitic, hyperthermic Chromic Epiaquerts		Coarse-silty over clayey, mixed over smectitic, superactive, nonacid, hyperthermic Aeric Fluvaquents		Coarse silty over clayey, mixed over smectitic, superactive, nonacid, hyperthermic Aeric Fluvaquents	

T1 - Romeville Transmission Pathway, T - 2 Sunshine bridge transmission pathway. *Source: Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at* http://websoilsurvey.nrcs.usda.gov/ accessed [04/16/2009].

2009

Prime and Unique Farmlands
In an effort to identify the extent and location of important farmlands, the NRCS, in cooperation with other interested Federal, state, and local government organizations, has inventoried land that can be used for the production of the Nation's food supply. The Farmland Protection Policy Act (1981) establishes regulatory protection for prime and unique farmlands and those of statewide or local importance so as to "minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses."

Prime farmland is defined as "land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion" (7 U.S.C. 4201(c)(1)(A)). Farmland areas not deemed "prime" but recognized as "unique" are also provided federal regulatory protection. Unique farmlands include "land other than prime farmland that is used for production of specific high-value food and fiber crops . . . [and which is capable of] sustained high quality or high yields of specific crops . . . [under] acceptable farming methods" (7 U.S.C. 4201(c)(1)(B)). Authority is also provided for the protection of "farmland, other than prime or unique farmland, that is of statewide or local importance as determined by the appropriate State or unit of local government agency or agencies, and that the Secretary determines" (7 U.S.C. 4201(c)(1)(C).

Of the soil resources within the study area, the NRCS (2007) lists several series as "Prime and Other Important Farmlands": Cancienne silt loam, Cancienne silty clay loam, Carville fine sandy loam, sandy variant, Mhoon silty clay loam, Schriever silty clay loam, Schriever clay, Vacherie fine sandy loam, sandy variant, and Vacherie silt loam. Hydrologic conditions and regulatory statutes may prevent some of these areas from functioning to this capacity. Review of affected soil resources is being conducted through coordination with NRCS input regarding Prime and Unique Farmlands.

4.2.1.2 Water Bottoms

These resources are institutionally significant because of the national Environmental Policy Act of 1969; the Coastal Zone Management Act; and the Estuary Protection Act. Louisiana Revised Statute 41:1701 defines state water bottoms as "[t]he beds and bottoms of all navigable waters and the banks or shores of bays, arms of the sea, the Gulf of Mexico, and navigable lakes" and establishes the management and protection of the resources. These resources are technically significant because the bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a benthic effect.

Historic Conditions
Detrital pathways are important to biotic cycling of organic matter in deepwater swamps (Mitsch and Gosselink, 2000). Depending on the extent of anaerobic

conditions of the water bottom, cycling and decomposition of organic matter can be impeded. In swamps adjacent to lakes and rivers, the export of organic matter can be significant (Mitsch and Gosselink, 2000) compared to swamps with low flow through conditions. These anaerobic conditions can lead to net losses of nitrogen due to denitrification. Sediments and water bottoms can be a sink for phosphorus. When mobilization of sediments from water bottoms is low, net export of phosphorus from swamps is generally low (Mitsch and Gosselink, 2000). Historically, the water bottoms in the study area provided an outwelling of organic matter (Odum, 1980) and a sink for phosphorus and nitrogen that supported the health of downstream ecosystems in Lake Maurepas and Blind River (e.g., Richardson, 1985; Lane et al. 2003). Cessation of near annual Mississippi flood events into the distribution area limited the capacity of these functions and the fulfillment of these services.

Existing Conditions

Water bottoms in the study area include the Blind River, parish canals, and open water areas. Lake Maurepas, the Mississippi River, and the Blind River are designated as a state water bottoms. Because of the stagnant conditions, the loss of sediment inputs reduced primary productivity, and limited consolidation, net phosphorus and organic matter export from the swamp is likely low. Therefore, support for dependent systems downstream (e.g., Lake Maurepas) is likely limited and substantially reduced from historic levels.

4.2.2 Hydrology

This resource is institutionally significant because of the National Environmental Policy Act of 1969; Clean Water Act; Flood Control Act of 1944; Coastal Barrier Resources Act; Rivers and Harbors Act of 1899; River and Harbor and Flood Control Act of 1970; Watershed Protection and Flood Prevention Act; Submerged Land Act; Coastal Zone Management Act; Safe Drinking Water Act; Estuary Protection Act; Resource Conservation and Recovery Act (RCRA); Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); and Executive Order 11988 Floodplain Management. This resource is technically significant because Civil Works water resources development projects typically impact (positively or negatively) the interrelationships and interactions between water and its environment. This resource is publicly significant because the public demands clean water, hazard-free navigation, and protection of estuaries and floodplains.

The study area is situated within the Lake Pontchartrain Basin, a 9,700-square-mile (25,122-square-km) area encompassing sixteen parishes that is among the largest estuarine ecosystems on the Gulf coast and in the United States. The Pontchartrain Basin contains three major estuarine lakes—Maurepas, Pontchartrain, and Borgne—that cover a total of 965 square miles (2,500 km^2) and lie within a five-parish region. Water drains into rivers and bayous throughout the basin, making its way to the Gulf of Mexico via a series of large open water bays. These bays and associated lakes comprise a large, shallow estuary where freshwater from rivers and bayous mixes with the salty waters of the Gulf. This

expanse of open water is fringed by swamps and marshes. In addition to the ecosystem and habitat value provided by the lakes, swamps, and marshes, the Pontchartrain Basin provides a major recreational and commercial resource for the people of Louisiana.

4.2.2.1 Flow and Water Levels

Lower Mississippi River

Historic Conditions

Over geologic history, the course of the Mississippi River has changed several times through the delta-switching process. Formation of a new delta lobe occurred roughly once every 1,000 years in response to changes in the flow path of the Mississippi River into the Gulf over the past 5,000-6,000 years; the modern delta consequently consists of smaller delta complexes formed over the past 8,000 years (Fisk 1944; Frazier 1967; Penland and Boyd, 1985; Autin et al., 1991, Saucier 1994). Major distributaries over this period have included Bayous Lafourche, Terrebonne, Des Familles, Barataria, and to a lesser extent, the Atchafalaya River (USACE 2000).

Historically, the Lower Mississippi River was prone to frequent spring floods that caused catastrophic damage and loss of life post-settlement (Davis 1993, USACE 2009). Federal flood control and navigation measures that began in earnest with the authorization of the Mississippi River and Tributaries Project by the Flood Control Act of 1928 have since regulated the river's stage and flow and mitigated damage (USACE 2009). Further description of these measures is provided in **Section 4.2.15.12, Flood Control and Hurricane Protection**. These actions have channelized the Lower Mississippi River and prevented the abandonment of the current flow path. Operation of the Old River Control Structure (ORCS) has strictly regulated Mississippi River flows since 1977 to prevent capture by the Atchafalaya River: thirty-percent of flows are allocated to the Atchafalaya and seventy-percent to the Mississippi River (USACE 2009).

Discharge rates for the Lower Mississippi River have been measured by the USACE at an approximate frequency of two times per week below the ORCS at Tarbert Landing, Mississippi, and are presented for January 1, 1978, through December 31, 2008, in **Figure 4-4**. **Figure 4-5** and **Figure 4-6** display annual and monthly discharge trends over this time period.

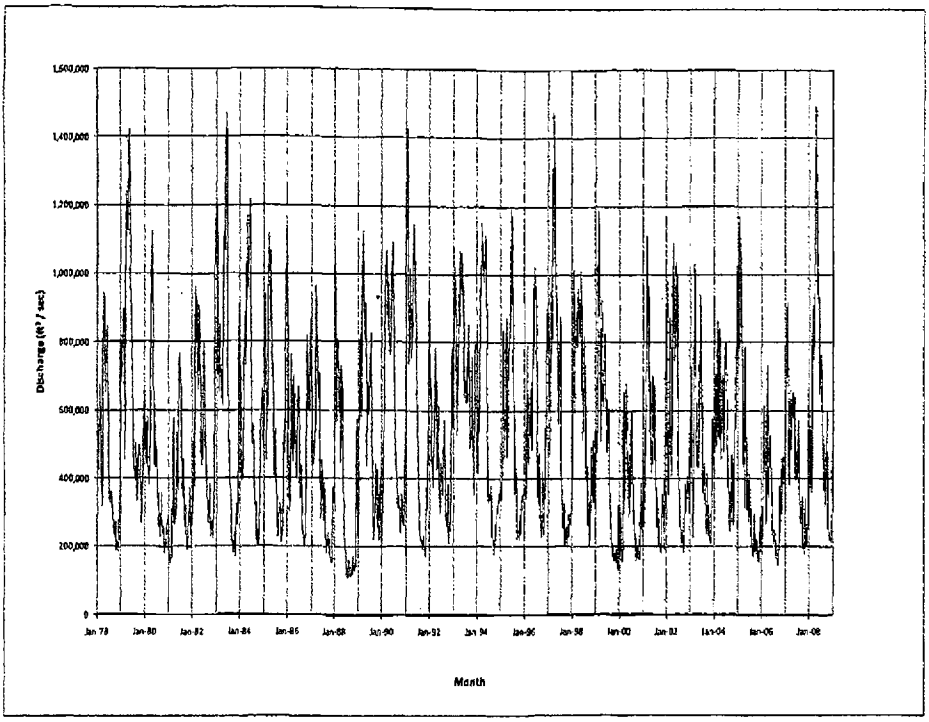


Figure 4-4: Lower Mississippi River discharge (ft^3 sec^{-1}) at Tarbert Landing, MS, from January 1, 1978, to December 31, 2008 (USACE 2009).

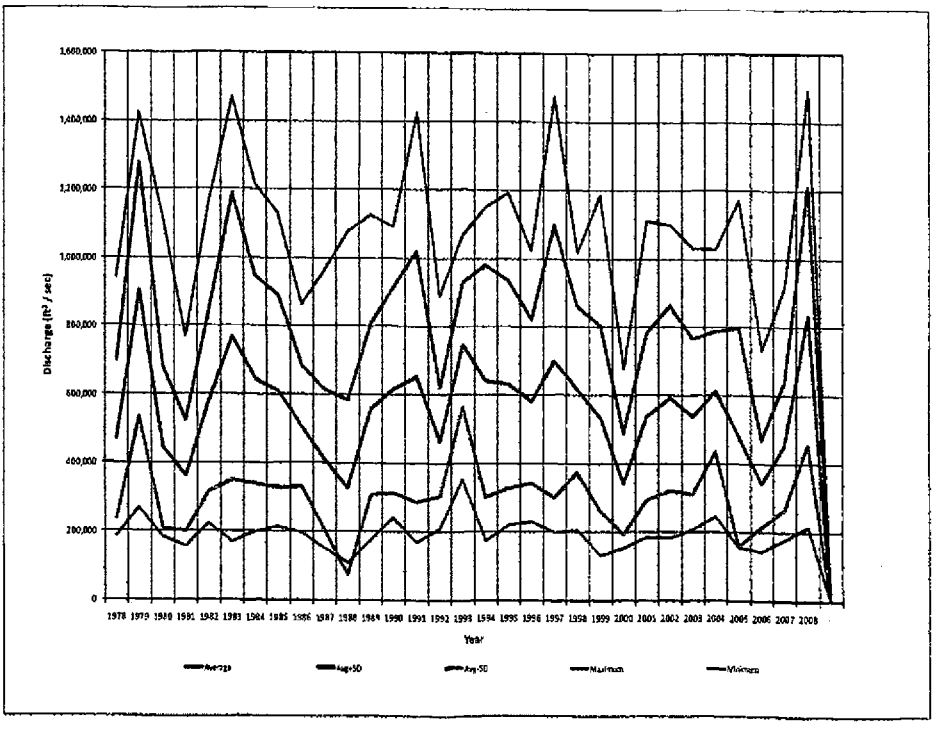


Figure 4-5: Lower Mississippi River discharge (ft3 sec-1) annual trends at Tarbert Landing, MS, from January 1, 1978, to December 31, 2008 (USACE 2009).

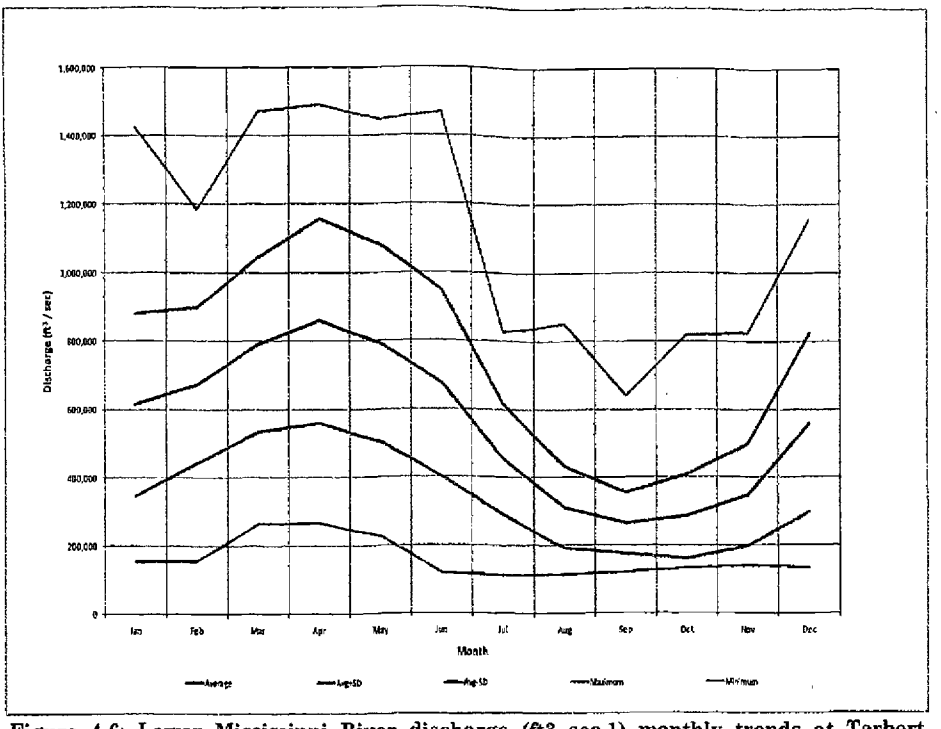


Figure 4-6: Lower Mississippi River discharge (ft3 sec-1) monthly trends at Tarbert Landing, MS, from January 1, 1978 to December 31, 2008 (USACE, 2009).

Stage, or river water level, data was developed for the Mississippi River at the proposed Romeville diversion location over the same time period by linear interpolation from two sets of existing gauge data from above and below this location: the College Point Landing Gauge (Gauge # 01240) and the Donaldsonville Gauge (Gauge # 01220) (USACE, 2009). **Figure 4-7** depicts daily average stage for the Lower Mississippi River at Romeville from January 1, 1978 to December 31, 2008.

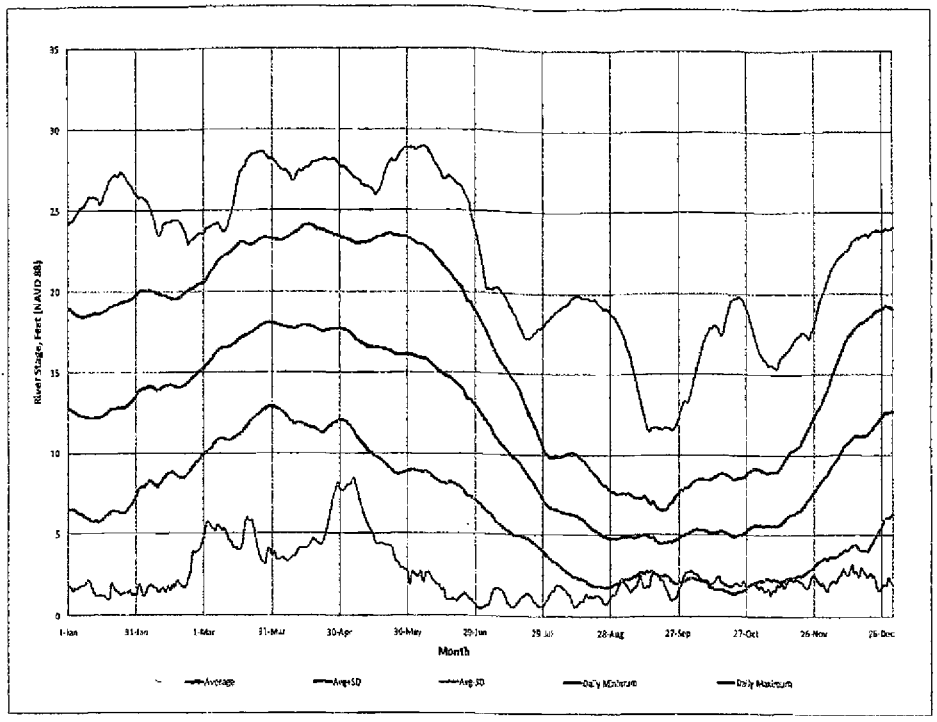


Figure 4-7: Lower Mississippi River daily stage (feet NAVD 88) trends at Romeville, LA, from January 1, 1978 to December 31, 2008 (USACE, 2009).

Existing Conditions

Flood control measures and flow management have resulted in relatively consistent flows and water levels in the Lower Mississippi River from 1978 to present in the Study Area. The flow and water level of the Lower Mississippi River are directly related and exhibit a seasonal pattern that is presumably linked to snowmelt runoff and spring rains. High flows and water levels are characteristic of spring months (March 1–May 31), while low flows and low water levels are typical from mid-summer to mid-fall (August 16 – November 15).

Based on data from 1978 to 2008, the average annual, spring, and summer-fall stages of the river at Romeville are 11.32 ± 7.03, 17.13 ± 5.99, and 5.16 ± 3.07 ft NAVD88 (Mean ± SD), respectively. Over this period, the average annual, spring, and summer-fall discharge rates at Tarbert Landing are 566,123 ± 306,846, 813,333 ± 283,377, and 283,925 ± 113,984 cfs (Mean ± SD), respectively. Stage and flow are more variable in the spring than summer-fall months. Other factors influencing the stage and flow of the Lower Mississippi River in the Study Area are astronomical and meteorological tides, which have the greatest effect during periods of low stage

and flow (USACE 2000). Astronomical tides have been observed as far upstream as the head of ship navigation in Baton Rouge, Louisiana. Strong south and southeasterly winds can cause rapid rise and northwesterly winds rapid decline in the river's stage (USACE, 2000).

Blind River and Maurepas Swamp

Historic Conditions

The study area is located in the Lake Maurepas Watershed of the Pontchartrain Basin. Historic surface flow within the basin was generally from west to east, towards Lake Pontchartrain. According to historic maps and records, hydrologic conditions of the study area were primarily influenced by the conveyance of surface runoff and precipitation as sheetflow across the forested wetlands and into the headwaters of Bayous des Acadiens—now known as Blind River. Bayous Conway and New River captured drainage from the west, conveying it eastward into Bayous des Acadiens as channel flow. To the north and northwest of the study area, hydrology was dominated by the Amite River, which flows into Lake Maurepas, and its distributaries, the Little Amite and Bayou Chene Blanc, which flowed southeast to their confluence with Bayous des Acadiens.

Prior to extensive human modification, overbank flow of the Mississippi River during spring floods and tidal inflow—through Pass Manchac, into Lake Maurepas, and southwest to the study area—significantly influenced the hydrologic conditions. Overbank flows from the Mississippi river brought nutrients, sediment, and freshwater that promoted productivity and sustained the health of the swamp ecosystem. As floodwaters receded, surface flows traveled eastward as sheetflow into existing channels and subsequently Lake Maurepas.

Some uncertainty surrounds the historic frequency of flooding events in the study area due to the natural variability of these events and limited historic record. Lopez (2003) estimated that flooding of the Mississippi River historically occurred once every 3.5 years in the Lake Pontchartrain Basin. Between 1799 and 1931, the frequency of major flood events for the Mississippi River was approximately every 2.8 years (Gagliano and van Beek, 1970), with twenty-three flood years recorded below Baton Rouge from 1849 to 1927 (Vogel 1930). Anecdotal accounts indicate that before the mechanization of cypress logging in the area (pre-1890), transportation of downed timber was often accomplished by floating logs out of the swamp when the water level typically peaked in June (Mancil 1972). This suggests that pre-levee spring flooding extended into the early summer.

Construction of artificial levees along the Mississippi River began in the Pontchartrain Basin in 1812 and by 1895 had completely severed the connection of the basin to the river during flood events (Davis, 2000; Lopez 2003). Additional flood control projects and developments have further disrupted the natural hydrology of the study area: these have included the Mississippi River and Tributaries Project (1928); the Amite River and Tributaries Project (1956); oil, gas, and utilities lines; active and abandoned railways; private and public roads; lateral

drainage ditches; parish drainage canals and spoil banks; and other projects. Further discussion is provided in **Sections 4.2.16.4, 4.2.16.7, 4.2.16.11, and 4.2.16.12.**

Existing Conditions

Flows and water levels in the Study Area differ substantially from historic conditions due to isolation from Mississippi River floods in conjunction with further human modifications. Flow directions in general correspond to historic patterns for the Study Area and vicinity. However, drainage features have altered the rates at which runoff and tidal inflow enter and leave the Blind River, adjoining channels, and adjacent swamp. The hydrologic effect of these modifications is variable and dependent on location within the Study Area. Most of the contributing watersheds are hydrologically "flashy" as runoff to the Study Area occurs very quickly after rainfall events and very little precipitation is lost to evapotranspiration or groundwater seepage in the contributing watersheds (Day et al. 2004).

A wide range of climate conditions (including tropical depressions, storms and hurricanes) within the Study Area provides the potential for hydrologic conditions ranging from extreme flooding to extended drought. Since the construction of the Mississippi River flood control levees, Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the River that brought freshwater, sediment and nutrients to the swamp. With minimal soil building and moderately high subsidence rates, there has been a net lowering of ground surface elevation, so that now the swamps are persistently inundated.

Based on the strong correlation between lake and swamp water levels, the observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with lower swamp than lake elevations (Shaffer et al., unpubl. data) suggests that the duration of inundation within the Study Area has drastically increased over the last fifty years. A limited ability to drain and persistent flooding characterize the existing hydrology in the swamp, which conflicts with historic drying cycles. The facilities described above such as drainage canals and roads and other utilities disrupt natural flow and drainage patterns. Short circuiting of the natural drainage patterns has created ponding and stagnant waters in some areas. The contribution and circulation of nutrients and sediments is minimal and limited under existing conditions.

Extensive modeling of hydrologic flow patterns in southwest Maurepas Swamp for an area to the northeast including a portion of the Study Area was conducted in support of CWPPRA Project PO-29, *Mississippi River Reintroduction into Maurepas Swamp* (Day et al., 2004; URS, 2007). Analysis examined physical hydrodynamic and hydrologic characteristics and trends for several factors under various conditions. Factors included precipitation, stage ranges, velocity, flow, water budget, tidal propagation, channel over-banking, and swamp circulation in relation to physical features. The results of these and other related investigations (Lee Wilson & Associates et al. 2001; Mashriqui et al. 2002; Penland et al. 2002) reveal

regional trends applicable to the hydrology of the Study Area, which include the following:

- Lake Maurepas stage exerts a significant influence (backflow) on water levels within Blind River and adjoining channels. When the swamp stage is less than the lake stage the potential for backflow exists.
- Propagation of astronomical tides decreases with distance from Lake Maurepas shoreline; is often absent from smaller channels and the swamp; and is overwhelmed by meteorological tides.
- Meteorological tides related to storm events and winds have a pronounced affect on stage and flows and exhibit seasonal and daily variability. Storms and prevailing winds from the southeast in the summer and early fall raise water levels in the swamp as they push Gulf water into the system. Continental fronts with prevailing winds from the northeast in the winter often lower swamp water levels as they push water out of the system towards the Gulf.
- Precipitation and runoff have small influences on the stage and flows of Blind River.
- Overbank flooding and flow through existing berm gaps from Blind River and adjoining channels into the swamp is dependent on river stage levels in relation to river bank and existing berm elevations.

CRMS stations have been established by the LADNR and USGS to monitor both the individual effectiveness of wetland restoration projects and the cumulative effects of all projects statewide. Site-specific parameters recorded relate to vegetation and hydrology and include salinity, water temperature, conductivity, and water level, among others. Two stations are located within the distribution area: one internal to the swamp (CRMS 65 along a north-south pipeline) and the other (CRMS 5167) along Conway Canal to the north of US Highway 61.

An apparent trend is greater fluctuation in hydroperiod and drawdown at higher elevations along canals relative to more stable water levels and extended inundation at interior swamp locations. The attenuation of storm surges both along canals and into the swamp is suggested by spikes in water levels caused by Hurricane Ike in September 2008.

Installation of piezometers throughout the interior swamp south of US Highway 61 is being completed as part of this study to supplement existing swamp water level data. A multi-directional flow gauge with water quality sensors that collects hourly data has also been installed on the Blind River near US Highway 61. Preliminary data depicts multi-directional flow patterns and suggests that flow direction under low flows may reverse at hourly intervals while flow direction may be sustained over several days during higher flow velocities. Long-term data over variable conditions will provide a better understanding of flow and water levels within the Study Area.

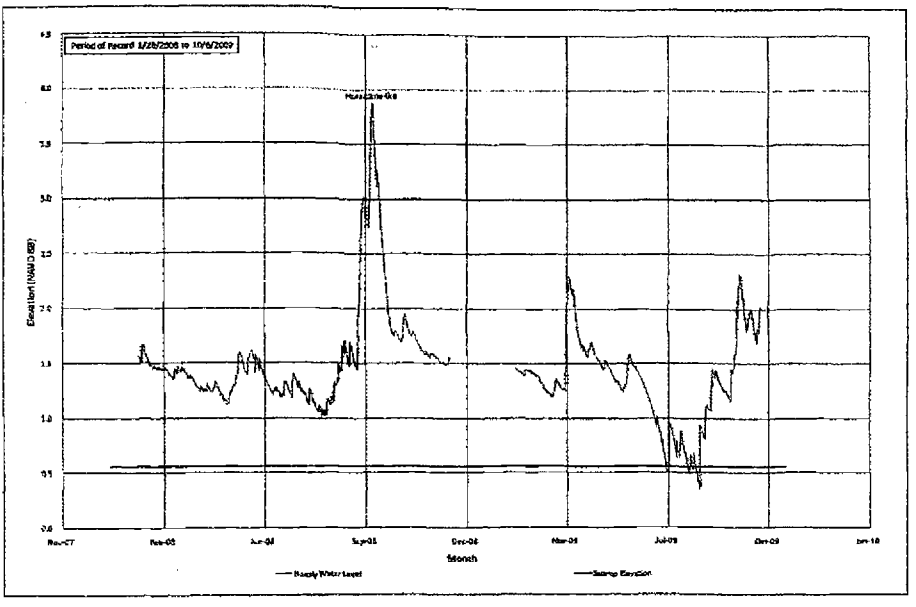


Figure 4-8: CRMS 65 hourly water level data in relation to swamp elevation (NAVD 88) from January 28, 2008, to October 6, 2009 (LA DNR, 2009).

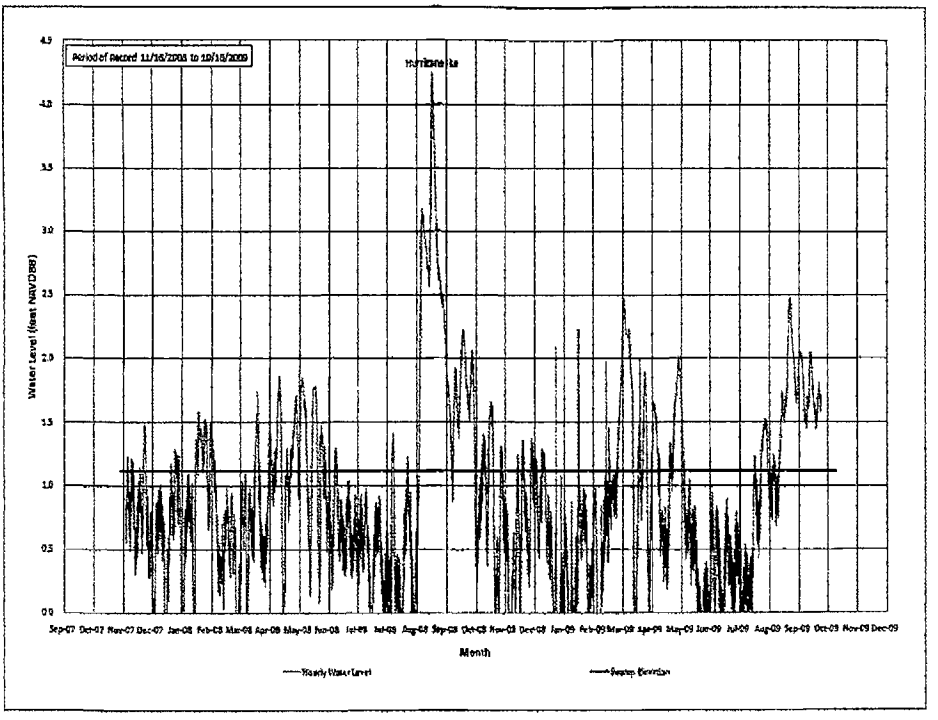


Figure 4-9: CRMS 5167 hourly water level data in relation to swamp elevation (NAVD 88) from November 16, 2008, to October 16, 2009 (LA DNR 2009).

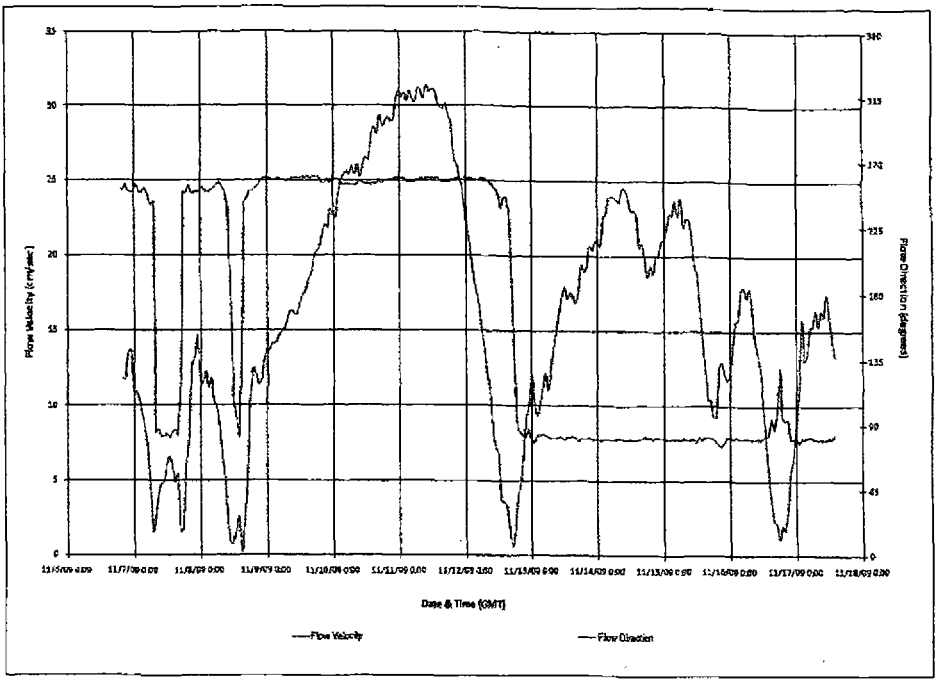


Figure 4-10: Blind River flow velocity and flow direction near U.S. Highway 61 measured hourly from November 6 to November 17, 2009.

Lake Maurepas

Historic Conditions

Limited information exists regarding the hydrology of Lake Maurepas prior to the separation of the Pontchartrain Basin from overbank flows of the Mississippi River and basin wide drainage modifications. Based on the physiography of the region, the dominant influence of elevation on flow, and an understanding of historic flow patterns and processes in comparable systems, predictable differences in the hydrology of Lake Maurepas can be reconstructed with high certainty. Overbank flows into the Pontchartrain Basin from the Mississippi River during spring flood events resulted in a significant increase of freshwater input into the system. These pulsed events would have reduced the influence of lake stages on hydrologic conditions in southwest Maurepas Swamp and contributed to the outwelling of organic material, the enhanced productivity and diversity of biotic resources, and the freshening of Lake Maurepas (Odum, 1980; Day et al. 1989).

Existing Conditions

Located to the northeast of the Study Area, Lake Maurepas is a 90 mi2 (233 km^2) shallow estuarine water body that receives tidal inflow from Lake Pontchartrain to the east and freshwater input from tributaries to the north, west, and southwest. Freshwater input occurs primarily during spring runoff through the Tickfaw and Blind Rivers and the Amite River Diversion Canal, having combined average flows less than 3,400 cfs (Lee Wilson & Associates, 2001). These rivers are prone to brief high-intensity flood events as a result of meteorological conditions that contribute the majority of freshwater and sediment that enters Lake Maurepas. Tidal flow passes between Lake Maurepas and Lake Pontchartrain through Pass Manchac and exhibits diurnal and seasonal fluctuation.

Because current water levels in the Study Area are primarily influenced by lake stages, a stage analysis for Lake Maurepas was performed as part of this study. The USACE maintains a gauge at Pass Manchac near Ponchatoula, LA (Gauge # 85420), that has daily stage data for a period of record from July 1955 to August 2005. Water levels at this location are representative of the stage in the east end of Lake Maurepas. Stage analysis was performed for a 30-year period (January 1, 1975 – December 31, 2004). Since this location is tidally influenced, the stage readings are for different parts of the tide, ranging from high to low tide. Tidal signatures make the determination of annual trends difficult and less pronounced. Subtle trends indicate that for a given year the stage for Lake Maurepas is bimodal: it generally rises in the spring, then falls during summer, rises in the fall, and again falls to low levels in the winter. Other analyses have detected a similar trend for the station (Keddy et al. 2007). Limited hourly stage data is available for part of 2009 (April 27, 2009 to the present). Based on this short term data, average tide heights are 0.4 $\pm$ 0.2 feet (0.1 $\pm$ 0.1 meters) (Mean $\pm$ SD).

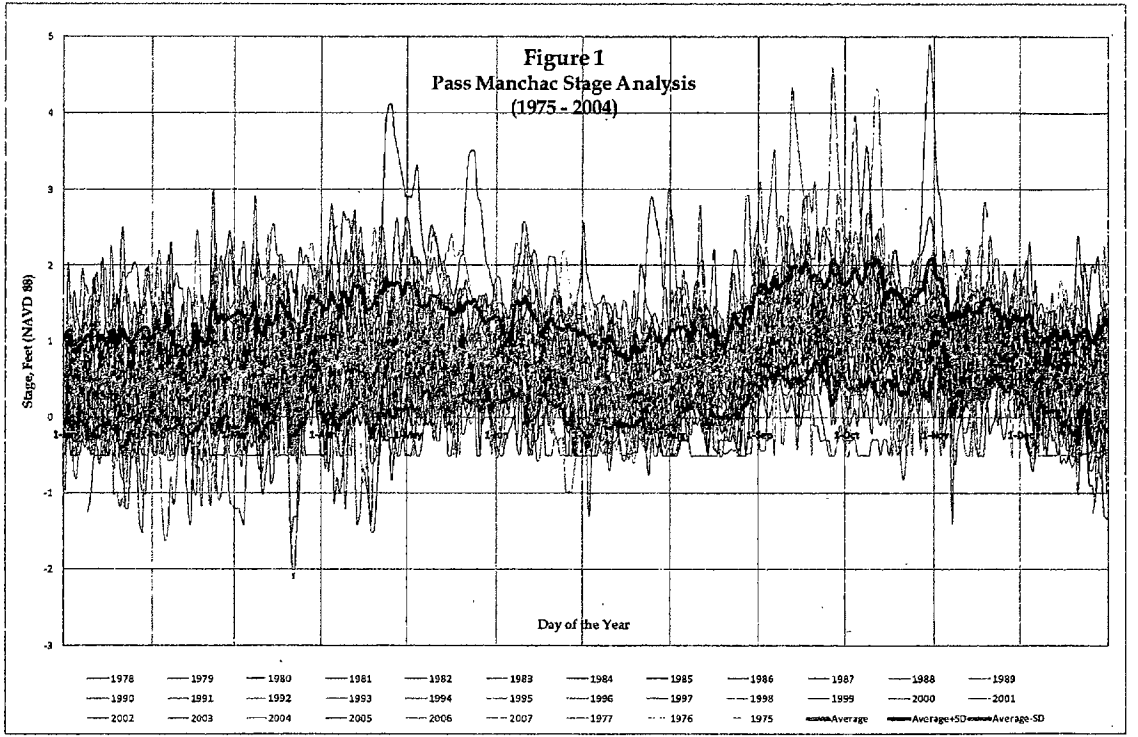


Figure 4-11: Pass Manchac daily stage analysis for 1974 to 2004.

4.2.2.2 Sedimentation and Erosion

Sediment quality is defined as the suitability of the habitat for supporting designated uses, including, but not limited to, benthic fauna and emergent wetland plants. Storm events, flowing water, and other factors can potentially re-mobilize sediments. Aquatic sediments are essential in maintaining the structure (assemblage of organisms) and function (processes) of aquatic ecosystems. Sediment quality is important due to the role that sediments play in supporting community productivity. The productivity of green plants, algae, and bacteria build on the foundation of food webs upon which higher aquatic organisms depend. Sediments provide important habitats for epibenthic (live on sediments) and infaunal (live in sediments) invertebrates and demersal fish, which represent important food sources for amphibians, reptiles, fish, birds, and mammals. In addition, many fish and amphibian species utilize sediments at different life cycle stages for the purposes of spawning, incubation, refuge, and over-wintering (LDEQ, 2005).

Lower Mississippi River

Historic Conditions

Extensive research and data exist on the historic and existing sediment dynamics of the Lower Mississippi River. Historically, the Lower Mississippi River transported extremely high sediment loads to the Gulf in association with deltaic processes. When it was a classical meandering alluvial river that was aggrading its channel throughout much of its length, the suspended sediment and bed loads of the Mississippi River have been estimated to have been as high as 270 x 106 m^3/hr (353 x 106 yd^3/hr) and 130 x 106 m^3/yr (170 x 106 yd^3/yr), respectively (Kesel et al. 1992). The Lower Mississippi River has experienced significant changes in sediment transport dynamics over its more recent history, with a general trend of decreased sediment transport from historic to present times. Kesel (1988) estimated a 43 percent reduction in sediment loading from historic (prior to 1900) to predam periods (1930-1952) and a 51 percent decline from predam to postdam periods (1963-1982). Increased land development along the Mississippi River during the 1800s would have contributed to higher sediment loading, and thus this period may provide an inappropriate reference time frame for long-term trend analysis (USACE 2000). Consequently, there is uncertainty as to how current sediment loads of the Lower Mississippi River compare to historic levels.

Existing Conditions

The USGS station at Tarbert Landing, Mississippi, maintains an extended record of sediment data for the Lower Mississippi River Period of record for daily measurements extends from 1975 to present. Sediment loading patterns suggest that daily-suspended sediment loads are above average from January through May and below average from August through November (USGS 1999, 2009). Based on water year 2002 through 2008, the average daily measured suspended sediment load at this location was 334,000 tons/day; the daily measured suspended sediment load varies from 39,000 to 119,000 tons/day (USGS 2009). The sand to silt ratio of

suspended sediment is typically 20% sand to 80% silt (USGS 1999). Mashriqui and Kemp (1996) reported the mean sediment load of the Mississippi River at Tarbert Landing to be 226 mg/L, of which about 26% was sand, with silts and clays each contributing between 30% and 40%.

Blind River and Maurepas Swamp

Historic Conditions

Flood events historically delivered sediments, nutrients, and freshwater from the Mississippi River into Maurepas Swamp. Though the volume and sediment load of floodwaters is uncertain, what is certain is that sediment delivery was adequate to offset subsidence and to support the development of an old growth baldcypress-tupelo forest. Furthermore, it is apparent that the severance of its hydrologic connectivity with the Mississippi River, in accompaniment of other drainage alterations, has resulted in reduced sediment delivery and the consequent subsidence of Maurepas Swamp.

Existing Conditions

Several sampling efforts have been recently conducted to determine sediment loads in Maurepas Swamp. Examining these, the total suspended solids (TSS) concentrations collected monthly were similar from April 2000 to June 2001 (mean: 16 mg L^{-1}; range: 4 – 101 mg L^{-1}) as for April 2002 to May 2002 (mean: 15 mg L^{-1}; range: 1 – 58 mg L^{-1}) (Day et al. 2001, Day et al. 2004). Furthermore, stations located around Lake Maurepas exhibited the highest TSS concentrations, which was likely due to re-suspension of bottom sediments due to high wave energy. The TSS concentrations were considerably less than those in the Mississippi River which generally range between 200 and 300 mg L-1.

The Blind River is listed on the 2006 303(d) list of impaired water bodies due to impairment from excess sediments, extending from its headwaters to its distribution into Lake Maurepas (LDEQ 2006). In accordance with EPA mandate, Total Maximum Daily Loads (TMDLs) must be developed for sediments and nutrients for Blind River by 2011.

4.2.2.3 Groundwater

Historic Conditions

An overview of the historic condition of groundwater resources in southern Louisiana is provided by LCA FPEIS (2004), and consistent with 40 CFR Parts §§1500.4 (j) and 1502.21, description of this resource is hereby incorporated by reference. Southern Louisiana historically has had very abundant fresh groundwater supplies. Saltwater encroachment due to groundwater extraction has and continues to threaten the viability of groundwater resources nearer the coast. Three major aquifer systems are present in the coastal areas of Louisiana: the Southern Hills (Chicot Equivalent), Chicot, and Mississippi River Alluvial aquifer systems—the former two of which are designated sole source aquifers (EPA, 2008). The study area lies within the Mississippi River Alluvial aquifer.

A general description of the aquifer system is provided by the "Mississippi River Alluvial Aquifer Summary, Baseline Monitoring Program, FY 2005" in Appendix 8 of *The Triennial Summary Report for the Water Quality Assessment Division of the Louisiana Department of Environmental Quality* (LDEQ, 2006). The Mississippi Alluvial Aquifer consists of poorly to moderately well sorted sediment that generally decreases in size from coarse sand and gravel in lower portions to fine to medium-grained sand near the top and is confined by layers of silt and clay. Hydraulic connectivity is maintained with the Mississippi River and its adjacent streams, which results in groundwater levels that fluctuate with precipitation trends, river stage, and seasonality. Across the aquifer, water levels are typically within 30 to 40 feet of ground surface with groundwater movement occurring via downgradient seepage towards rivers and streams. Direct infiltration of precipitation, lateral and upward movement of water from adjacent and underlying aquifers, and overbank stream flooding all contribute to aquifer recharge. Natural discharge events include seepage into the Mississippi River and streams, but stages exceeding groundwater levels often allow aquifer recharge. Hydraulic conductivity varies between 10 to 530 feet day^{-1} (3 to 161 m day^{-1}). The aquifer thickness of the freshwater interval ranges from 50 to 500 feet (15 to 152 m), and the maximum depths of occurrence of freshwater range from 20 to 500 feet (6 to 152 m) below sea level.

Existing Conditions

Under the Federal Safe Drinking Water Act, EPA established maximum contaminant levels (MCLs) for pollutants that may pose a health risk in public drinking water. An MCL is the highest level of a contaminant that EPA allows in public drinking water. EPA has defined non-enforceable secondary standards in taste, odor, or appearance guidelines.

The LDEQ Baseline Monitoring Program determines and monitors the quality of groundwater in major aquifers statewide as a Clean Water Act activity. Groundwater wells are sampled every three years for water quality parameters, inorganics (total metals), nutrients, volatile organic compounds, semi-volatile organic compounds, pesticides, polychlorinated biphenyls, and field parameters. Under this program, the sampling of 24 wells in 2005 indicates that the Mississippi Alluvial aquifer exhibits the poorest water quality characteristics of any of the fourteen aquifers or aquifer systems monitored (LDEQ, 2006). Analysis supporting this determination include the presence of methyl-t-butyl ether (MTBE)—a volatile organic compound with no primary MCL—at one well; the production of extremely hard groundwater; and exceedance of the primary MCL for arsenic at five wells and secondary standards for 43 parameters (LDEQ, 2006). No pesticides or PCBs were detected at this time. Comparison of historic data collected every three years from 1996 to 2005 indicates increases in color, sulfate, barium, and iron; decreases in chloride; and fluctuations in average values for turbidity, nitrate-nitrite, arsenic, and zinc (LDEQ, 2006).

The need for a groundwater and seepage model for the project was considered to determine the flux of water from the Mississippi River to the Swamp. After

analysis of the subsurface soils between the River and the Swamp and additional analysis on the data collected from the flow monitor installed on the Blind River for this project, it was determined that seepage and groundwater transmission was negligible in this area. The determining factors were: 1. Flow rates on the Blind River without rainfall events are non-existent. The tidal action shows nearly equal flows upstream and downstream due to the rising and falling of the tide. 2. Geotechnical data collected indicate the soil permeability between the River and the Swamp is very low so that transmission of flow is nil (**Appendix L**). 3. Field visits to the site on numerous occasions indicate very dry conditions between the River and the Swamp so any groundwater recharge mentioned previously is in aquifers far below the level of the Swamp.

4.2.3 Water Quality and Salinity

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Clean Water Act; the Coastal Zone Management Act; and the Estuary Protection Act. This resource is technically significant because the water quality supports most physical, chemical, geological, and biological processes throughout the entire estuarine system. This resource is publicly significant because the public demands clean water and healthy wildlife and fisheries for recreational and commercial use.

4.2.3.1 Lower Mississippi River

Historic Conditions

Historic and current water quality issues for rivers and streams in coastal Louisiana include the transport of nutrients, pesticides, synthetic organic compounds, trace elements, suspended sediment, and bacteria. The Louisiana Department of Health and Hospitals coordinates with the LDEQ, the LDWF, and the Louisiana Department of Agriculture and Forestry to issue water body advisories aimed at protecting the public's health.

The USGS maintains water quality stations on the Mississippi River both upstream and downstream of the potential diversion locations. The West Baton Rouge station is located north of the proposed diversion locations. Water quality data have been collected approximately monthly from 2004 to 2009 with a few data points in 1993 and 1975. During this time period the average total nitrogen concentration was 2.34 mg/L with a minimum and maximum of 1.1 and 4.0 mg/L, respectively. Total phosphorus concentrations ranged from 0.1 to 0.41 mg/L with an average of 0.23 mg/L. Downstream of the diversion locations at the Belle Chase station, the period of record includes approximately monthly data from 1977 to 1997 and 2006 to 2009. The average total nitrogen concentration during this time was 2.26 mg/L with a minimum and maximum of 0.47 and 4.5 mg/L, respectively. Total phosphorus concentrations ranged from 0.06 to 0.51 mg/L with an average of 0.22 mg/L.

The LDEQ also operated two ambient water quality stations on the Mississippi River near Lutcher, Louisiana, that were sampled approximately monthly over their period

of record: LDEQ station 0081 (1969-1990) and LDEQ station 0321 (1991-1995). Ambient water quality samples were analyzed for alkalinity, chloride, color, dissolved oxygen, fecal coliform, hardness, pH, salinity, specific conductance, sulfate, total dissolved solids, total suspended solids, turbidity, water temperature, nitrate/nitrite, total kjeldahl nitrogen, phosphorus, total organic carbon. Metals and VOCs were analyzed approximately quarterly. Metals analyzed include arsenic, cadmium, chromium, copper, lead, mercury, and nickel. VOCs include 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane,1,2-dichloropropane, 2-chlororthylvinyl ether, benzene, bromodichloromethane, bromoform, bromomethane, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, chloromethane, cis-1,3-dichloropropene, dibromochloromethane, ethylbenzene, methylene chloride, tetrachloroethene, toluene, trans-1,2-dichloroethene, trans-1,3-dichloropropene, trichloroethene, and vinyl chloride. The data from these two stations was combined and the summary statistics are presented in Table 4-2.

Table 4-2: Lower Mississippi River summary water quality data recorded at LDEQ station 0081 (1969-1990) and LDEQ station 0321 (1991-1995) (LDEQ, 2009).

Parameter	Mean	Minimum	Maximum	LDEQ Water Quality Criteria Based on Designated Use
Alkalinity (mg/L)	106.4	9.4	168	NA
Chloride (mg/L)	26.66	5	220	75
Color (PCU)	22.7	5	110	NA
Dissolved Oxygen (mg/L)	8.2	0.1	13	5
Fecal Coliform (COL/100mL)	626	20	5400	400 (May 1 – Oct 31)/ 2,000 (Oct 31 – April 30)
Hardness (mg/L as CaCO3)	149.6	53	211	NA
pH (SU)	7.41	6.18	8.88	6.5 - 9.0
Salinity (ppt)	0.82	0.01	1	NA
Specific Conductance (µmhos/cm)	387.86	162	600	NA
Sulfate (mg/L)	49.3	12.7	96	120
Total Dissolved Solids (mg/L)	268.56	14	536	400
Total Suspended Solids (mg/L)	107.8	1	426	NA
Turbidity (NTU)	67.68	3.5	510	NA
Water Temperature (°C)	18.48	0.1	32	32
Nitrate/Nitrite (mg/L)	1.326	0.08	2.8	NA
Total Kjeldahl Nitrogen (mg/L)	0.92	0.02	3.08	NA
Phosphorus as P (mg/L)	0.2234	0.02	0.59	NA
Total Organic Carbon (mg/L)	5.55	1	29.4	NA
				LDEQ Toxic Substance

				Criteria for Freshwater	
Metals (µg/L)				Acute	Chronic
Arsenic	6.829	0.3	334	339.8	150
Cadmium	0.7	0.1	9	15, 67	0.62, 1.76
Chromium	9.37	0.1	63.7	NA	NA
Copper	14.18	0.1	243	10, 35	7, 22
Lead	5.407	0.1	67.5	30, 138	1.2, 5.31
Mercury	0.225	0.05	1.6	2.04	0.012
Nickel	6.594	0.09	45.3	788, 2,495	88,279

NA indicates "Not Available"
Based on hardness values of 50 and 200 mg/L"

Existing Conditions

Current water quality data for the Mississippi River is not available from the LDEQ station at Lutcher, Louisiana. The closest LDEQ ambient water quality station with current data is approximately 22 miles up valley from the proposed diversion locations at Plaquemine, Louisiana (LDEQ station 0053). Ambient water quality samples were analyzed approximately monthly for alkalinity, chloride, color, dissolved oxygen, fecal coliform, hardness, pH, salinity, specific conductance, sulfate, total dissolved solids, total suspended solids, turbidity, water temperature, nitrate/nitrite, total kjeldahl nitrogen, phosphorus, total organic carbon. Metals and VOCs were analyzed approximately quarterly. Metals analyzed include arsenic, cadmium, chromium, copper, lead, mercury, and nickel. Summary statistics of data from this station from 2006 to 2009 are presented in **Table 4-3.**

Table 4-3: Lower Mississippi River summary water quality data recorded at LDEQ station 0053 (2006-2009) near Plaquemine, Louisiana (LDEQ, 2009).

Parameter	Mean	Minimum	Maximum	LDEQ Water Quality Criteria Based on Designated Use
Alkalinity (mg/L)	120.5	86.9	161	NA
Chloride (mg/L)	32.4	16.9	55	75
Color (PCU)	23	5	110	NA
Dissolved Oxygen (mg/L)	9.2	5.7	13	5
Fecal Coliform (COL/100mL)	76	1	5400	400 (May 1 – Oct 31)/ 2,000 (Oct 31 – April 30)
Hardness (mg/L as CaCO3)	168	116	211	NA
pH (SU)	6.4	4.8	8.88	6.5 - 9.0
Salinity (ppt)	0.19	0.01	1	NA
Specific Conductance (µmhos/cm)	41.9	299	600	NA
Sulfate (mg/L)	269	26.1	96	120
Total Dissolved Solids (mg/L)	269	185	536	400
Total Suspended Solids (mg/L)	97.4	10	426	NA

Parameter	Mean	Minimum	Maximum	LDEQ Water Quality Criteria Based on Designated Use	
Turbidity (NTU)	67.38	7.9	510	NA	
Water Temperature (°C)	16.9	2.46	32	32	
Nitrate/Nitrite (mg/L)	1.326	0.64	2.8	NA	
Total Kjeldahl Nitrogen (mg/L)	0.92	0.28	3.08	NA	
Phosphorus as P (mg/L)	0.2234	0.08	0.59	NA	
Total Organic Carbon (mg/L)	5.55	3.8	29.4	NA	
				LDEQ Toxic Substance Criteria for Freshwater	
Metals (µg/L)				Acute	Chronic
Arsenic	1.5	0.1	60.7	339.8	150
Cadmium	0.025	0.02	0.03	15, 67	0.62, 1.76
Chromium	0.14	0.1	0.23	NA	NA
Copper	2.03	1.51	3.09	10, 35	7, 22
Lead	0.079	0.02	0.16	30, 138	1.2, 5.31
Mercury	NA	NA	NA	2.04	0.012
Nickel	1.78	0.08	3.57	788, 2,495	88, 279

NA indicates "Not Available"

Based on hardness values of 50 and 200 mg/L.

The closest LDEQ ambient water quality station with data on mercury levels for fish in the Mississippi River is station 1131 near Donaldsonville, LA. In 2001, a total of 35 fish were sampled including species of catfish and drum. Mercury concentrations in fish ranged from 0.01 to 0.52 mg/L with an average of 0.75 mg/L.

Data on mercury levels in sediment are available from the Baton Rouge station (LDEQ station 3580) and from the Donaldsonville station (LDEQ station 1131). Both stations were sampled only once: the Baton Rouge station in 2007 and the Donaldsonville station in 2001. Sediment mercury concentrations were 12.58 µg/kg and 10.0 µg/kg, respectively.

4.2.3.2 Blind River and Maurepas Swamp

Historic Conditions

The LDEQ maintains an ambient water quality station on the Blind River at the US Highway 61 bridge (LDEQ station 0117). The period of record for this station is from 1978 to 1998 during which an average of eight samples per year were taken.

Summary statistics for this data are present in **Table 4-4**. The mean concentrations of chloride, sulfate, total dissolved solids and temperature were below the LDEQ numeric criteria. The pH values observed during this time were within the numeric criteria range of 6 to 8.5 standard units. Mean dissolved oxygen (DO) was slightly higher than the numeric criteria value of 3.0 mg/L.

Existing Conditions

There are seven categories for water use as identified under the Louisiana Administrative Code (LAC) Title 33 Part IX. Primary contact recreation (PCR) includes activities such as swimming, water skiing, tubing, snorkeling, skin diving, and other activities that involve prolonged body contact with water and probable ingestion. Secondary contact recreation includes fishing, wading, and recreational boating, and other activities that involve only incidental or accidental body contact and minimal probability of ingesting water. Fish and wildlife propagation (FWP) includes the use of water by aquatic biota for aquatic habitat, food, resting reproduction, and cover, including indigenous fishes and invertebrates, reptiles, amphibians, and other aquatic biota consumed by humans. Outstanding natural resource waters (ONR) include those that are specified under LAC 33:IX.1123. These ONR are designated for preservation protection, reclamation, or enhancement of wilderness, aesthetic qualities, and ecological regimes.

Within the study area, the Blind River from the headwaters to the ARDC is identified by the LDEQ as water body subsegment 040403. The designated uses assigned for this subsegment are PCR, secondary contact recreation (SCR), FWP, and ONR. Based on the LDEQ 2006 Integrated Report both the PCR and SCR designated uses were fully supported, while FWP and ONR were not supported. The suspected causes of impairment for the FWP designated use were mercury, nitrate/nitrite, non-native aquatic plants, total phosphorus (TP), and turbidity. The suspected sources for mercury were listed as atmospheric deposition and unknown sources. Site clearance (land development or redevelopment) and flow alterations from water diversions were listed as the suspected sources for nitrate/nitrite, DO, and TP. The suspected causes of impairment for the ONR designated use were sedimentation/siltation and turbidity, which are believed to be caused by site clearance.

Table 4-4: Blind River summary water quality data recorded near U.S. Highway 61 bridge (LDEQ station 0117) from 1978 to 1998 (LDEQ, 2009).

Parameter	Mean	Minimum	Maximum	LDEQ Water Quality Criteria Based on Designated Use
Alkalinity (mg/L)	59.6	11.6	115	NA
Chloride (mg/L)	80.4	5.4	610	250
Color (PCU)	75	20	160	NA
Dissolved Oxygen (mg/L)	3.2	0.2	8.5	3
Fecal Coliform (COL/100mL)	712	20	24000	400 (May 1 – Oct 31)/

Parameter	Mean	Minimum	Maximum	LDEQ Water Quality Criteria Based on Designated Use	
				2,000 (Oct 31 – April 30)	
Hardness (mg/L as CaCO3)	79.9	11	226.6	NA	
pH (SU)	6.75	6	8.35	6 -8.5	
Salinity (ppt)	0.79	0.01	8	NA	
Specific Conductance (µmhos/cm)	379	88	1950	NA	
Sulfate (mg/L)	13	2	64.8	75	
Total Dissolved Solids (mg/L)	277	72	1210	500	
Total Suspended Solids (mg/L)	34.7	4	310	NA	
Turbidity (NTU)	28.1	2	480	NA	
Water Temperature (°C)	21	6.5	31.9	30	
Nitrate/Nitrite (mg/L)	0.17	0.01	2.28	NA	
Total Kjeldahl Nitrogen (mg/L)	1.25	0.24	2.76	NA	
Phosphorus as P (mg/L)	0.27	0.06	0.76	NA	
Total Organic Carbon (mg/L)	13.3	0.5	22.1	NA	
				LDEQ Toxic Substance Criteria for Freshwater	
Metals (µg/L)				Acute	Chronic
Arsenic	3.66	0.1	30	339.8	150
Cadmium	0.68	0.1	7.4	15, 67	0.62, 1.76
Chromium	3.9	0.1	84.2	NA	NA
Copper	35.7	0.1	1025.5	10, 35	7, 22
Lead	6.8	0.1	76.4	30, 138	1.2, 5.31
Mercury	0.19	0.05	1.3	2.04	0.012
Nickel	4.1	0.09	15	788, 2495	88, 279

Baseline water quality data for the Blind River and areas of Maurepas Swamp north of the study area from Lee Wilson Associates 2001 and Day et al. 2004 were compiled in the *Phase I Assessment of Potential Water Quality and Ecological Risk and Benefits from a Proposed Reintroduction of Mississippi River Water into Maurepas Swamp* (Battelle 2005).

LDEQ data on mercury levels in fish, vegetation, and sediment is available from four ambient water quality stations on the Blind River. These stations (117, 156, 235, and 538) include a period of record from 1996 to 2008. A total of 417 fish were sampled including species of bass, bowfin, catfish, drum, crappie, and buffalo. Mercury concentrations in fish ranged from 0.001 to 2.27 mg/L with an average of 0.51 mg/L. A total of ten vegetation samples were taken from Spanish moss. Mercury concentrations in vegetation ranged from 0.001 to 0.18 ppm with an

average of 0.07 ppm. The average concentration of mercury in sediment measured from the four stations ranged from 41.77 to 520 µg/kg with an average of 208 µg/kg.

While the best available data were used to establish existing conditions for water quality within the study area, the installation of piezometers throughout the interior swamp south of US Highway 61 was completed as part of this study and data from these stations is being collected to supplement existing swamp water quality data. A multi-directional flow gauge with water quality sensors that collects hourly data has also been installed on the Blind River near US Highway 61 and data is currently being collected from that gauge. Long-term data over variable conditions will provide a better understanding of flow and water quality fluctuations within the Study Area.

4.2.3.3 Salinity

Lower Mississippi River

Historic Conditions

Salinity data for a brief period of record is available from the LDEQ for a station on the Mississippi River south of Lutcher, Louisiana, which is approximately eight miles down valley from the proposed diversion locations. The period of record for this station includes thirteen observations between 1994 and 1995 and one observation in 1991. During this time the salinity levels ranged from 0.1 to 1 ppt with an average of 0.82 ppt. A longer period of record is available for specific conductance at this location. While conductance is a measure of the ability of water to transmit an electrical current, it is proportional to the amount of solids in solution. Specific conductance has been used as an indicator of salinity (Giovannelli 1980). Approximately monthly specific conductance readings from 1966 to 1995 are available for this station. During this time, the specific conductance ranged from 162 to 600 µmhos/cm with an average of 388 µmhos/cm.

Existing Conditions

The availability of recent salinity data is limited for the Mississippi River near the diversion locations. The nearest LDEQ station with a current period of record for salinity is approximately 22 miles up valley from the proposed diversion locations at Plaquemine, Louisiana. From 2006 to 2009, salinity ranged from 0.01 to 0.3 ppt with an average of 0.19 ppt at this location, and specific conductance ranged from 299 to 578 µmhos/cm with an average of 423 µmhos/cm. These values are similar to historic data observed downstream at the LDEQ Lutcher station.

Blind River, Maurepas Swamp, and Lake Maurepas

Historic Conditions

Over the past 6,000 to 7,000 years, the salinity of the study area has shifted with the major deltaic meandering of the Mississippi River. Modern efforts to control flooding and improve navigation have involved numerous bank stabilization, channel alignment, dredging, lock, dam, levee, and spillway projects on the Mississippi River. Flood control measures and infrastructure installations (e.g.,

pipelines, roads, and railways) have also altered the hydrology of coastal Louisiana wetlands. Together, human modifications to hydrology have significantly affected the salinity within Maurepas Swamp, Blind River, and Lake Maurepas by reducing freshwater input and increasing tidal inflow of more saline waters. However, a general trend across the Lake Pontchartrain Basin is decreasing salinity inland from east to west as saline water from the Gulf mixes with freshwater inputs.

Historically, overbank flooding of the Mississippi River into the study area delivered freshwater, nutrients, and sediments. Freshwater diluted tidal inflow and limited backflow of saline water through Pass Manchac into Lake Maurepas, the Blind River, and Maurepas Swamp. Sediments and nutrients supported primary productivity and accretion, offsetting the effects of RSLR. The construction of levees along the Mississippi River eliminated overbank flooding, which had direct and indirect effects on salinity within the study area. Tidal inflow through Pass Manchac became more strongly correlated with salinity fluxes in the study area. Decreased accretion and productivity increased RSLR and consequently promoted the backflow of saline waters from Lake Maurepas. The construction of parish drainage canals and installation of pipelines exacerbated these effects by increasing the conveyance of more saline waters into Maurepas Swamp.

Throughout the Pontchartrain Basin, the opening of the Mississippi River Gulf Outlet (MRGO)—a 76-mile navigation channel that connects the City of New Orleans with the Gulf of Mexico—resulted in increased tidal connectivity and saltwater intrusion. Tate et al. (2002) examined the effects of MRGO on salinities in the basin and found that the mean monthly salinity for all months increased at Pass Manchac following partial completion of MRGO in 1963: the 1963 to 1977 period average salinity (1.6 ppt) was 0.4 ppt higher than the 1951 to 1963 period average (1.2 ppt).

Salinity fluxes in the study area have been historically related to both tidal and meteorological events. Thomson et al. (2002) observed high intra- and inter-annual variability in salinity levels at Pass Manchac from 1951 to 2000, with the average salinity typically ranging from slightly above 0 to 3.5 ppt (**Figure 4-12**). Unprecedented salinity levels, however, were observed during the three-year drought from 1998 to 2000 (**Figure 4-13**). Salinity levels reached 12 ppt at Pass Manchac and 6 ppt across Lake Maurepas at the entrance of Blind River in October of 2000 (Lee Wilson & Assoc. et al., 2001; Lane et al. 2002; Lane et al. 2003). A similar spike was observed within the interior of southeastern Maurepas Swamp, where salinity levels reached 5 and 4 ppt in channels and shallow wells, respectively (Lee Wilson & Assoc. 2001, Shaffer et al. 2003). In addition to infrequent drought events, pulses of higher salinity waters have been characteristic of late summer and early fall and are often associated with tropical storm events in the Gulf (Thomson et al. 2002, Shaffer et al. 2003, Day et al. 2004).

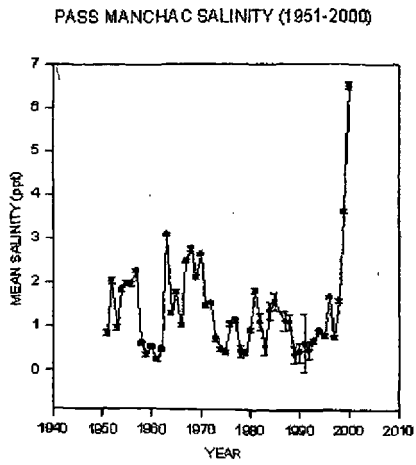


Figure 4-12: Mean salinity at Pass Manchac: 1951 to 2000 (from U.S. Army Corps of Engineers, New Orleans District).

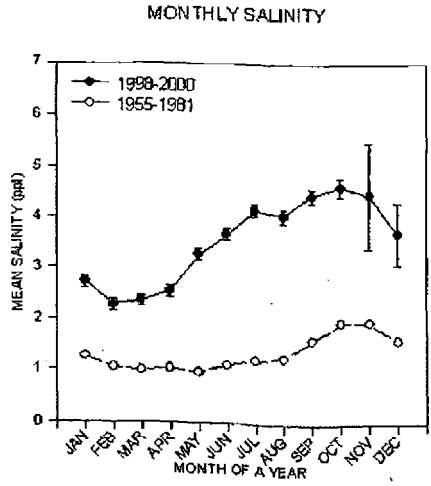


Figure 4-13: Mean annual and monthly salinity at Pass Manchac 1955 to 1981 and during the 1998 to 2000 drought (from U.S. Army Corps of Engineers, New Orleans district).

Periodic pulses of higher salinity tidal inflow have had detrimental impacts on plant communities. Persistent saltwater intrusion events observed in 1999 and 2000 caused over ninety-seven percent mortality of tens of thousands of baldcypress seedlings that were planted in the northwestern portion of Maurepas Swamp (Lee Wilson & Assoc. 2001). Nearer Lake Maurepas, where salinity pulses had a greater effect, mortality of both understory and overstory plants resulted due to elevated salinity. Previously forested baldcypress-tupelo habitats have transitioned to open marsh in some areas (Shaffer et al. 2003). Although these pulses are typically infrequent and short-lived, salts may persist in the soil at levels detrimental to plants for several years, as observed in Maurepas Swamp following the 1998 to 2000 drought (Shaffer et al., 2005; personal communication, Dr. Gary Shaffer, 2009).

Existing Conditions

Established by the LDNR and USGS to monitor both the individual effectiveness of wetland restoration projects and the cumulative effects of all projects statewide, two CRMS sites are located within the study area. Data were accessed through the Strategic Online Natural Resources Information System (SONRIS) (LDNR, 2009). Hourly salinity readings from CRMS 65 were available from January 28 to December 1, 2008. During this time period, the average salinity at this site was 0.24 ppt with a maximum of 0.33 ppt and a minimum of 0.12 ppt. The period of record for salinity readings at CRMS site 5167 extended from November 6, 2007 to February 9, 2009. Over this time period, the average salinity was 0.25 ppt with a maximum of 1.35 ppt and a minimum of 0.06 ppt.

Additional static salinity readings were taken at numerous locations within the study area during site visits in the summer and fall of 2009. The average salinity levels recorded in July, 2009, at eight locations along the Blind River and canals south of Highway 61 was 0.37 ppt. In August 2009, salinity levels were recorded at ten locations within the distribution area south of US Highway 61. The average salinity at this time for these stations was 0.30 ppt with a maximum of 0.72 ppt and a minimum of 0.13 ppt. Salinity levels recorded during these site visits in 2009 are similar to those previously observed at the CRMS stations within the study area.

Lane et al. (2003) collected salinity readings monthly from April to October during the 2000 drought at sixteen locations in southern Maurepas Swamp and Lake Maurepas. Sample sites were chosen based on hydrological boundaries, with the inclusion of the Amite and Blind Rivers; Hope Canal and Dutch Bayou waterways; Reserve Canal; and Lake Maurepas. General trends suggested in their study include higher salinities in the lake than the swamp and decreasing salinity eastward from the lake to Blind River from April through August. Over the period of study, salinity across stations averaged 3 practical salinity units (psu) but ranged from 0 to 12 psu and reached 5 psu at all locations at some time. Practical salinity units approximate salinity concentrations measured in parts per thousand. In the spring and summer, infrequent precipitation and runoff allowed the Amite and Blind Rivers to incur lower salinity influx than elsewhere. However, salinity

averaged 4.5 psu across locations during September and October—a level detrimental to woody vegetation.

Day et al. (2004) recorded salinity readings monthly from April 2007 to May 2008 at nineteen locations within Maurepas Swamp using site groupings consistent with Lane et al. (2003). Salinities during this period ranged from 1 to 7 psu in the Blind River upstream of the confluence of the Amite River Diversion.

Shaffer et al. (2003) observed a trend of decreasing salinity levels in the swamp between Lake Maurepas and the Mississippi River with increasing distance from the lake. However, this trend was not evident for stations measured along Blind River itself. At interior sites along Blind River, salinities recorded in wells were generally less than 2 ppt.

Salinity data is available from 1982 to 1998 from a LDEQ station located on the Blind River at US Highway 61. During this period of record, salinity ranged from 0.1 to 8 ppt with an average of 0.8 ppt. Approximately monthly specific conductance data is available at this station from 1978 to 1998. During this time, specific conductance ranged from 84 to 2,100 µmhos/cm with an average of 391µmhos/cm.

4.2.4 Air Quality

This resource is institutionally significant because of the Clean Air Act of 1963, as amended, and the Louisiana Environmental Quality Act of 1983, as amended. Air quality is technically significant because of the status of regional ambient air quality in relation to the National Ambient Air Quality Standards (NAAQS). Air quality is publicly significant because of the desire for clean air and public health concerns expressed by many citizens. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the air quality resources provided in the LCA PEIS (2004) is hereby incorporated by reference.

Historic Conditions

The Clean Air Act Amendment of 1990 directed the USEPA to set NAAQS (40 CFR part 50) for pollutants considered harmful to public health and the environment. Federal air quality standards have been established for six pollutants termed criteria pollutants: carbon monoxides (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur oxides (commonly measured as sulfur dioxide [SO_2]), lead (Pb), particulate matter less than 2.5 micrometers (µm) in diameter ($PM_{2.5}$), and particulate matter no greater than 10 µm in diameter (PM_{10}).

Review of air quality monitoring data from January 1998 through December 2008 indicates that Ascension Parish was in nonattainment for the intervals 1998-2000 and 2003-2007 for O_3 (8-hour average) (EPA,2009b). Likewise, St. James Parish was in nonattainment for 1998-2000, 2003, and 2005-2007 for O_3 (8-hour average) (EPA, 2009b).

Ascension and St. James Parishes historically have had good to moderate air quality with infrequent days where air quality was unhealthy for sensitive groups and the general population (EPA, 2009a). Air quality in the surrounding metropolitan statistical areas (MSAs) has been historically more impaired than for these parishes and the study area therein (EPA, 2009a, b).

Existing Conditions
The Baton Rouge MSA is currently a nonattainment area for O_3 (8-hour average) (EPA, 2010). The class of nonattainment for the MSA is moderate, indicating that the area has a design value of 0.092-0.107 parts per million (ppm) for this pollutant.

Further analysis conducted by the Louisiana Department of Environmental Quality – Air Quality Division (LDEQ-AQD indicate no violations of state air quality standards at the monitoring stations nearest the study area in 2006 and 2007 (LDEQ 2006, 2007). Nearby stations include Convent, Dutchtown, French Settlement, and Garyville. Nonattainment for the Baton Rouge MSA is largely due to decreased air quality in the more immediate Baton Rouge area. Furthermore, air quality in Ascension and St. James Parishes was not in exceedance of NAAQS for criteria pollutants in 2008. These findings indicate that the existing air quality within the study area is generally good to moderate with infrequent days where air quality is unhealthy for sensitive groups and the general population.

4.2.5 Noise

Noise is institutionally significant because of the Noise Control Act of 1972 that declares the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare; and the Occupational Safety and Health Standards (29 CFR, part 1910) regarding protection against the effects of noise exposure. Noise is technically significant because noise can negatively affect the physiological or psychological well-being of an individual (Kryter, 1994) ranging from annoyance to adverse physiological responses, including permanent or temporary loss of hearing, and other types of disturbance to humans and animals, including disruption of colonial nesting birds. Noise is publicly significant because of the public's concern for the potential annoyance and adverse effects of noise on wildlife and humans.

Historic Conditions
Limited information exists regarding historical noise exposure within the study area. Presumptively, increases in noise exposure occurred within the study area following the construction of transportation infrastructure within and surrounding the study area, and subsequent forestry activities. After which, it is presumed that noise exposure reflected trends in traffic related to activities that occurred in and proximal to the study area.

Existing Conditions

Noise is typically associated with human activities and habitations, such as operation of commercial and recreational boats, water vessels, air boats, and other recreational vehicles; operation of machinery and motors; and human residential-related noise (air conditioner, lawn mower, etc.). However, the proposed study area is a remote and uninhabited swamp. The noise from distant urban areas surrounding the study area has little if any impacts on the area. Frequent localized noises are related to train transit and vehicle traffic on railroads and highways within and adjacent to the study area. Noise generated by recreational outboard motorboat operation is also common, with airboat operation infrequent and restricted by the WMA.

4.2.6 Vegetation Resources

Coastal vegetation resources attain institutional significance through the following federal statutes: the Coastal Barrier Resources Act of 1982; the Coastal Zone Management Act of 1972; the Emergency Wetlands Resources Act of 1986; the Estuary Protection Act of 1968; the Fish and Wildlife Conservation Act of 1980; the Fish and Wildlife Coordination Act of 1958, as amended; the Migratory Bird Conservation Act; the Migratory Bird Treaty Act; the Endangered Species Act of 1973 (ESA); the Magnuson Fishery Conservation and Management Act 1990; the National Environmental Policy Act of 1969; the North American Wetlands Conservation Act; the Water Resources Development Acts of 1976, 1986, 1990, and 1992; and Executive Order 13186—Responsibility of Federal Agencies to Protect Migratory Birds. Coastal vegetation resources are technically significant because they are a critical element of the coastal habitats. In addition, coastal vegetation resources serve as the basis of productivity, contribute to ecosystem diversity, provide various habitat types for fish and wildlife, and are an indicator of the health of coastal habitats. Coastal vegetation resources are publicly significant because of the high priority that the public places on their aesthetic, recreational, and commercial value.

4.2.6.1 Wetland Vegetation

Historic Conditions

Prior to European settlement in the early eighteenth century and subsequent large-scale land modification, ninety percent of the wetlands in the Pontchartrain Basin were forested, baldcypress-tupelo swamp (Saucier, 1963). Southwest Maurepas Swamp was vegetated by an expanse of old growth, freshwater forested swamp that extended as far as 26 miles north from the Mississippi River to the Baton Rouge-Denham Springs fault line (LPBF, 2005). Baldcypress trees over 1,000 years old dominated the canopy (Mattoon, 1915) with water tupelo, ashes, and red maple also important (Conner and Day, 1976). Inland towards the Mississippi River, the swamp transitioned to bottomland hardwood forests at slightly higher elevations that constructed the lower portions of the natural levee (Kelley 1989, Shaffer et al. 1999). Typical tree species included laurel oak, water oak, swamp chestnut oak,

and other water-tolerant oaks, in addition to species such as sweetgum, sugarberry, water hickory, and American elm (Kelley 1989, Shaffer et al. 1999).

Forest clearing ensued after colonization to make way for homesites and agriculture as well as for building materials and commercial exploits (Robin 1966, Brasseux 1987, Daigle 1995). Extensive clearing of bottomland hardwood forest occurred more readily than clearing of the swamp due to the former's suitability for agriculture and the difficulty of harvesting in the deepwater characteristic of the latter (Shaffer et al. 1999). Nonetheless, small-scale timber harvests in Maurepas Swamp began as early as 1700 (Keddy et al. 2007). The advent of the pull-boat and mechanized harvesting techniques in the late 1880's allowed rapid expansion of these efforts (Mancil 1980, LPBF 2005). Commercial deforestation of the Pontchartrain Basin began in 1890 but continued only until 1938—at which time merchantable timber resources had been nearly exhausted (Lopez, 2003). Small-scale extraction of remnant trees continued after this time, with a pull boat logging along Blind River observed by Mancil (1980) as late as 1961. The effects of these land use impacts altered the old growth forest and are still visible in the secondary forest present today.

Vegetation communities of coastal Louisiana have been extensively mapped across an expansive area and over an extended period of record based on major association or habitat type (e.g. Penfound and Hathaway 1938; O'Neil 1949; Chabreck et al. 1968; Chabreck 1970, 1972b; Cowardin et al. 1979; Chabreck and Linscombe 1978, 1988; Visser et al. 1998, 1999, 2000; Chabreck et al. 2001). However, the differing classification and analysis methods between these studies limit any spatial assessment of habitat change within the study area during this period.

Referencing historic maps and current community characteristics, following widespread timber harvesting activities the study area has developed into a primarily baldcypress-tupelo forested wetland. Historic habitat types within the study area for selected dates from 1956 to 2000 are presented in Figure 4-15 and post hurricane Katrina in 2005 in Figure 4-16.

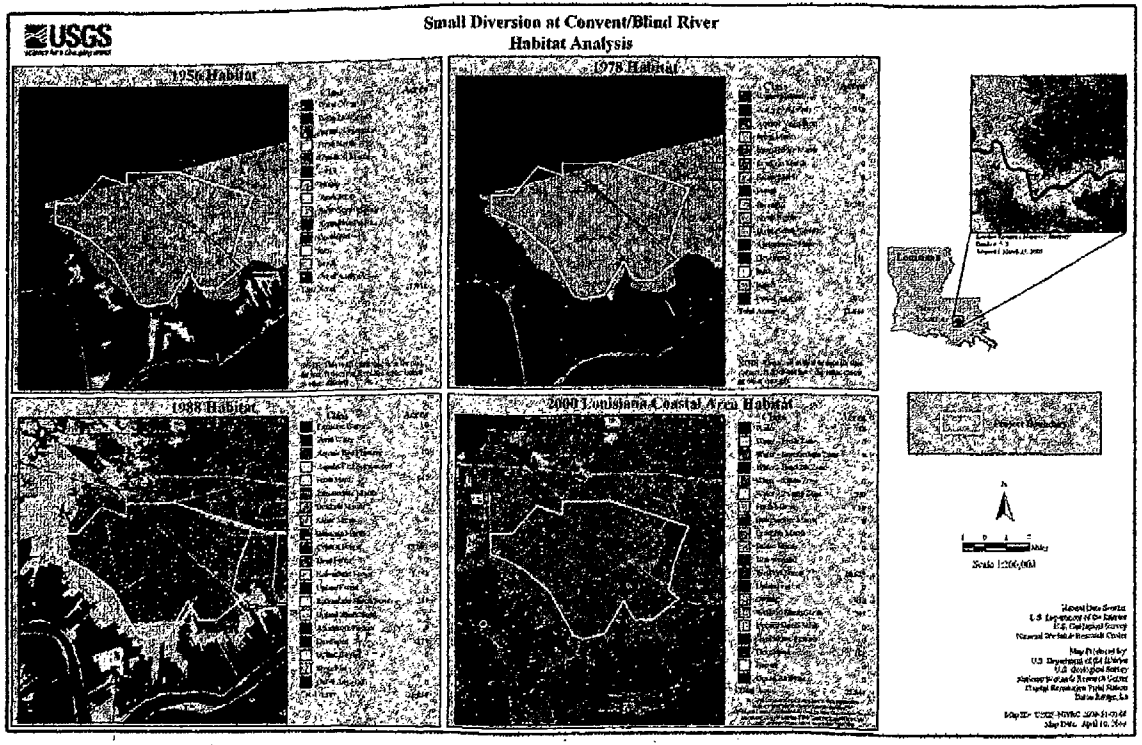


Figure 4-14: Habitat analysis in study area for years 1956, 1978, 1988, and 2000 (Wicker 1980; Barras et al. 1994;

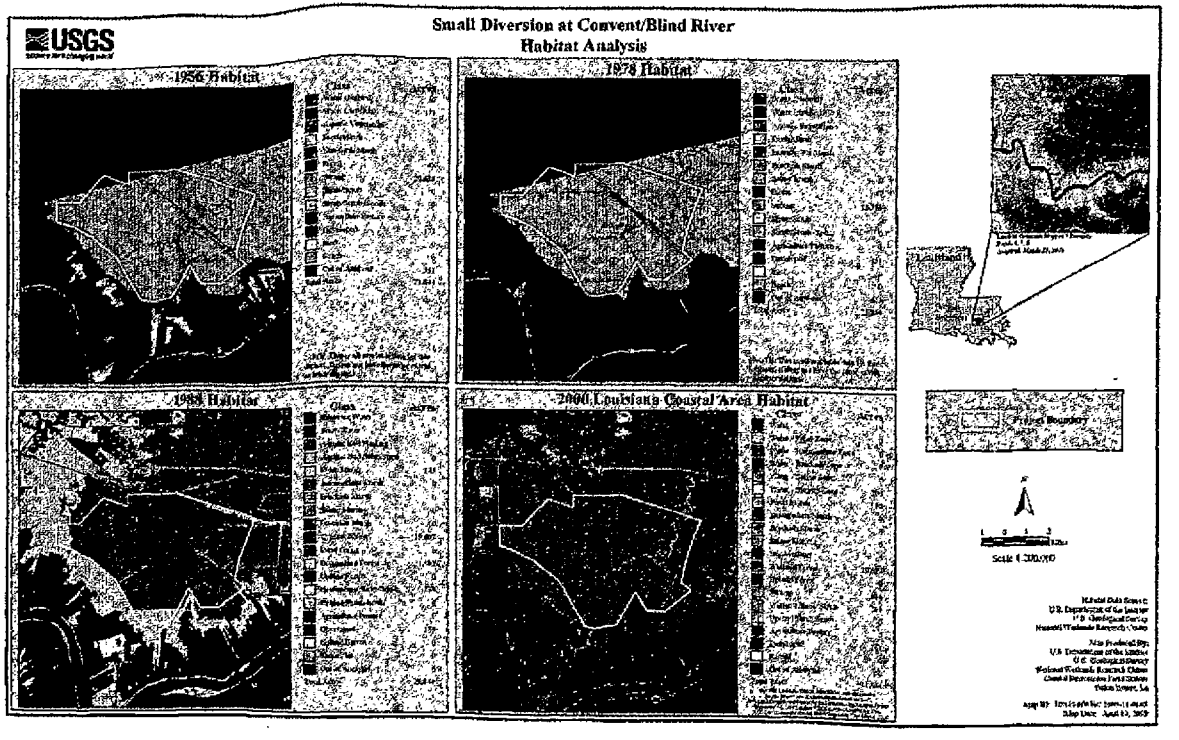


Figure 4-15: Habitat analysis for the project distribution area for 2005Existing Conditions

Existing Conditions

Community Types

Wetland Vegetation

Wetland vegetative habitat descriptions are based on field observations and are described in accordance with *The Natural Communities of Louisiana* (LNHP, 2009). Existing habitat types and respective acreages discussed below are based on the 1988 USGS National Wetlands Research Center (NWRC) map (USGS NWRC, 1999) and include aquatic bed floating vascular, bald cypress-tupelo swamp, bottomland hardwood forest, fresh marsh, and scrub-shrub swamp. Despite more recent mapping efforts, the 1988 USGS NWRC represents the most refined habitat classification to date for the Study Area with regards to spatial resolution and community taxonomy. Habitat structure has changed over time; however, bald cypress-tupelo swamp has remained the predominant habitat type, pre-dating human disturbance and persisting today. Table 4-5 describes wetland acreages by community type for the project distribution and transmission channels.

Table 4-5: Wetland community type acreages by location within the Study Area (USGS NWRC, 1999).

Community Type	Location		
	Distribution Area (ac)	Romeville Transmission (ac)	South Bridge Transmission (ac)
Aquatic Bed Floating Vascular	27.1	0.0	0.0
Bald cypress-tupelo	20,187.9	0.0	0.0
Bottomland Forest	1,614.4	91.0	117.6
Fresh Marsh	138.1	1.8	6.0
Scrub/Shrub swamp	253.1	0.2	0.0
Water	117.9	0.4	6.0

Aquatic Bed Floating Vascular

The Aquatic Bed Floating Vascular habitat (Cowardin et al. 1979) includes a diverse group of floating vascular plant communities that requires surface water for optimum growth and reproduction, preferring continuous or frequent flooding (see Table 4-7). Aquatic beds are easily moved by water currents or wind and include species that float freely either in the water or on its surface. This habitat type is found along the Blind River and the canals maintained by St. James Parish. Common species present include water lily, alligator weed, and duckweed.

Depending on the season and rainfall regime, duckweeds can dominate the canals forming dense mats several inches thick. Communities are frequently dominated by one or two species, though several species may coexist (LNHP 2009). The Louisiana Natural Heritage Program (LNHP 2009) characterizes aquatic bed floating vascular communities as highly productive habitat that serves as an important coastal ecosystem component through supplying oxygen, detrital material, and dissolved organic nutrients to the water and producing organic matter that is consumed by organisms. Further, these systems provide valuable habitat for numerous fish and wildlife species.

Bald cypress-Tupelo Swamp

Bald cypress-tupelo swamp is the most prevalent habitat type in the distribution area, comprising over ninety percent of the total area. Habitat assessment using the US Fish and Wildlife Service Wetland Value Assessment (WVA) methodology swamp Model determined that the majority of sampling sites were characterized by bald cypress and water tupelo as canopy dominants based on percent canopy composition and basal area. While bald cypress was the canopy dominant in a few locations, water tupelo was the predominant species across sites. Red maple and green ash were prevalent in the midstory in most areas. Further description of observed community characteristics is presented in **Appendix K.**

Occupying a landscape position slightly higher in elevation than fresh marsh but lower in elevation than bottomland hardwoods, bald cypress-tupelo swamp habitats are typically located along surface water channels and in back swamp depressions and swales. This habitat is inundated or saturated by surface water or groundwater on a nearly permanent basis throughout the growing season, except during periods of extreme drought (Penfound, 1952; Mitsch and Gosselink, 2000). Seasonal fluctuation of water level is typical (LNHP, 2009).

Bottomland Forest

This forest association is found at higher ground elevations than surrounding swamp habitats and is therefore inundated less frequently. Bottomland hardwoods are generally intolerant of inundation during the growing season (Putnam et al. 1960; Hodges 1997; Shaffer et al. 2000). Fluctuations in water level are more prevalent in the bottomland forest than bald cypress-tupelo swamp, with characteristic alternating wet/dry periods. Nutrient transport and organic matter deposition during flood events result in high productivity. Numerous distinct community types are recognized as bottomland hardwood forests, each associated with unique landforms, soils, and hydrologic regimes. Biogeographic separation of plant species within bottomland hardwoods is centrally dependent on soil oxygen availability which is related to various abiotic and biotic factors. Bottomland hardwoods provide habitat for many species of wildlife, such as white-tailed deer, grey squirrels, raccoons, and numerous bird species. These areas typically were the first to be cleared when logging in the area occurred.

Bottomland forests in the Study Area are most commonly found at topographically higher areas. As elevation increases from the swamp towards the natural levee, species assemblages transition from flood tolerant species characteristic of bald cypress-tupelo swamp to less flood tolerant bottomland hardwood species. Within the distribution area, these forests have undergone high mortality of less flood tolerant species (e.g, green ash) and appear to be transitioning towards bald cypress-tupelo swamp. Upgradient from the distribution area, the Romeville and South Bridge transmission canals also transect areas of bottomland forest. The batture—the area between the natural levee crest and the Mississippi River—is vegetated by bottomland forest characterized by pioneer species, such as black willow (*Salix nigra*), and frequent inundation during the spring and summer at higher river stages.

Fresh Marsh

This habitat type is typically located adjacent to intermediate marshes near the northern extent of coastal marshes. Floristic composition of fresh marshes is extremely heterogeneous within and between habitats based largely on the frequency and duration of flooding, as related to microtopography, which collectively influence species composition. Other factors regulating species distribution include substrate, current flow, salinity, competition, and allelopathy. Consequently, fresh marshes exhibit the highest species diversity of any marsh type, with as many as ninety-two plant species reported (LNHP 2009). Epiphytic and benthic algae are common autotrophic groups present, with much of this habitat consisting of floating marsh (flotant). Soil organic matter content is highest for fresh marsh in relation to all other marsh types. Fresh marsh supports the highest wildlife populations of any marsh type, providing overwintering habitat for many migratory waterfowl. Fisheries important to Louisiana's economy and ecology depend on fresh marsh for critical nursery areas, including such species as flounder, croaker, and juvenile brown and white shrimp. (LNHP, 2009).

Within the Study Area, fresh marsh habitat mainly consists of pipeline and powerline easements. While some of these easements have ditches, many of the easements are slightly elevated above the adjacent swamp and are thickly vegetated with grasses and forbs. These areas are usually saturated to the surface, and flooded only during higher water periods. Therefore, it is unlikely that fresh marshes within the Study Area currently provide nursery habitat for estuarine species. However, these fresh marshes would provide habitat for other wildlife species such as reptiles and amphibians.

Scrub/Shrub Swamp

Characterized as a low, flat freshwater swamp, scrub/shrub swamp vegetation includes large shrubs and small trees less than 35 feet in height. Landscape position includes depressional, semi-permanent pools and along slow flowing channels and streams where soils are flooded for extended periods. Dry periods are infrequent, occurring during summer months and often associated with drought

events. This habitat is found along the Blind River and canals within the Study Area. It is also present along the edges of pipeline easements.

Table 4-6: Common plant species observed or likely to occur in the study area by habitat type.

Common Name	Scientific Name
Aquatic Bed Floating Vascular	
Alligator Weed*	*Alternanthera philoxeroides*
Big Floatingheart*	*Nymphoides aquatica*
Bladderworts	*Utricularia* spp.
Coontail*	*Ceratophyllum demursum*
Duckweeds*	*Lemna, Spirodella, Wolfia, and Wolfiellea* spp.
Fanwort	*Cabomba caroliniana*
Lemon Bacopa	*Bacopa caroliniana*
Mosquito Fern	*Azolla caroliniana*
Pondweeds	*Potamogeton* spp.
Southern Naiad	*Najas guadalupensis*
Spatterdock	*Nuphar luteum*
Water Hyacinth*	*Eichhornia crassipes*
Water Lettuce	*Pistia stratioites*
Water Lily*	*Nymphaea odorata*
Water Milfoil	*Myriophyllum* spp.
Water Shield	*Brasenia schreberi*
Baldcypress-Tupelo Swamp	
American Cupscale	*Sacciolepis striata*
Arrow Arum*	*Peltandra virginica*
Aster	*Symphyotrichum (aster)* spp.
Baldcypress*	*Taxodium distichum*
Bog Hemp*	*Boehmeria cylindrica*
Boxelder*	*Acer negundo*
Bulltongue Arrowhead*	*Sagittaria lancifolia*
Climbing Dayflower*	*Commelina diffusa*
Fox Clubmoss*	*Lycopodium alopecuroides*
Giant Cutgrass*	*Zizaniopsis miliacea*
Green Ash*	*Fraxinus pennsylvanica*
Japanese Climbing Fern*	*Lygodium japonicum*
Lizard's Tail*	*Saururus cernuus*
Maidencane*	*Panicum hemitomon*
Marsh Seedbox*	*Ludwigia palustris*
Pennywort*	*Hydrocotyle* spp.
Pickerelweed*	*Pontederia cordata*
Red Maple (swamp variant)*	*Acer rubrum* var. *drummondii*

Common Name	Scientific Name
Rough Horsetail*	*Equisetum hyemale*
Savannah Panicgrass*	*Phanopyrum gymnocarpon*
Sedges*	*Carex* spp.
Smartweed*	*Polygonum punctatum*
Soft Rush*	*Juncus effusus*
Southern Amaranth	*Amaranthus australis*
Southern Blue-flag Iris*	*Iris virginica*
Southern Swamp Lily*	*Crinum americanum*
Swamp Privet*	*Forestiera acuminata*
Three-way Sedge*	*Dulichium arundinaceum*
Walter's Millet*	*Echinochloa walteri*
Warty Sedge*	*Carex verrucosa*
Water Ferns*	*Salvinia* spp.
Water Horehound*	*Lycopus virginicus*
Water Tupelo*	*Nyssa aquatica*
Bottomland Forest	
American Elm*	*Ulmus americana*
American Sycamore*	*Platanus occidentalis*
Blackgum*	*Nyssa Sylvatica*
Black Willow*	*Salix nigra*
Cherrybark Oak*	*Quercus pagoda*
Laurel Oak*	*Quercus laurifolia*
Nuttalls Oak*	*Quercus nutalli*
Overcup Oak*	*Quercus lyrata*
Persimmon*	*Diospyros virginiana*
Red Maple*	*Acer rubrum*
Sugarberry*	*Celtis laevigata*
Sweetgum*	*Liquidambar styraciflua*
Water Hickory*	*Carya aquatica*
Water Oak*	*Quercus nigra*
Scrub/Shrub Swamp	
American Basswood*	*Tilia americana*
American Black Elderberry*	*Sambucus nigra* ssp. *canadensis*
Boston Swordfern*	*Nephrolepsis exaltata*
Boxelder*	*Acer negundo*
Buttonbush*	*Cephalanthus occidentalis*
Cattail*	*Typha* spp.
Chinese Privet*	*Ligustrum sinense*
Chinese Tallow Tree*	*Triadica sebifera*
Common Greenbrier*	*Smilax rotundifolia*
Deer Pea	*Vigna luteola*
Dwarf Palmetto*	*Sabal minor*

Common Name	Scientific Name
Great Ragweed*	*Ambrosia trifida*
Japanese Climbing Fern*	*Lygodium japonicum*
Marsh Fern*	*Thelypteris* spp.
Peppervine*	*Ampelopsis arborea*
Poison Ivy*	*Toxicodendron radicans*
Red Maple (swamp variant)*	*Acer rubrum* var. *drummondii*
Saltbush*	*Baccharis halmifolia*
Spikerush	*Eleocharis* spp.
Trumpet Creeper*	*Campsis radicans*
Wand Lythrum	*Lythrum lineare*
Wax Myrtle*	*Morella cerifera*
Willows*	*Salix* spp.

*Indicates observed in study area during field survey.

Ecological Condition

Based on the predominance of bald cypress-tupelo forest in the Study Area, this chapter describes the ecological condition of that forest type. Numerous studies indicate a trend of declining health in deepwater, bald cypress-tupelo forests throughout coastal Louisiana (Conner et al. 1981; Barras et al. 1994; Myers et al. 1995; Chambers et al. 2005), and the forests of the Study Area are no different. The forests exhibit numerous symptoms of stress that are regionally apparent in southwest Maurepas Swamp and are most evident in more degraded locations.

In forested swamps of the southeastern United States, recorded rates of aboveground primary productivity range from roughly 200 to 2,000 g m-2 yr-1 (e.g., Mitsch and Gosselink, 1993; Conner and Day, 1976; Conner and Buford, 1998). Over a five-year study in southwest Maurepas Swamp, however, Shaffer et al. (2003) observed average aboveground productivity of only 400-700 g m-2 yr-1—rates typically associated with wetlands that are nearly permanently flooded, nutrient limited, or exhibit limited flow (e.g., Schlesinger, 1978; Taylor, 1985; Mitsch et al. 1996; Megonigal et al. 1997; Conner and Buford, 1998). A comparison of site conditions suggests that rates at the upper end of this range may be typical for the Study Area.

Comparison with the structural characteristics of other bald cypress-tupelo forests further suggests stressed growing conditions in the Study Area. More so, field observations in the Study Area and research by Shaffer et al. (2003) in adjacent areas indicate that the forests support atypically low stem densities and basal areas for the community type. Existing conditions are comparable to those of impounded or continuously flooded forests (e.g., Conner et al. 1981; Dicke and Toliver, 1990; Conner and Day, 1992; Conner and Buford, 1998). Furthermore, high mortality

rates—approximately two percent or less annually according to Shaffer et al.'s (2003) estimates—coupled with limited to no regeneration threaten the persistence of these forests. Throughout coastal Louisiana, increased mortality of less flood tolerant species due to increased flooding is a common trend (Conner et al. 1981; Shaffer et al. 2003).

Interacting stressors implicated in the degradation of forests in the Study Area are increased flood duration, stagnation, salinity, and nutrient limitations as well as top-down herbivore pressure. Across the Lake Pontchartrain Basin and coastal Louisiana in general, records indicate increasing flooding depths and duration (Conner and Day, 1988; Conner and Day, 1991; Thomson et al. 2002; Shaffer et al. 2003). Flooding results in both decreased aboveground net primary productivity (Megonigal et al. 1997) and the prevention of regeneration.

Bald cypress and water tupelo are among the most flood tolerant tree species in the Southeast (e.g., Hook 1984). Though, prolonged, deep flooding over an extended period may have detrimental effects on growth and survival (Penfound, 1949; Eggler and Moore, 1961; Harms et al. 1980; Brown, 1981; Kozlowski, 1984; Conner and Brody, 1989; Dicke and Toliver, 1990; Conner and Day, 1992; Stable et al. 1992; Yount et al. 1995). Where water levels fluctuate and pulsed flows occur, bald cypress-tupelo forests exhibit among the highest productivity rates for forested ecosystems (Brinson et al. 1981; Brown, 1981; Conner and Day, 1982; Brinson, 1990; Lugo et al. 1990; Conner, 1994).

Permanent flooding prevents the regeneration of bald cypress and water tupelo, whose seeds cannot germinate under water and hence require a dry period (Mattoon, 1915; DeMaree, 1932; DuBarry, 1963; DeBell and Naylor, 1972). Seeds remain viable for an extended period when submerged or buried (DeMaree 1932; Applequist, 1959; Middelton, 2000), and seed dispersal is primarily dependent on flows (Johnson, 1990; Wilhite and Toliver, 1990). When germination does occur, seedlings can only withstand complete submergence over short intervals, up to 45 days (Souther and Shaffer, 2000), and increased mortality occurs when seedlings are inundated for greater than two weeks (Brandt and Ewel, 1989). Consequently, water levels low enough and over adequate duration to allow germination and seedling growth to heights above subsequent flood stages are required for successful regeneration of bald cypress and tupelo (Conner et al. 1986; Chambers et al. 2005). The widespread failure of coastal Louisiana forests to regenerate in bald cypress was commonplace after commercial harvests in the early twentieth century due to increased impoundment (Mattoon, 1915; Conner et al. 1986). Similar impediments to regeneration remain in the Study Area today; their effects have been exacerbated by further hydrologic modifications and RSLR.

Swamps can survive short-term salinity pulses over several days to weeks (Allen et al. 1994; Campo, 1996; Conner et al. 1997; Kraus et al. 2007); however, salt stress due to increases in background levels and extended exposure during meteorological events (e.g., droughts and hurricanes) is a major factor influencing tree productivity

and survival across coastal Louisiana and at all but the most interior sites in Maurepas Swamp (Pezeshki et al. 1990; Conner and Askew, 1992; Allen, 1992; McLeod et al. 1996; McCarron et al. 1998; Krauss et al. 2000; Shaffer et al. 2003; Effler et al. 2007). Together, flooding and salinity have a more detrimental effect on seedling growth and survival (Conner, 1994; Allen et al. 1996). Of the common tree species in the Study Area, bald cypress is the most salt tolerant. As salinity increases to approximately 1.2 ppt, tree species diversity decreases, and species such as water tupelo, green ash, and sweetgum are eliminated from some forests (Kraus et al. 2007). Red maple is slightly more salt tolerant but exhibits mortality at 2.5 ppt salinity (Kraus et al. 2007). At salinities above 1.8 ppt, only bald cypress remains dominant in natural settings (Kraus et al. 2007). The species is tolerant of salinities reaching 8 ppt, but is negatively affected by greater than 4 ppt salt content (Pezeshki et al. 1990; Conner and Askew, 1992; Conner, 1994; Pezeshki et al. 1995; Allen et al. 1996; Conner and Ozalp, 2002), and its natural range is less than 3-4 ppt (Harlow and Harrar, 1969; Chabreck 1972; Myers et al. 1995).

Additional stressors that impact forest health in the Study Area are nutrient limitations and herbivory. Overbank floods from the Mississippi River brought nutrient laden, sediment rich freshwater into the Study Area. Prevention of these floods has resulted in nutrient, specifically nitrogen, limitations (Lane et al. 2003; Effler et al. 2007). Herbivory also significantly influences forest health in the Study Area. Common defoliators of bald cypress and water tupelo are bald cypress leafroller (*Archips goyerana*) and forest tent caterpillar (*Malacosoma disstria*), respectively, with other minor pests (Chambers et al. 2005). The first recorded outbreak of bald cypress leafroller in Louisiana occurred in 1983 (Goyer and Lenhard, 1988; Goyer and Chambers, 1996). Regular outbreaks of forest tent caterpillar have been reported for Louisiana since 1948 (Nachod and Kucer, 1971). Nutria also negatively impact tree species regeneration (Meyers et al. 1995).

Based on field observations of forest structure within the Study Area trends observed through research in adjacent regions of Maurepas Swamp, and aerial photography (past and present), the Environmental Project Team developed a habitat condition map to spatially classify areas of swamp habitat according to degree of degradation. The classification scheme was in accordance with the approach used by Dr. Shaffer for other areas within Maurepas Swamp. Patches were discretely defined based on the relative period of time over which they would transition to fresh marsh: 20-30 years to marsh, 30-50 years to marsh, and greater than 50 years to marsh.

Figure 4-16 depicts the arrangement of these habitat condition classes across the distribution area. Acreages by condition class for the distribution area are presented in Table 4-7, with further description provided in the Wetland Value Assessment Report (**Appendix B & K**).

Table 4-7: Acreages by habitat condition class for the Study Area.

Habitat Condition Class	Acres
20-30 Years to Marsh	3,294
30-50 Years to Marsh	7,934
>50 Years to Marsh	10,140
Total	**21,368**

4.2.6.2 Upland Vegetation

Historic Conditions

Before colonization in the early eighteenth century, upland forests of white oaks, water oak, and hickories are reported to have grown in the study area on higher portions of the natural levee between the Mississippi River and the distribution area (Kelley 1989). The extent of upland vegetation increased significantly with drainage efforts. Timber harvests for revenue and to clear fields for agriculture and homesites converted much of the natural levee land cover from forests to agrarian fields.

Existing Conditions

Based on the USGS National Land Cover Database (2003) and remote verification, upland areas within the Study Area include lands in cultivation, pasture, developed, and shrub/scrub cover classes. Table 4-8 presents acreages by land cover class and location within the Study Area for upland areas.

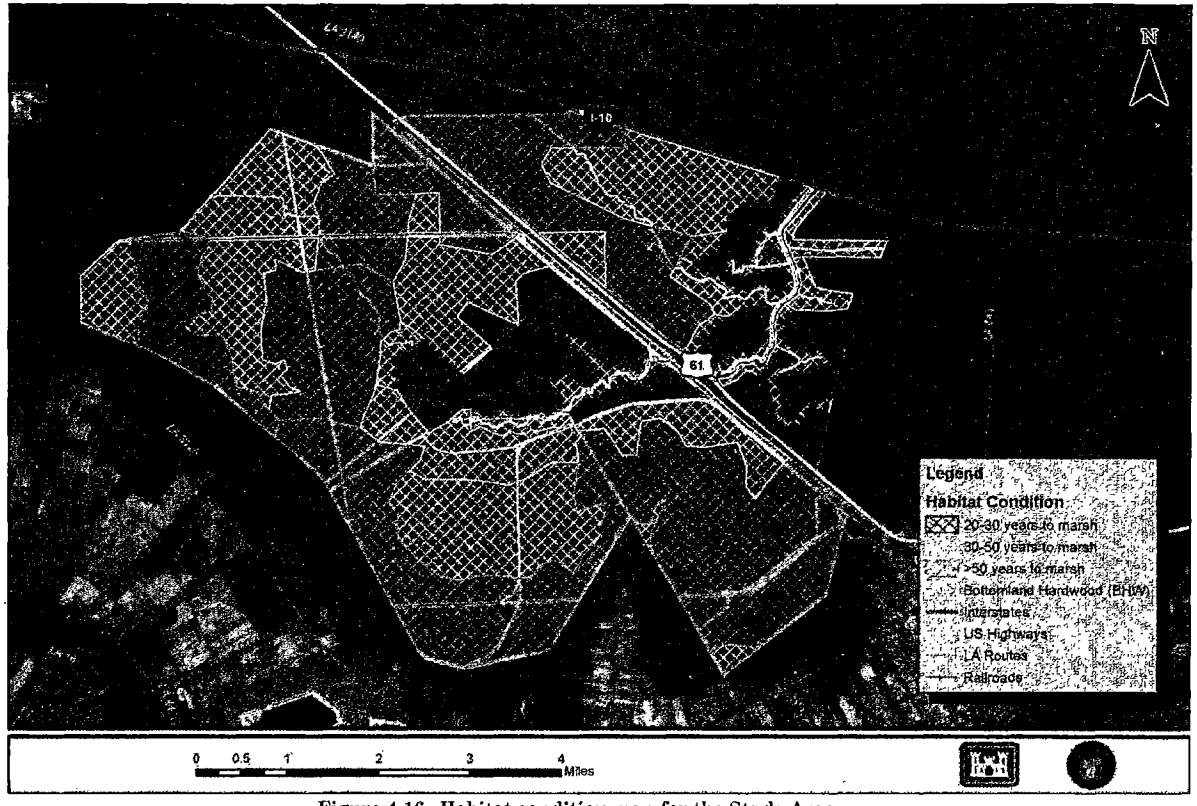


Figure 4-16. Habitat condition map for the Study Area.

Table 4-8: Upland vegetation by land cover class and Study Area location (USGS 2003).

Land Cover Class	Location		
	Distribution Area (ac)	Romeville Transmission (ac)	South Bridge Transmission (ac)
Cultivated Crops	1.3	85.8	68.1
Developed, Low Intensity	207.5	6.7	29.6
Developed, Medium Intensity	3.1	0.0	0.0
Developed, High Intensity	1.6	0.0	0.0
Pasture/Hay	8.0	0.2	0.0
Shrub/Scrub	0.0	0.9	3.3
Source: National Land Cover Database Zone 37B Land Cover Layer (USGS, 2003).			

4.2.6.3 Invasive Species - Vegetation

Historic Conditions

Federal mandate to "prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause" is provided under Executive Order 13112. Signed on February 3, 1999, the executive order created the National Invasive Species Council and charged this body with, among other tasks, overseeing its implementation.

Invasive plant species often increase and spread rapidly because the habitat into which they are introduced is free of insects and diseases that are natural controls in their native habitats (e.g., Keane and Crawley 2002). Habitats intrinsically vary in their vulnerability to invasion, with disturbance events increasing susceptibility. Picket and White (1985) define disturbance as the process by which an ecosystem is modified by an exogenous event (human or natural) to a condition that is not otherwise common for that ecosystem. By reducing competition, disturbance events facilitate the colonization and establishment of invasive species. The clearcutting of baldcypress, associated and subsequent canal construction/maintenance, levee construction and the severance of flood events, as well as tropical storms and hurricanes, all constitute disturbance events that have affected the study area.

Once established, invasive species negatively impact extant ecosystem function and structure. Through mechanisms such as competitive exclusion, these species alter the ability of native species to grow and reproduce, thus impacting the continuance of ecosystem services formerly provided. For example, invasive plant species may interfere with drainage and flood control, impede navigation and recreational activities, and degrade water and habitat quality (Westbrooks 1998). More so,

invasive species frequently displace native species, often leading to their extinction (e.g., Sax et al. 2002).

Existing Conditions

In coastal Louisiana, Chinese tallow (*Triadica sebifera*), water hyacinth (*Eichhornia crassipes*), and hydrilla (*Hydrilla verticillata*) are well-known invasive plant species observed in the Study Area. More recently, common salvinia (*Salvinia minimai*), a floating aquatic fern, has colonized and established populations in the Study Area and often covers the parish drainage canals (LCA 2004, LACPR 2008). Alligator weed (*Alternanthera philoxeroides*) also grows in the canals and interior swamp of the Study Area. Chinese tallow and chinaberry (*Melia azerdarach*) are established on berms along the canals. Invasive plant species that were not observed in the Study Area but are confirmed within the Lake Maurepas Watershed and thus may likely be present in the Study Area include parrot feather (*Myriophyllum aquaticum*), wild taro (*Colocasia esculenta*), Brazilian waterweed (*Egeria densa*), and water lettuce (*Pistia stratiotes*) (Kravitz et al. 2005).

4.2.6.4 Rare, Unique, and Imperiled Vegetation

The following unique communities, nested within the broader vegetative habitats, are important in that they contribute to the extensive diversity of the coastal ecosystem, are the basis for its productivity, and are essential to the maintenance of its biodiversity. Overall, plant communities provide protection against substrate erosion and contribute food and physical structure for cover, nesting, and nursery habitat for wildlife and fisheries. Continued degradation and loss of existing wetland areas, in concert with the truncation of replenishing processes, will accelerate decline in the interdependent processes of plant primary productivity and vertical maintenance through accretion necessary to sustain the ecosystem.

The LNHP, administered by the LDWF, maintains a directory of over 6,000 occurrences of rare, threatened, or endangered species; unique natural communities; and other distinctive elements of natural diversity. Across the state, LNHP has identified 380 ecologically significant sites also included in the database. The LNHP database was queried for the occurrence of rare, unique, and imperiled vegetative communities within the Study Area. Of these, the presence of bald cypress-tupelo swamp was the only recorded occurrence. Additional unique communities known to occur in Ascension and St. James parishes and recorded in the Study Area by the 1988 NWRC habitat map and field inventory include bottomland hardwood forest and fresh marsh.

Bald cypress-tupelo Swamp (Rarity Rank S4/G3G5)

Despite the prevalence of bald cypress-tupelo forest in the Study Area, statewide estimates of swamp losses range from 25-50% of the original presettlement acreage, and old-growth forests are very rare statewide and regionally. Numerous inter-related and synergistic forces threaten the persistence and expansion of bald cypress-tupelo swamp. Threats include, but are not limited to, development

activities; saltwater intrusion, subsidence, and hydrologic alteration; logging (where natural and artificial regeneration is prohibited or soil damage likely); chemical contamination; and invasive exotic species.

Bottomland Hardwood Forest (Rarity Rank S4/G4G5)

Throughout Louisiana, bottomland hardwood forests are found in all river basins. However, the current range has been significantly reduced, with loss estimated at 50-75% of its original presettlement acreage with old growth stands very rare. Historically, clearing of forests for agricultural production has been the primary cause of habitat fragmentation and destruction. Additional past and present threats include hydrologic alterations; construction of roads, utilities, and pipelines; and invasive exotic species.

Fresh Marsh (Rarity Rank S1S2/G3G4)

Although fresh marshes, as previously described, compose a large amount of the entire coastal marsh acreage, the LNHP ranks this community as imperiled because it has undergone the largest reduction in acreage of any marsh type over the past 20 years due to saltwater intrusion. Of the estimated 1 to 2 million acres of fresh marsh in Louisiana during presettlement times, only 25-50% of this habitat remains. Saltwater intrusion poses a significant threat to this habitat type, in addition to other factors

4.2.7 Wildlife and Habitat

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Coastal Zone Management Act; Estuary Protection Act; the Fish and Wildlife Coordination Act of 1958, as amended; the Migratory Bird Conservation Act of 1929, as amended; the Migratory Bird Treaty Act of 1918; the Endangered Species Act of 1973 (ESA), as amended; the Fish and Wildlife Conservation Act of 1980; the North American Wetlands Conservation Act; Executive Order 13186 Migratory Bird Habitat Protection; Migratory Bird Conservation Act; and the Marine Mammal Protection Act. Wildlife resources are technically significant because they are a critical element of the coastal ecosystem, they are an important indicator of the health of coastal habitats, and many wildlife species are important recreational and commercial resources. Wildlife resources are publicly significant because of the high priority that the public places on their aesthetic, recreational, and commercial value.

Beyond local and regional scales, the wildlife resources of Louisiana constitute a critical component of the nation's biodiversity reserve. Over forty percent of the vegetated, estuarine wetlands in the contiguous United States are in Louisiana, harboring a diverse assemblage of species dependent on this habitat. Further, the economic value of the ecosystem services provided by these systems is immense (Costanza et al. 1997). Louisiana's coastal wetlands provide important habitats for various life cycle stages for over 50 rare, threatened, and endangered species.

Table 4-9 shows the status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999).

4.2.7.1 Birds

Historic Conditions

Coastal Louisiana's wetlands have historically supported an abundance of neotropical and other migratory and non-migratory avian species, such as rails, gallinules, shorebirds, wading birds, and waterfowl. Diving ducks, seabirds, rails, coots, and gallinules have historically preferred the open water habitats of Lake Maurepas and West Manchac Land Bridge, while wading birds have occurred in fresh swamp habitats, such as those found in the study area.

The LCWCRTF & WCRA (1999) reports that since 1985 most bird species and species groups have exhibited either increasing or stable populations in the study area (Table 4-10). Notable increases have been observed for bald eagles, wading birds, and other woodland residents, such as pileated woodpecker, Carolina chickadee, and belted kingfisher, in the Amite/Blind River Mapping Unit, which includes the study area.

Louisiana coastal wetlands also have historically served as essential stopover habitat for neotropical migratory birds on their annual migration route. Whereas bottomland hardwood forests provide critical breeding habitat for approximately 70 species of birds, diversity is lower in baldcypress-tupelo swamp forests (Kennedy 1977, Wakeley and Roberts 1996). Nonetheless, baldcypress-tupelo swamp forests support dense breeding populations of several neotropical migrants. Many of these species have undergone long-term population declines and are of regional conservation concern (Sauer et al. 2003). Within the study area, these species include northern parula (*Parula americana*), prothonotary warbler (*Protonotaria citrea*), and yellow-throated warbler (*Dendroica dominica*), of which the latter is of greatest concern (Kennedy 1977, Stouffer et al. 2005).

Multiple organizations have officially recognized the study area's importance as critical habitat for avian species. The Audubon Society named Maurepas Swamp an official Important Bird Area on May 12, 2007 based on its status as one of the largest contiguous tracts of wetland forest remaining in the Lower Mississippi River Alluvial Valley and its support of over 20,000 breeding pairs of yellow-throated warblers and 190,000 breeding pairs of northern parula and prothonotary warbler nests per year. The North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCLV): Mississippi River Coastal Wetlands Initiative identified the coastal marshes and forested wetlands of the Lake Pontchartrain Basin as a key waterfowl wintering area (Wilson, 2002).

Table 4-9: Status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999).

Mapping Unit	1988 Habitat		Avifauna																	
	Type	% of Unit	Bald Eagle				Seabirds				Wading Birds				Dabbling Ducks			
			Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.
Amite/Blind	FS	73	Ne	Hi	I	I		NH			Ne	Hi	I	Sy	Mu	Lo	Sy	Sy
	HF	21		NH				NH				NH			Mu	Lo	Sy	Sy
Lake Maurepas	OW	100	Mu	Mo	Sy	Sy	Mu	Mo	Sy	Sy		NH			W	Lo	Sy	Sy
Tickfaw River Mouth	FS	53	Ne	Lo	Sy	Sy		NH			Ne	Hi	I	Sy	Mu	Lo	Sy	Sy
	HF	37		NH				NH				NH			Mu	Lo	Sy	Sy
West Manchac Land Bridge	OW	6		NH			Mu	Mo	Sy	Sy		NH			W	Lo	Sy	Sy
	FM	22		NH			Mu	Lo	Sy	Sy	Mu	Hi	I	Sy	W	Lo	D	D
	FS	61	Ne	Lo	I	I		NH			Ne	Hi	I	Sy	W	Lo	Sy	Sy
	HF	11		NH				NH				NH			W	Lo	Sy	Sy

Habitat Types: FS = Fresh swamp; HF = Hardwood Forest; OW = Open Water. Habitat types comprising less than 5% of unit are shown only if habitat type is particularly rare or important to wildlife.
Status: NH = Not Historically Present; NL = No Longer Present; Lo = Low Numbers; Mo = Moderate Numbers; Hi = High Numbers.

Functions of Particular Interest: Ne = Nesting; St = Stopover Habitat; W = Wintering Area; Mu = Multiple Functions.

Trends (since 1985) / **Projections** (through 2050): Sy = Steady; D = Decrease; I = Increase; U = Unknown.

Table 4-9 (*continued*): Status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999).

Mapping Unit	1988 Habitat		Avifauna (cont.)																			
	Type	% of Unit	Diving Ducks				Raptors				Rails, Coots, and Gallinules				Other Marsh / OW Residents				Other Woodland Residents			
			Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.
Amite/Blind	FS	73		NH				NH				NH			Ne	Lo	Sy	Sy	Ne	Mo	I	Sy
	HF	21		NH				NH				NH				NH			Ne	Hi	I	D
Lake Maurepas	OW	100	W	Lo	Sy	Sy		NH			W	Lo	Sy	Sy	Mu	Mo	Sy	Sy		NH		
Tickfaw River Mouth	FS	53		NH			Mu	Mo	Sy	Sy		NH			Ne	Lo	Sy	Sy	Ne	Mo	I	Sy
	HF	37		NH			Mu	Hi	I	D		NH				NH			Ne	Hi	I	D
West Manchac Land Bridge	OW	6	W	Lo	Sy	Sy		NH			W	Lo	Sy	Sy	Mu	Mo	Sy	Sy		NH		
	FM	22	W	Lo	D	D	Mu	Lo	Sy	Sy	Mu	Lo	D	D	Ne	Hi	Sy	Sy		NH		
	FS	61		NH			Mu	Mo	I	Sy		NH			Ne	Lo	Sy	Sy	Ne	Mo	I	Sy
	HF	11		NH			Mu	Hi	I	D		NH				NH			Ne	Hi	I	D

Habitat Types: FS = Fresh swamp; HF = Hardwood Forest; OW = Open Water. Habitat types comprising less than 5% of unit are shown only if habitat type is particularly rare or important to wildlife

Status: NH = Not Historically Present; NL = No Longer Present; Lo = Low Numbers; Mo = Moderate Numbers; Hi = High Numbers.

Functions of Particular Interest: Ne = Nesting; St = Stopover Habitat; W = Wintering Area; Mu = Multiple Functions.

Trends (since 1985) / **Projections** (through 2050): Sy = Steady; D = Decrease; I = Increase; U = Unknown.

Table 4-9 (*continued*): Status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999).

Mapping Unit	1988 Habitat		Avifauna (cont.)								Furbearers											
	Type	% of Unit	Other Marsh/OW Migrants				Other Woodland Migrants				Nutria				Muskrat				Mink, Otter, and Raccoon			
			Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.
Amite/Blind	FS	73	Mu	Lo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
	HF	21		NH			Mu	Mu	Sy	D	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
Lake Maurepas	OW	100	Mu	Mo	Sy	Sy		NH				NH				NH				NH		
Tickfaw River Mouth	FS	53	Mu	Lo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
	HF	37		NH			Mu	Hi	Sy	D	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
West Manchac Land Bridge	OW	6	Mu	Mo	Sy	Sy		NH			Mu	Mo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
	FM	22	Mu	Hi	Sy	Sy		NH			Mu	Mo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
	FS	61	Mu	Lo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Mo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy
	HF	11		NH			Mu	Hi	Sy	D	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy	Mu	Lo	Sy	Sy

Habitat Types: FS = Fresh swamp; HF = Hardwood Forest; OW = Open Water. Habitat types comprising less than 5% of unit are shown only if habitat type is particularly rare or important to wildlife

Status: NH = Not Historically Present; NL = No Longer Present; Lo = Low Numbers; Mo = Moderate Numbers; Hi = High Numbers.

Functions of Particular Interest: Ne = Nesting; St = Stopover Habitat; W = Wintering Area; Mu = Multiple Functions.

Trends (since 1985) / **Projections** (through 2050): Sy = Steady; D = Decrease; I = Increase; U = Unknown.

Table 4-9 (*continued*): Status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles within the study area (LCWCRTF & WCRA, 1999).

Mapping Unit	1988 Habitat		Game Mammals												Reptiles			
	Type	% of Unit	Rabbits				Squirrels				Deer				American Alligator			
			Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.	Func.	Status	Trend	Proj.
Amite/Blind	FS	73	Mu	Lo	D	D	Mu	Lo	Sy	D	Mu	Mo	I	D	Mu	Mo	I	I
	HF	21	Mu	Lo	D	D	Mu	Mo	Sy	D	Mu	Mo	I	S	Mu	Lo	Sy	Sy
Lake Maurepas	OW	100		NH				NH				NH				NH		
Tickfaw River Mouth	FS	53	Mu	Lo	Sy	D	Mu	Lo	Sy	Sy	Mu	Mo	I	D	Mu	Mo	I	I
	HF	37	Mu	Lo	Sy	D	Mu	Mo	Sy	Sy	Mu	Mo	I	S	Mu	Lo	Sy	Sy
West Manchac Land Bridge	OW	6		NH				NH				NH			Mu	Mo	I	I
	FM	22	Mu	Lo	D	D		NH			Mu	Lo	Sy	D	Mu	Mo	I	I
	FS	61	Mu	Lo	D	D	Mu	Lo	D	D	Mu	Mo	Sy	D	Mu	Mo	I	I
	HF	11	Mu	Lo	D	D	Mu	Mo	D	D	Mu	Mo	Sy	D	Mu	Lo	Sy	Sy

Habitat Types: FS = Fresh Swamp; HF = Hardwood Forest; OW = Open Water. Habitat types comprising less than 5% of unit are shown only if habitat type is particularly rare or important to wildlife.

Status: NH = Not Historically Present; NL = No Longer Present; Lo = Low Numbers; Mo = Moderate Numbers; Hi = High Numbers.

Functions of Particular Interest: Ne = Nesting; St = Stopover Habitat; W = Wintering Area; Mu = Multiple Functions.

Trends (since 1985) / **Projections** (through 2050): Sy = Steady; D = Decrease; I = Increase; U = Unknown.

Existing Conditions

Over four-hundred species of birds are known to occur in Louisiana, most of which inhabit the coastal region. During a bird survey of Maurepas Swamp conducted from 2002 to 2005, Stouffer et al. (2005) observed 117 bird species of 14 orders and 38 families. Research indicates that the diversity of bird species in the forested wetlands of the study area is directly related to habitat condition. Zoller (2004) reported that the mean number of migrant bird species observed in less degraded sites was nearly four times higher than in degraded sites in Maurepas Swamp. Despite the high species richness of wading birds, densities are typically low, and large nesting colonies are absent or rare within the swamp suggesting that suitable habitat may be limited for these species (LDWF 2001, Stouffer et al 2005). Colonial wading bird nesting colonies have not been reported within the study area but have been recorded in Maurepas Swamp to the north and east of the study area, though the status of these colonies is unknown (LNHP 2009).

4.2.7.2 Mammals

Historic Conditions

Across the state, coastal wetlands have historically provided habitat for many of the 58 terrestrial mammal species known to occur in Louisiana (Lowery, 1974). Common game mammals have included white-tailed deer, eastern cottontail, swamp rabbit, gray squirrel, fox squirrel, and raccoon; furbearers have included muskrat, nutria, raccoon, mink, Virginia opossum, striped skunk, bobcat, beaver, and coyote. Various other non-game mammals have inhabited the state, including bats, rodents, and the nine-banded armadillo. Historically, large populations of furbearers, particularly mink and raccoon have been reported in nearby baldcypress-tupelo swamps (Tinkle, 1955). The LCWCRTF & WCRA (1999) reports that since 1985 furbearer populations have typically remained stable across the Upper Pontchartrain Basin (Table 4-10). Rabbit populations, conversely, have experienced declines in the Amite/Blind and West Manchac Land Bridge mapping units, as have squirrels in the West Manchac Land Bridge mapping unit. Squirrel populations have remained steady in the study area, while deer populations have increased (Table 4-11).

Existing Conditions

Despite changes in populations, mammal species historically present in the Upper Pontchartrain Sub-Basin remain today. The coastal wetlands in the study area provide important and essential wildlife habitats, especially transitional habitat between estuarine and marine environments used for shelter, nesting, feeding, cover, and other life requirements. However, both game animals and furbearers are typically found at low densities (Table 4-10). Although one-third of Louisiana's deer population is reported to live in the coastal marshes, very few studies have reported on their feeding and habitat requirements in this environment. According to Gosselink (1984), fresh marshes are preferred by deer almost to the exclusion of brackish and saline marshes. Mammal species likely to occur within the study area based on available habitat and species' distributions and habitat preferences are included in Table 4-10.

Table 4-10: Mammal species likely to occur within the study area based on available habitat and species' distributions and habitat preferences.

Common Name	Scientific Name
Beaver	*Castor Canadensis*
Bobcat	*Felis rufus*
Cotton Mouse	*Peromyscus gossypinus*
Cotton Rat	*Sigmodon nispidus*
Coyote	*Canis latrans*
Eastern Cottontail	*Sylvilagus floridanus*
Eastern Harvest Mouse	*Reithrodontomys humulis*
Eastern Spotted Skunk	*Spilogale putorius*
Feral Hog	*Sus scrofa*
Fox Squirrel	*Sciurus niger*
Golden Mouse	*Ochrotomys nuttalli*
Gray Fox	*Urocyon cinereoargenteus*
Gray Squirrel	*Sciurus carolinensis*
House Mouse	*Mus musculus*
Least Shrew	*Cryptotis parva*
Long-tailed Weasel	*Mustela frenata*
Marsh Rice Rat	*Oryzomys palustris*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Nine-banded Armadillo	*Dasypus novemcinctus*
Nutria	*Myocastor coypus*
Old World Rats	*Rattus* spp.
Raccoon	*Procyon lotor*
Red Fox	*Vulpes vulpes*
River Otter	*Lutra canadensis*
Southern Flying Squirrel	*Glaucomys volans*
Southern Short-tailed Shrew	*Blarina carolinensis*
Striped Skunk	*Mephitis mephitis*
Swamp Rabbit	*Sylvilagus aquaticus*
Virginia Opossum	*Didelphis virginiana*
West Indian Manatee	*Trichechus manatus*

4.2.7.3 Reptiles

Historic Conditions

Deepwater baldcypress-tupelo swamps historically provided habitat for only a few locally abundant reptile species (Wharton et al. 1982). The most common reptiles have included snakes, turtles, skinks, and the American alligator (*Alligator mississippiensis*). Due to the ecological and economic importance of the American alligator, historical and current figures on population numbers are available. In contrast, data on other reptile species in the area is unavailable.

The American alligator has been historically exploited in Louisiana since the 1880s. The species was considered endangered throughout its range by the 1960s due to habitat destruction and overharvest. Harvests were driven by the high economic value of their skin and meat, and in the taking of nuisance individuals. In 1962, the state of Louisiana outlawed the slaughter of alligators, but illegal harvests continued. Due to population declines, the species was listed under the federal Endangered Species Preservation Act of 1967.

During the 1960s, the LDWF developed a scientifically-based management program for the species that allowed incremental harvest of alligators after the species' delisting in 1967 and has resulted in the proliferation of alligator populations. Legal hunting was reinstituted in 1972, and since then, alligator numbers have increased ten-fold. Over $500 million in revenue has been generated through the program. Based on the program's effectiveness, numerous states across the Southeast have used it as a model of wildlife management in designing similar programs.

Existing Conditions

Based on LDWF survey data from 1996-2000, alligator nest densities within the study area are medium (approximately 1 nest per 250 acres). In June-August 2006, alligator spotlight surveys were conducted in the Maurepas Swamp. Alligators in size classes less than four feet long were most frequently detected (Stouffer et al. 2005). Few alligators under one foot long or over seven feet long were detected. Although the trend was not documented, alligator density, and the density of large alligators, appeared to increase with proximity to Lake Maurepas (Stouffer et al. 2005).

There are at least four lizard species, 16 snake species, and 9 turtle species documented in baldcypress-tupelo swamps of southern Louisiana (Dundee and Rossman, 1989). The lack of recorded evidence obscures accurate historic and existing conditions for other reptile species that are known or are likely to have inhabited the Maurepas Swamp.

Amphibians

The baldcypress-tupelo swamp ecosystem in southern Louisiana supports a wide array of amphibians. Many species of amphibians are known or likely to occur in

the study area. Amphibians are often exceptional indicators of wetland ecosystem health. Limited information exists regarding historic population trends of amphibians in the study area and baldcypress-tupelo forests in general.

Historic Conditions

Historic information on amphibians in the study area is limited. Data obtained through literature accounts and museum specimens suggest the presence of pig frogs (*Rana grylio*) (Dundee and Rossman 1989) in Ascension and St. James Parishes. This species, along with the bullfrog, are important to the Louisiana frog-leg industry. In a study on similar habitat close in proximity to the study area, Tinkle (1954) observed numerous amphibian species over the course of a year.

Existing Conditions

Many studies have documented the continued decline of amphibian populations worldwide. The situation is no different in Louisiana. The LDWF established the Louisiana Amphibian Monitoring Program (LAMP) in 1996 to gain detailed information on the possible causes of amphibian decline. The LAMP is a primarily volunteer-driven effort to accumulate data on Louisiana's amphibians. To date, the majority of the organization's efforts have been towards establishing calling frog surveys. Several of the monitoring sites established for such surveys are near the study area.

The baldcypress-tupelo ecosystem in southern Louisiana supports a wide variety of frogs, toads, and salamanders. The abundant water, shelter, and food sources enable several species to thrive. At least 13 species of frogs and toads and six species of salamanders are known to inhabit this community type in southern Louisiana.

4.2.7.4 Invasive Wildlife Species

Historic Conditions

Invasive wildlife species are institutionally significant because of Executive Order 13112. They are technically significant because of the damage they can cause to coastal wetlands that provide important and essential fish and wildlife habitats, used for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. Prior to the reported introduction of nutria (*Myocastor coypus*) to Louisiana in 1937 (USGS, 2000), no invasive wildlife species were present in the study area. The species likely appeared in the study area shortly after its introduction based on its rapid dispersal throughout coastal Louisiana. A substantial population increase was attributed to a decline in the price of nutria pelts in 1989 (USGS, 2000).

Existing Conditions

Although population estimates are uncertain, nutria is currently present within the study area according to field observations and reports. The species is a voracious herbivore that consumes the roots of wetland plants, including the seedlings of woody species and herbaceous and aquatic plants at all life stages (USGS, 2000;

APHIS, 2005). Areas of extensive nutria damage, or "eat outs," alter the composition and habitat type of wetland communities (USGS 2000, APHIS 2005). Research suggests that nutria damage may substantially reduce herbaceous productivity in Maurepas Swamp (Shaffer et al. 2006). Further, nutria damage may limit the regeneration of baldcypress and other wetland tree species (Blair and Langlinais, 1960; Conner et al. 1986; Conner, 1988; Brantley and Platt, 1992; Myers et al. 1995; Chambers et al., 2005).

Currently, a 2002 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Coast-wide Nutria Control Program is in place to reduce nutria populations and reduce negative impacts on wetland communities. The program offers incentives for nutria harvesting and monitors vegetation damage and habitat changes due to nutria herbivory. As of the 2009 report, over two million nutria have been harvested from the program area since its inception, averaging over three hundred thousand nutria per year (Wiebe and Mouton, 2009). In St. James Parish, 34,040 nutria have been harvested. Annual vegetation surveys of the program area have shown a decrease in the estimated acres of herbivory damage from 97,271 acres in 2000 to 20,333 acres in 2009 for coastal Louisiana. Data specific to St. James and Ascension Parishes are not available.

4.2.8 Aquatic Resources

4.2.8.1 Plankton

This resource is institutionally significant because of the National Environmental Policy Act of 1969, the Coastal Zone Management Act, and the Estuary Protection Act. This resource is technically significant because plankton provide a major, direct food source for animals in the water column and in the sediments; plankton are responsible for at least 40 percent of the photosynthesis occurring on the earth; plankton are important for their role in nutrient cycling; plankton productivity is a major source of primary food-energy for most estuarine systems throughout the world; and phytoplankton production is the major source of autochthonous organic matter in most estuarine ecosystems (Day et al. 1989). This resource is publicly significant because plankton constitute the lowest trophic food level for many larger organisms important to commercial and recreational fishing. In addition, there is a public health concern with noxious plankton blooms (red and brown tides) that produce toxins, and large-scale blooms can lead to hypoxic conditions, which can result in fish kills. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of plankton resources provided in the LCA PEIS (2004) is hereby incorporated by reference.

Lower Mississippi River

Historic Conditions

Limited information is available regarding historic plankton resources in the Lower Mississippi River. Zooplankton in the Lower Mississippi River have served as an important food source for many fish species. Despite their importance in the trophic web, little is known about zooplankton populations in this waterbody (USGS 1998).

Sabol et al. (1984) noted that the main channel of the Mississippi River was characterized by low concentrations of chlorophyll and zooplankton.

The Louisiana Wildlife and Fisheries Commission (1971) prepared "The Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana" in 1971, in which they summarize the status of plankton resources across the coastal estuaries of Louisiana during the late 1960s. The dominant member of the zooplankton community throughout that study was the copepod *Acartia tonsa*. The Mississippi River exhibited high species diversity in relation to other locations sampled.

Existing Conditions

Limited information is available regarding existing plankton resources within the Lower Mississippi River. Pinkney et al. (2009) observed that both high turbidity and total suspended sediment concentrations limit light penetration in the river's water column. When turbidity exceeds 50 mg/L, light is attenuated rapidly restricting phytoplankton photosynthesis to a shallow zone (Pinckney et al. 2009).

Blind River and Maurepas Swamp

Historic Conditions

Plankton communities serve an important role in the coastal waters of Louisiana. Phytoplanktons are the primary producers of the water column, and forms the base of the estuarine food web. Zooplankton provide the trophic link between the phytoplankton and intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989). Coastal swamps characterized by historic ditching, brown water, and low nutrient concentrations have been found to have numerous species of zooplankton present (Anderson et al. 1977). Zooplankton populations present in swamp ditches were similar to those found in the adjacent lake in a study by Anderson et al. (1977).

Historically, salinity appears to be the chief controlling factor of species richness (the number of species) in a community, while temperature, competition, and predation regulate population densities (Day et al. 1989). The abundance of certain zooplankton species may be indicative of fishing conditions. While some zooplankton are euryhaline, others have distinct salinity preferences (Day et al. 1989).

Existing Conditions

There is little information available on plankton communities in Lake Maurepas and the upstream waterbodies in Maurepas Swamp. Data available for Lake Maurepas supports the dominance of Anabena, dinoflagellates, diatoms, and cyanobacteria with occasional strong presence of chlorophytes (Atilla et al. 2007).

Phytoplankton

Phytoplankton are tiny, single-cell algae that drift with the motion of water. The dominant groups are diatoms and dinoflagellates. Other important groups include cryptophytes, chlorophytes (green algae), and chrysophytes (blue-green algae). In

Louisiana, eutrophic conditions can induce noxious blooms of blue-green algae. These algal blooms are often, but not always, dominated by a single species of the genus Anabaena or Microcystis. Large-scale blooms result in hypoxic conditions that can cause fish kills, and some species even produce toxins. Occurrence of algal blooms tends to occur in freshwater and oligohaline waters with a maximum salinity of approximately 7 ppt.

Large-scale blooms of blue-green algae occurred in Lake Pontchartrain in 1993 and 1997, with smaller blooms observed in other years. The 1997 bloom occurred after a month-long opening of the Bonnet Carre Spillway, which introduced up to 240,000 cfs of Mississippi River water into Lake Pontchartrain. Blooms in the lake are not unusual in July and August when light winds allow for low turbidity. This in turn allows for light penetration into the water column, and in combination with high nutrient concentrations and high temperatures, conditions are optimal for phytoplankton growth. Lake Pontchartrain, Lac Des Allemands, and various other coastal lakes that receive runoff high in nutrients experience algal blooms under these conditions. Runoff from fertilized areas, including lawns, golf courses, agricultural fields and both treated and untreated sewerage contribute nutrients that promote eutrophication.

Increased primary productivity often results from high nutrient loading in waterbodies; however, in and of itself, this is not necessarily detrimental. Phytoplankton production is the major source of autochthonous (produced within the system) organic matter in most estuarine systems (Day et al. 1989), and as such, it is essential for the outwelling of organic material and the maintenance of complex estuarine trophic webs. In fact, abundant growth of green algae can be observed in healthy waterbodies. When productivity exceeds the systems threshold during blooms, particularly of blue-green algae, detrimental impacts are incurred.

Palustrine freshwater swamps such as the study area have been observed to be both sources and sinks of nutrients, particularly nitrogen. Whereas phosphorus is often the limiting nutrient responsible for inducing algal blooms in inland systems, nitrogen is more often the limiting nutrient in coastal ecosystems (Lane et al. 2003). Plant uptake of phosphorus and allocation to biomass is typically low, with phosphorus storage in the system typically occurring through adsorption to sediment. As such, sediment transport further leads to mobilization of phosphorus. Denitrification drives large reductions of nitrogen in wetland systems, but burial in subsiding sediments provides an alternate means of nutrient storage in wetland systems (Lane et al. 2003).

4.2.8.2 Benthic Resources

These resources are institutionally significant because of the NEPA of 1969; the Coastal Zone Management Act; and the Estuary Protection Act. These resources are technically significant because the bottom of an estuary regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system through what is called a "benthic effect." Benthic animals are

directly or indirectly involved in most physical and chemical processes that occur in estuaries (Day et al. 1989). Benthic resources are publicly significant because members of the epibenthic community (e.g., oysters, mussels, etc.) provide commercial and recreational fisheries as well as creating oyster reef habitats used by many marine and estuarine organisms.

Lower Mississippi River

Historic Conditions

Due largely to difficult sampling conditions, historic populations of benthic organisms are relatively unknown in the Lower Mississippi River. Habitat destruction has undoubtedly had an effect on benthic populations and has been documented. Most floodplain habitats have decreased dramatically due to the development of the levee system and development under the MR&T project. The loss of a substantial portion of floodplain habitats has indirectly affected invertebrates within the river ecosystem by reducing suspended and dissolved organic matter (Baker et al. 1991).

In addition, channel habitat has declined modestly due to losses from river shortening and to a general constriction of river width by dikes to produce a deeper navigation channel. The historic presence of 125 or more islands, and the sandbar habitats associated with these islands, would have provided conditions for a number of oligochaetes and chironomids that are now exceedingly rare (Baker et al. 1991). Natural steep bank habitat has declined substantially due largely to the construction of revetments and dikes, especially at the upstream entrance to secondary channels, and to the overall shortening of the river that has resulted from navigation and flood control works.

Existing Conditions

Potential macroinvertebrate habitats in the Lower Mississippi River near the Romeville and South Bridge diversion intake sites include channel, natural bank, revetment bank, and pool. Macroinvertebrates common to these habitats per Baker et al. (1991) are included in **Table 4-11**.

Table 4-11: Common macroinvertebrates by habitat type for the Lower Mississippi River (Baker et al. 1991).

Channel, lotic sandbar	Natural steep bank	Revetted bank	Lentic sandbar	Pool	Tributary, Oxbow lake, Borrow pit, slough	Seasonal floodplain	Pond
Sand-Gravel *Corbicula* Oligochaeta Chironomidae Microturbellaria Nematoda	**Sand-Gravel** Ephemeroptera *Corbicula* Trichoptera Amphipoda **Clay** Ephemeroptera Trichoptera Chironomidae Amphipoda **Snags** Trichoptera Chironomidae Oligochaeta	**ACM**[1] Trichoptera Chironomidae Ephemeroptera Oligochaeta Amphipoda **Sand** Oligochaeta Chironomidae Nematoda	**Sand-Silt** Oligochaeta Ephemeroptera Chironomidae Cladocera Copepoda	**Sand-Gravel** *Corbicula* Oligochaeta Chironomidae Trichoptera **Mud-Sand** Oligochaeta *Chaoborus* Chironomidae Ephemeroptera **Clay** Trichoptera Ephemeroptera **Dikes** Trichoptera Ephemeroptera Chironomidae	**Mud** Oligochaeta *Chaoborus* *Sphaerium* Chironomidae **Clay** Oligochaeta *Chaoborus*	**Mud, Debris** Lumbriculidae Enchytraeidae Turbellaria Nematoda Oligochaeta Copepoda Isopoda Amphipoda Chironomidae Ostracoda	**Mud, Debris** Oligochaeta Copepoda Ostracoda Nematoda Chironomidae Amphipoda Isopoda Odonata *Sphaerium* Turbellaria *Chaoborus* Plecoptera

[1]Articulated concrete mattress revetment

Macroinvertebrate communities of channel habitat were once thought to exhibit low diversity and abundance. However, recently, a unique assemblage of very small organisms (three chironomids, nematodes, aeolosomatid worms, and microturbellarians) has been found in very high densities in sand substrates (Baker et al. 1991).

Revetments in the study area are constructed of mostly articulated concrete mattress (ACM) with riprap occasionally near the top bank. Revetment habitat is colonized by a large number of macroinvertebrate species, and densities are often quite high. Caddisflies are abundant wherever unsedimented ACM is exposed to strong currents. Where sediments cover the revetment, oligochaetes, amphipods, and some chironomids are found (Baker et al. 1991).

Invasive Benthic Species

Invasive benthic species are institutionally significant because of Executive Order 13112. They are technically significant because of the damage they can cause to coastal wetlands in the study area. Damage to these systems is of public concern in that it impedes their capacity to provide services valued by society. Introduced from Eurasia to the Great Lakes in 1988, the zebra mussel (*Dreissena polymorpha*) had spread through the Mississippi River's drainage to Louisiana by 1992 (USGS, 2009). Diversion of freshwater from the Mississippi River into the study area would likely result in the introduction of zebra mussels. Research is currently underway to determine the range of zebra mussels in Louisiana and the potential impacts to the Lake Pontchartrain Basin from the potential introduction of this species through the proposed diversions (Font, 2007).

Blind River and Maurepas Swamp

Historic Conditions

Within riverine and forested wetland systems, aquatic and wetland invertebrates are critical components of the trophic web. Of these, benthic macroinvertebrates tend to dominate deepwater swamp invertebrate communities. Characteristic species include crayfish, clams, oligochaete worms, snails, freshwater shrimp, midges, amphipods, and various immature insects (Mitsch and Gosselink 1993). Primary factors regulating species distribution and abundance are the water depth, duration of flooding, current, substrate, food availability, and oxygen level (Beck 1977; Sklar 1983; Murkin et al. 1992). Pulsing and periodic flooding are important in maintaining the density and diversity of invertebrate communities (Sklar and Conner 1979, Conner and Buford 1998). Several studies have found a high diversity and density of invertebrates in both permanently flooded (Mitsch and Gosselink 1993; Sharitz and Mitsch 1993) and seasonally inundated (Sklar and Conner 1979) baldcypress-tupelo forested wetlands. Compared to other habitat types, baldcypress-tupelo wetlands may support higher invertebrate densities. In the Atchafalaya Basin of Louisiana, Beck (1977) observed greater invertebrate densities in a baldcypress-tupelo swamp (3,768 individuals/m^2) than nearby bayous (3,292/m^2), lakes (1,840/m^2), canals (1,593/m^2), and rivers (327/m^2).

Existing Conditions

Limited data exists on benthic communities in the study area. Species present are likely typical of deepwater forested wetlands and slow-flowing rivers in the region. However, the increased duration of inundation and the low flow and exchange due to impoundment have promoted a system characterized by low dissolved oxygen levels and limited drawdown of water levels to below surface elevations. These conditions likely have resulted in reduced diversity of benthic organisms. More so, species composition has likely shifted towards species more tolerant of low dissolved oxygen levels, such as oligochaetes and midges. Reduced soil bulk densities and changes in average particle size, texture, and organic content due to low sediment input may further influence habitat suitability and species presence (Day et al. 1989, Vittor and Associates 1995). Within Blind River, woody debris introduced from the adjacent swamp may provide suitable substrate for invertebrates to colonize and thus support benthic community diversity (Thorp et al. 1985).

In addition to factors previously mentioned, salinity strongly influences the species composition of invertebrate communities. Higher abundance of benthic organisms has been associated with decreasing salinity from saline to freshwater sites in coastal Louisiana (Philomena 1983). Invertebrate species vary in the range of salinities within which they can survive and their tolerance to fluxes (Day et al. 1989).

4.2.9 Fisheries

Fishery resources are institutionally significant because of the Fish and Wildlife Coordination Act of 1958, as amended; the Endangered Species Act of 1973; the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (Magnuson-Stevens Act); the Magnuson-Stevens Act Reauthorization of 2006; the Coastal Zone Management Act; and the Estuary Protection Act. Fishery resources are technically significant because they are a critical element of many valuable freshwater and marine habitats; they are indicators of the health of various freshwater and marine habitats; and many species are commercially important. Fishery resources are publicly significant because of the high priority placed on their aesthetic, recreational, and commercial value. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the fisheries resources provided in the LCA PEIS (2004) is hereby incorporated by reference.

The NMFS in a letter dated February 20, 2009 (**Appendix C**), indicated that the water bodies and wetlands in the study area provide essential nursery and foraging habitats supportive of a variety of economically important estuarine-dependent fishery species, including blue crab, striped mullet, and Gulf menhaden.

In developing the Coast 2050 report, regional planning team members for the Upper Pontchartrain Sub-Basin assessed population trends for major fishery species within the Amite/Blind River mapping unit, which contains the study area. Over a ten- to twenty-year period, several species, including blue crab, largemouth bass,

and channel catfish, exhibited stable population trends in 1999. Furthermore, populations of these species are anticipated to remain stabile through 2050. Gulf menhaden is also present in the study area, but population trends are unknown for this species (LCWCRTF & WCRA 1999).

4.2.9.1 Lower Mississippi River

Historic Conditions

The Lower Mississippi River has been sampled relatively poorly because of its great size, depth, and strong currents. Until the early 1970s, there had been almost no large-scale fish studies of the river (Baker et al. 1991). Habitats have since been studied in inverse proportion to the difficulty in sampling them. Therefore, more information is available on pools and sandbars while channels remain relatively unexplored.

Most habitats have been decreasing in abundance since river regulation activities began over 250 years ago. The single-most deleterious modification has been reduction in the amount of seasonally inundated floodplain due to levee construction (Baker et al. 1991). Channelization works that have prevented the river from meandering to form new backwater floodplain habitats have also had a negative ecological impact (Beckett and Pennington 1986).

Existing Conditions

At least 91 species of freshwater fishes have the Lower Mississippi River as their primary population center; 30 or more species may be present sporadically (Baker et al. 1991). Other studies have listed from 110 to 121 species. Fish collections from channel habitat in the Lower Mississippi River are essentially nonexistent. From what is known of its physical attributes, few species could regularly inhabit the upper and middle water column in this habitat. 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 moving among other habitats (Baker et al. 1991).

At least 63 species have been recorded from natural steep banks and 55 from revetted banks (Beckett and Pennington 1986). Centrarchids, more typical of floodplain habitats, are regularly collected along natural steep banks, but are much less common along revetments (Baker et al. 1991). A number of small species (e.g. minnows, silversides) have been documented in steep bank habitat (Beckett and Pennington 1986). Fish were primarily distributed close to the shoreline, near the bottom, or in eddies, although exceptions to this general pattern were common, and distributions can change with river stage and season.

Pools support a diverse array of species, perhaps 68 or more (Baker et al. 1991). Among mainstem habitats, the wide variety and often high densities of fishes found in these habitats may stem from the relatively benign physical conditions of pools. High biomass recordings for pools appear to be attributable to high numbers of

gizzard and threadfin shad, and to a lesser extent, river carpsucker and freshwater drum (Baker et al. 1991).

4.2.9.2 Blind River, Maurepas Swamp, and Lake Maurepas

Historic Conditions

Pre-levee construction, little information exists on the condition of fisheries in the study area and throughout the state (Moore 1963). Speculatively, however, frequent inflow of Mississippi River flood water that delivered sediments, nutrients, and freshwater most likely led to a less saline, aquatic environment with physicochemical properties more conducive to fisheries.

During a survey conducted from January 1976 to August 1977, Watson et al. (1981) sampled fisheries species at six locations along Blind River from south of Highway 61 to Lake Maurepas using gill nets and rotenone. In doing so, 57 species of finfish, across 23 families and 12 orders, were collected and included 12 estuarine, 43 freshwater, one catadromous (living in freshwater but breeding in saltwater) and one anadramous (living in saltwater but breeding in freshwater) species. Freshwater species were dominant both spatially and temporally. Finfish diversity appeared to be higher at the lower stretches of Blind River, below the Amite River Diversion Canal and nearer Lake Maurepas.

Shortly preceding Watson's survey efforts, Laiche (1980) sampled fisheries at 73 locations along the Amite River to the north of the study area. Species richness was comparable to that observed by Watson, with marine species present but freshwater species predominant. The most abundant species observed included blacktail shiner (*Cyprinella venusta*), bullhead minnow (*Pimephales vigilax*), mosquitofish (*Gambusia affinis*), longear sunfish (*Lepomis megalotis*), mimic shiner (*Notropis volucellus*), blackstripe topminnow (*Fundulus notatus*), bluegill (*L. macrochirus*), and longnose shiner (*N. longirostris*).

Conversely, in earlier sampling events along the Amite River, Lantz (1970) observed only 21 species using rotenone and seine techniques. Common species collected using rotenone included blue catfish (*Ictalurus furcatus*), gizzard shad (*Dorosoma cepedianum*), spotted gar (*Lepisosteus oculatus*), freshwater drum (*Aplodinotus grunions*), channel catfish (*I. punctatus*), striped mullet (*Mugil cephalus*), and largemouth bass (*Micropterus salmoides*); young of the fish collected by seining (in order of decreasing abundance) included bluegill, black crappie (*Pomoxis nigromaculatus*), longear sunfish (*L. megalotis*), spotted bass (*M. punctulatus*), and largemouth bass.

In a later fisheries survey of Lake Maurepas, Hastings et al. (1987) used various techniques: trawls, gill nets, and rotenone. An approximately equal proportion of freshwater (55 percent) and marine (40 percent) fish species were collected in these efforts, with four-percent of individuals diadromous. A correlation was observed between the fisheries species present in the lake and mouth of Blind River and salinity levels in Lake Maurepas: marine species exhibited a higher contribution to

the fisheries of Lake Maurepas and had a greater likelihood of presence in Blind River with increasing salinity levels, with the opposite trend apparent for freshwater species.

Though finfish dominate the fisheries resource of the study area, shrimp have historically constituted an important part of Louisiana's commercial fisheries by value and have been present in the vicinity of the study area (LADWF 2000). For the Lake Pontchartrain Basin, white shrimp have been typically more prevalent than brown shrimp in the inland fisheries (Schexnayder and Caffey, 2002), NMFS annual shrimp landings data from 1988-2000, however, indicate a continuing trend of brown shrimp landings exceeding those of white shrimp.

Existing Conditions

A fisheries survey of Maurepas Swamp surface waters adjacent to the study area was conducted in support of CWPPRA Project PO-29, *Mississippi River Reintroduction into Maurepas Swamp (Kelso et al. 2005)*.. Based on the hydrologic connectivity of these areas, the survey should be indicative of existing fishery resources within the study area. Kelso et al. (2005) observed high spatial, variability of physical and chemical water quality parameters in southern Maurepas Swamp, with many areas characterized by hypoxic and stagnant conditions. Associated fish communities differentiated across these conditions. In total, 26 fish species were observed; however, spotted gar (*Lepisosteus oculatus*) and striped mullet (*Mugil cephalus*) composed over three-fourths of fish sampled. Community diversity was highly variable. Areas more interior to the swamp were characterized by little flow, lower pH values and lower DO levels, and exhibited lower species diversity, richness, and evenness. Similar conditions are characteristic of the study area, and as such, low fish community diversity is expected. A list of observed species is included in **Table 4-12**.

Table 4-12: Fish species sampled by Kelso et al. (2005) in southwest Maurepas Swamp.

Scientific Name	Common Name
Alosa chrysochloris	skipjack herring
Ameiurus melas	black bullhead
Amia calva	bowfin
Anguilla rostrata	American eel
Aplodinotus grunniens	freshwater drum
Brevoortia patronus	Gulf menhaden
Cyprinus carpio	common carp
Dorosoma cepedianum	American gizzard shad
Dorosoma petenense	threadfin shad
Elops saurus	ladyfish
Fundulus chrysotus	golden topminnow
Ictalurus furcatus	blue catfish
Ictalurus punctatus	channel catfish

Scientific Name	Common Name
Ictiobus cyprinellus	bigmouth buffalo
Lepisosteus oculatus	spotted gar
Lepisosteus osseus	longnose gar
Lepomis gulosus	warmouth
Lepomis humilis	orangespotted sunfish
Lepomis macrochirus	bluegill
Lepomis megalotis	longear sunfish
Lepomis microlophus	redear sunfish
Micropterus punctulatus	spotted bass
Micropterus salmoides	largemouth bass
Morone mississippiensis	yellow bass
Mugil cephalus	striped mullet
Pomoxis nigromaculatus	black crappie

The LDWF has also conducted electrofishing surveys of Blind River at five locations distributed from slightly northeast of US Highway 61 to its outflow at Lake Maurepas. Biannual, spring and fall sampling occurred from 1996-1997 and 2006-2008. Only game fish were inventoried in spring sampling events, while forage species were included in fall sampling (personal communication, Rachel Walley, LDWF, 2009). Additional species recorded in these surveys but not Kelso et al. (2005) included white crappie (*Pomoxis annularis*), black tail shiner, mosquito fish, sailfin molly (*Poecilla latipinna*), bay anchovy (*Anchoa michilli*), Atlantic croaker (*Micropogonias undulatus*), Southern flounder (*Paralichthys lethostigma*), and inland silverside (*Menidia beryllina*),

In the southwestern portion of Lake Maurepas, Peyre et al. (2007) conducted a survey of fish and decapods crustaceans during the fall of 2005 and 2006 and the spring of 2006. Ten stations stratified by salinity and representing five habitat types were sampled by electrofishing and otter trawl. Based on the number of individuals caught and catch per unit effort, low abundances of white shrimp (*Penaeus setiferus*) and blue crab (*Callinectes sapidus*) were observed. Field observations and interviews with local residents familiar with the study area confirm the occurrence of these species well into the headwaters of Blind River. These species are believed to be infrequently present in the distribution area, and when present, occur at low densities.

4.2.10 Essential Fish Habitat (EFH)

Essential fish habitat (EFH) is institutionally significant due to the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act. This resource achieves technical significance through its critical role in sustaining various life stages of fisheries and the persistence of the species. It is publicly

significant through the high priority placed on the aesthetic, recreational, and commercial value of fishery resources that are dependent on EFH.

The aforementioned 1996 amendments established a mandate that fishery management councils (FMC), with assistance from NMFS, delineate EFH in fishery management plans (FMP) or FMP amendments for all federally managed fisheries. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS and FMC recommendations. NMFS is further directed to comment on any state agency activities that may potentially impact EFH.

The study team has been coordinating with the NMFS to determine potential no action and action alternative impacts to EFH. In correspondence dated February 20, 2009, NMFS stated that no EFH exists within the study area. The study area does provide foraging and nursery habitat for economically-important, estuarine-dependent species including blue crab, striped mullet, and Gulf menhaden. Additional guidance provided April 17, 2009, indicates that Lake Maurepas is designated EFH for red drum (*Sciaenops ocellatus*) and white shrimp. If proposed alternatives will have water quality impacts on Lake Maurepas, further evaluation of potential impacts on EFH must be conducted. It is anticipated the the project will improve the water quality. During PED hydrology and water quality will be further modeled as necessary to address any remaining uncertainties regarding water quality impacts.

Historic Conditions

The study area has not historically served as EFH for any managed species.

Existing Conditions

The study area does not provide EFH for any managed species. Lake Maurepas contains designated EFH for red drum and white shrimp.

4.2.11 Threatened and Endangered Species

This resource is institutionally significant because of the Endangered Species Act of 1973, as amended, and the Marine Mammal Protection Act of 1972. Endangered (E) and threatened (T) species are technically significant because of the role these species play in maintaining ecosystems and, because of which, these species serve as indicators of overall ecosystem health. These species are publicly significant because of the public desire to protect these species and their habitat.

Historic Conditions

The study area has historically and continues presently to provide critical habitat for nesting, foraging, reproduction, and other life stage requirements for numerous threatened and endangered species. Historical records are limited for individual populations of threatened and endangered species in the study area. The

distribution area likely provided suitable habitat for bald eagle and American alligator, and consequently supported the recovery of these species following their protection in 1967. As today, the Blind River and Lake Maurepas provided suitable habitat for West Indian manatee (*Trichechus manatus*) and Gulf sturgeon (*Acipenser oxyrinchus desotoi*). Pallid sturgeon (*Scaphirhynchus albus*) likely inhabited the reach of the Lower Mississippi River within the study area. Additional description of historic conditions for threatened and endangered species is provided in **Appendix A**.

Existing Conditions

Within the State of Louisiana there are 29 animal and three plant species (some with critical habitats) under the jurisdiction of the USFWS and/or the NMFS that are presently classified as endangered or threatened (13) (Table 4-13). The USFWS and the NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon. Of the animals and plants under USFWS and/or NMFS jurisdiction, four animal species and no plant species are potentially found within the Study Area (Table 4-13).

The pallid sturgeon is an endangered fish species found in large rivers in the Mississippi River Basin (Lee et al. 1980; Killgore et al. 2007). The species is adapted to large, free-flowing turbid rivers with a diverse assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. Occurrence of pallid sturgeon in the Mississippi River near the diversion site is extremely likely according to Kilgore et al. (2007) and based on sampling efforts by Kirk et al. (2007) in August 2005 and monthly from December 2005 through June 2006. Presence of sub-adult and adult pallid sturgeon is nearly certain within this reach of the Mississippi River; however, occurrence of juvenile specimens is unconfirmed. Their presence warrants further consideration given that these individuals would be at greatest potential risk from diversion installation (Kirk et al. 2007).

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Table 4-13: Federally listed threatened and endangered plant and animal species located within Louisiana, organized by jurisdictional authority, and bolded if potentially occurring within study area.

Species Under Jurisdiction of the USFWS Status Common Name (*Scientific Name*)	Species Under Jurisdiction of NMFS Status Common Name (*Scientific Name*)
mammals E[1] – Florida Panther (*Felis concolor coryi*) E[1] – Red wolf (*Canis rufus*) **E – West Indian manatee (*Trichechus manatus*)** T – Louisiana black bear (*Ursus americanus luteolus*) Birds E[2] – Bachmans's warbler (*Vermivora bachmanii*) E[1] – Eskimo curlew (*Numenius borealis*) E[1] – Ivory-billed woodpecker (*Campephilus principalis*) E – Least tern; interior population (*Sterna antillarum*) E – Red-cockaded woodpecker (*Picoides borealis*) T – Piping plover (*Charadrius melodus*) Reptiles E[3] – Hawksbill sea turtle (*Eretomchelys imbricata*) E[3] – Kemp's (Atlantic) Ridley sea turtle (*Lepidochelys kempii*) E[3] – Leatherback sea turtle (*Dermochelys coriacea*) **T(S/A)[4] –American alligator (*Alligator mississippiensis*)** T – Gopher tortoise (*Gopherus polyphemus*) T[3] – Green sea turtle (*Chelonia mydas*) T[3] – Loggerhead sea turtle (*Caretta caretta*) T – Ringed sawback turtle (*Graptemys oculifera*) Fish **E – Pallid sturgeon (*Scaphirhynchus albus*)** **T[3] – Gulf sturgeon (*Acipenser oxyrinchus desotoi*)** Invertebrates E – Mussel, Fat pocketbook (*Potamilus capax*) E – Pink pearlymussel Mucket (*Lampsilis abrupta*) T – Inflated (Alabama) heelsplitter (*Potamilus inflatus*) T – Louisiana pearlshell (*Margaritifera hembeli*) Plants E – American chaffseed (*Schwalbea americana*) E – Louisiana quillwort (*Isoetes louisianensis*) T – Earth fruit (*Geocarpon minimum*) Candidate Species[5] C – Snake, Louisiana pine (*Pituophis ruthveni*)	Marine Mammals E – Sperm whale (*Physeter macrocephalus*) E – Sei whale (*Balaenoptera borealis*) E – Humpback whale (*Megaptera novaeangliae*) E – Finback whale (*Balaenoptera physalus*) E – Blue Whale (*Balaenoptera musculus*) Sea Turtles[3] E – Hawksbill sea turtle (*Eretomchelys imbricata*) E – Kemp's (Atlantic) Ridley sea turtle (*Lepidochelys kempii*) E – Leatherback sea turtle (*Dermochelyscoriacea*) T – Green sea turtle (*Chelonia mydas*) T – Loggerhead sea Turtle (*Caretta caretta*) Fish **T – Gulf sturgeon (*Acipenser oxyrinchus desotoi*)** Candidate Species[5] C – Dusky shark (*Carcharhinus obscurus*) C – Sand tiger shark (*Odontaspis taurus*) C – Night shark (*Carcharinus signatus*) C – Speckled hind (*Epinephelus drummondhayi*) C – Saltmarsh topminnow (*Fundulus jenkensi*) C – Jewfish (*Epinephelus itajara*) C – Warsaw grouper (*Epinephelus striatus*)

[1] Florida panther, red wolf, Eskimo curlew, and ivory-billed woodpecker presumed extirpated in the state.

[2] No confirmed sightings of Bachman's warbler on U.S. nesting grounds since mid-1960s. Species may be extirpated in Louisiana.

[3] USFWS and NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon.

[4] Alligator in Louisiana is classified for law enforcement purposes as "Threatened due to Similarity of Appearance." They are biologically neither endangered nor threatened. Regulated harvest is permitted under state law.

[5] Candidate species are not protected under the ESA, but concerns regarding their status indicate they may warrant listing in the future. Federal agencies and the public are encouraged to consider these species during project planning so that future listings may be avoided.

Formal consultation was conducted on the pallid sturgeon in compliance with ESA of 1973. A Biological Opinion (**Appendix A**) was received on September 23, 2010 from the USFWS outlining the following *Reasonable and Prudent Measures* and *Terms and Conditions* for the pallid sturgeon:

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and ***appropriate*** *to minimize the incidental take of pallid sturgeon by entrainment through the small diversion at Convent/Blind River.*

1. Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).
2. Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.
3. Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.
4. The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.
5. In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.
6. The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.
7. The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.
8. Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.
2. Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual

inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.
3. Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.
4. Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.

Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

Gulf sturgeon have been reported in rivers and lakes of the Lake Pontchartrain Basin and adjacent estuarine areas (personal communication, USFWS, 2009). Within Louisiana, areas including Lake Pontchartrain east of the Causeway Bridge have been designated as critical habitat for the Gulf sturgeon. The Study Area is not designated critical habitat for this species (personal communication, James F. Boggs, USFWS, 2009). Based on habitat preferences and past studies, the presence of Gulf sturgeon is unlikely along the reach of the Mississippi River where proposed diversion uptake locations are proposed (Douglas 1974, Ross 2001). The species may however seasonally inhabit Lake Maurepas during migratory periods—most likely during October or November and again from February through April (Kirk et al. 2007). Kirk et al. (2007) conducted an inventory for Gulf sturgeon in Lake Maurepas from November 2005 through June 2006. No Gulf sturgeon were detected or captured in Lake Maurepas in this investigation.

Based on habitat preferences and past studies, the presence of Gulf sturgeon is unlikely along the reach of the Mississippi River where proposed diversion uptake locations are proposed (Douglas 1974, Ross 2001). The species may however seasonally inhabit Lake Maurepas during migratory periods—most likely during October or November and again from February through April (Kirk et al. 2007). Kirk et al. (2007) conducted an inventory for Gulf sturgeon in Lake Maurepas from November 2005 through June 2006. Gill nets and mobile sonic telemetry were used in an attempt to locate 40 individuals tagged from 2001 through 2006 by LDWF in the Pearl River system and other Gulf sturgeon. No Gulf sturgeon were detected or captured in Lake Maurepas in this investigation.

The West Indian manatee may occasionally enter Lake Pontchartrain, Lake Maurepas, and the associated coastal waters and marshes of Louisiana (personal communication, James F. Boggs, USFWS, 2009). On April 29, 1985, a manatee was sighted in the Blind River approximately 200 yards south of the I-10 bridge (USFWS, 1997). Additional sightings have occurred in the vicinity of the Study Area (USFWS, 1997). Manatees are found within local waterways only during months with warm enough conditions. While rare, the potential exists for the manatee to be within the Study Area.

While the bald eagle was officially removed from the Endangered Species Act list of threatened and endangered species it has continued protection under the Migratory Bird Treaty Act (16 U.S.C. 703-712) and the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c). The LDWF has identified three recorded nesting sites within the Study Area. Field investigations to determine the exact locations and potential statuses of these bald eagle nests were performed and resulted in the location of one potentially active nest. The existence of other bald eagle nests is possible, and several adult and juvenile birds were observed during field studies in 2009.

The American alligator, a recently recovered species, is still listed as threatened due to similarity of appearance with other protected species and provided protection under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). At present, Louisiana's wild alligator population is estimated by LDWF to be approximately 1.5 million animals, with over 500,000 additional specimens on alligator farms in the state. Nest densities within the Study Area are medium (approximately 1 nest per 250 acres) based on survey data from 1996-2000 (LDWF 2001).

State Listed Threatened and Endangered Species

The LNHP is maintained by the LDWF. The organization was founded in 1984 through a partnership between the State of Louisiana and The Nature Conservancy with their purpose to develop and maintain a database of rare, threatened and endangered species of plants and animals, and natural communities for Louisiana. Currently, the LDWF maintains the LNHP Biological Conservation Database, which includes over 6,000 occurrences of rare, threatened, and endangered species,

unique natural communities and other distinctive elements of natural diversity, and some 380 ecologically significant sites statewide. Within Ascension and St. James Parishes, LNHP tracks the occurrence of the species and habitats listed in Table 4-14.

Table 4-14: LNHP Rare, Threatened and Endangered Species and Natural Communities in Ascension and St. James Parishes (April 2008)

Common Name	Scientific Name	State Rank[1]
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	S1S2
swamp milkweed	*Asclepias incarnate*	S2
bottomland hardwood forest	-	S4
cypress swamp	-	S4
cypress-tupelo swamp	-	S4
bald eagle	*Haliaeetus leucocephalus*	S2N, S3B
four-toed salamander	*Hemidactylium scutatum*	S1
long-tailed weasel	*Mustela frenata*	S2S4
Correll's false dragon-head	*Physostegia correllii*	S1
inflated heelsplitter	*Potamilus inflatus*	S1
eastern spotted skunk	*Spilogale putorius*	S1
West Indian manatee	*Trichechus manatus*	SZN
waterbird nesting colony	-	SNR

[1]State Element Ranks: S1 = critically imperiled in Louisiana because of extreme rarity; S2 = imperiled in Louisiana because of rarity; SZ = transient species in which no specific consistent area of occurrence is identifiable; B = breeding occurrence; N = nonbreeding occurrence; SR = reported from Louisiana but without conclusive evidence to reject or accept the report; S? = rank uncertain.

4.2.12 Cultural and Historic Resources

Historic Conditions

Eight cultural units are used to characterize the prehistoric cultural sequence in southeast Louisiana: Paleo-Indian (10,000 – 8,000 B.C.), Archaic (8,000 – 1,000 B.C.), Poverty Point (1,700 – 500 B.C.), Tchefuncte (500 B.C. – A.D. 100), Marksville (100 A.D. – A.D. 500), Baytown (A.D. 400 – 700), Coles Creek (A.D. 700 – 1,200) and Mississippian/Plaquemine (A.D. 1,200 – 1,700). In addition to prehistoric cultural sequences, historical overviews of Ascension and St. James Parishes were completed to provide a context in which to assess land use data for the project study area. Historical perspectives of these two parishes were researched beginning with

the period of French exploration to present, and include development and economic growth in the area. Historic perspectives generally cover the colonial period to 1764, Acadian migration to the area (1764 to 1790), end of the Colonial period (1790 to 1803), the Antebellum period (1803 to 1861), the Civil War (1861 to 1865), reconstruction in the late nineteenth century (1880s), and the early twentieth century. Both prehistoric and historic research results are summarized and historic conditions characterized in detail in the "Background Research and Cultural Resources Inventory for the Convent/Blind Freshwater Diversion Project" (Earth Search, December 2009). Background research of the cultural resources within the study area found that there were 39 previously recorded prehistoric and/or historic archaeological sites located within one mile of the study area **(Figure 4-17)**. Eighteen (18) sites are located within the perimeter of the Area of Potential Effect (APE) and are shown in **Figure 4-18**, of which four sites (16SJ20, 16SJ21, 16SJ30 and 16SJ64) are eligible to the National Register of Historic Places (NRHP). Seven sites (16SJ7, 16SJ9, 16SJ15, 16SJ16, 16SJ18, 16SJ54 and 16SJ57) have been determined ineligible for the NRHP. Five sites (16SJ34, 16SJ49, 16AN30 and 16AN32) are listed as potentially eligible, while the NRHP status of two previously recorded sites (16SJ5 and 16AN50) has not been determined and cannot be ascertained for certain until further investigations can be conducted at these sites. Archaeological investigations within one mile of the study area have identified four prehistoric sites (16SJ1, 16SJ50, 16SJ51 and 16AN50). These sites represent occupations ranging in age from the Archaic-Indian to Mississippian Period.

Existing Conditions

Recorded archival and historical research was conducted to develop a baseline level of knowledge for prehistoric and historic period cultural developments and to identify archaeological and historical sites previously recorded in the Small Diversion at Convent/Blind River Study Area. Information maintained by the Louisiana Division of Archaeology was consulted to identify previous cultural resources surveys in the area as well as to obtain site forms for previously recorded sites. Detailed results for the background research and cultural resources inventory conducted for the study area are presented in "Background Research and Cultural Resources Inventory for the Convent/Blind Freshwater Diversion Project" (Earth Search, December 2009). Additional cultural resource surveys will be conducted in the study area to verify existing resources, and determine whether previously unknown resources exist, based on geomorphology and historical sequence of growth and development in the area.

Coordination with the State Historic Preservation Office and Native American Tribes was initiated during the study, and will continue throughout the completion of the study. Initiation letters to SHPO and various native American tribes are included in **Appendix F**.

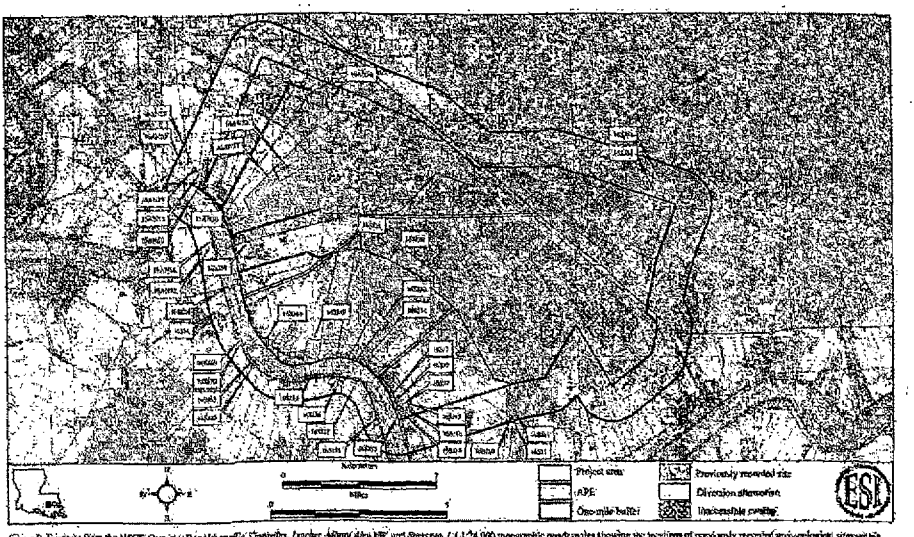


Figure 4-17— Area of Potential Effect (APE) for Study Area

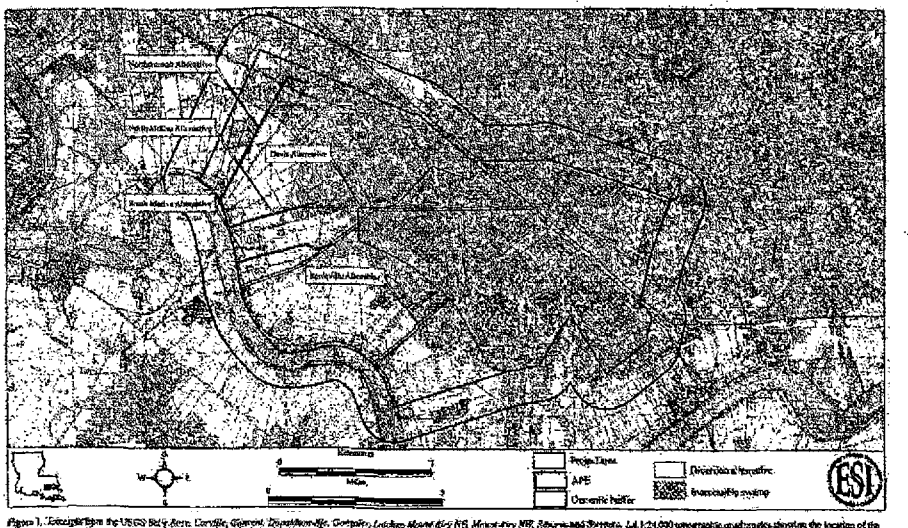


Figure 4-18 Cultural Resource Sites Located within the Study Area

In accordance with ER 1105-2-100, Appendix C, paragraph C-4(d)(5)(d)(2), the U.S. Army Corps of Engineers (USACE) elected to fulfill its obligations under Section 106 of the National Historic Preservation Act of 1966, as amended, through the execution and implementation of a Programmatic Agreement. In consultation with the Advisory Council on Historic Preservation (ACHP), Louisiana State Historic Preservation Officer (SHPO), Indian tribes, representatives of local governments, and other consulting parties, the USACE developed a Programmatic Agreement among the USACE, Coastal Protection and Restoration Authority of Louisiana, SHPO, and ACHP, pursuant to 36 CFR § 800.14(b)(1), executed July 29, 2010 **(Appendix F)**. The Programmatic Agreement establishes the procedures for consultation, identification of historic properties, assessment and resolution of adverse effects.

4.2.12.1 Previous Investigations

The present chapter provides background contextual information regarding previous archeological and architectural investigations completed within the general vicinity of the study area in St. James and Ascension Parishes, Louisiana. This background information was compiled to ensure that any previously recorded cultural resources situated within the current study area were relocated accurately during fieldwork, as well as to provide data on the nature and distribution of previously recorded cultural resources in the immediate project vicinity. A records review was undertaken of all previously completed archeological investigations conducted within 1.0 mile (1.6 km) of the study area, as well as for archeological sites, historic standing structures, and National Register properties situated within this area. The review involved the following activities: a search of relevant archeological site forms, surveys, and historic map data on file with the Louisiana Division of Archaeology and the State Library; a review of the historic standing structures files housed at the Louisiana Division of Historic Preservation; and a search of the online National Register of Historic Places (NRHP) database for St. James Parish, Louisiana. The results of this background investigation are summarized in the "Background Research and Cultural Resources Inventory for the Convent/Blind Freshwater Diversion Project" (Earth Search, December 2009).

4.2.12.2 Previously Conducted Cultural Resources Surveys

A total of 37 (32 archaeological and 5 architectural) previously completed cultural resources surveys and archeological inventories were identified within 1.0 mi (1.6 km) of the study area. These investigations resulted in the identification of 39 archeological sites and 115 structures that were greater than 50 years old. Of these studies, six of the archaeological studies were conducted from 2002 to the present; 11 were conducted during the 1990's; and the remaining 20 were conducted previous to 1990.

Background research discovered that there are 115 previously recorded standing structures greater than 50 years old within the APE. One structure lies within Ascension Parish and 114 within St. James Parish. In addition, there are two

structures listed on the National Register of Historic Places under Criterion C (buildings of fine architectural standard) within the APE: the Chauvin House and the Colomb House.

4.2.13 Aesthetics

This resource's institutional significance is derived from laws and policies that affect visual resources, most notably the National Environmental Policy Act of 1969, the National Scenic Byway program, the Louisiana Scenic Rivers Act (1988). This resource is technically significant because of the visual accessibility to unique geological and botanical features that are an asset to the study area. Public significance is based on expressed public perceptions and professional evaluation. Consistent with 40 CFR Parts §§1500.4 (j) and 1502.21 description of the aesthetics resources provided in the LCA PEIS (2004) is hereby incorporated by reference.

Historic Conditions

The study area is located in the Lower Mississippi Riverine Forest Provence in the Subtropical Division as described in "Ecological Subregions of the United States" (1994). This province is generally flat and very gently sloping. Historically, the aesthetic resources of the study area were shaped by land use changes and depended, to a large part, on the viewer and their relationship with their surroundings. Pivotal transformations of the viewscapes occurred with early settlement and colonization, the clearing of old growth forests, the construction of levees along the Mississippi River, and the industrialization of St. James and Ascension Parishes. These events and their chronology are discussed further in their pertinent sections of this document.

Existing Conditions

As part of the LCA Small Diversion at Convent/Blind River, the Visual Resource Assessment Procedure is being used to evaluate aesthetic resources in the study area. While the Maurepas Swamp can be viewed from U.S. Highway 61 and I-10, the characteristics of the study area are most often viewed by boaters on the river itself and recreationists and hunters within the WMA.

The Blind River is a winding and complex waterway. The river is lined with mature baldcypress and tupelo trees with Spanish moss. Old baldcypress trees lean into the channel, and oftentimes the trunks are broken and hollowed. Based on canopy closure, the visible portions of the interior swamp either have sparse or dense herbaceous vegetation. Very little mid-story is present in either open- or closed-canopy environments.

The parish canals through the study area are generally straight. A dense mat of common salvinia often covers these areas in summer months. Elevated berms of side castings are covered with a tangle of upland shrubs, trees, weeds, and vines, and on either one or both bank of parish canals. These features block the view of the adjacent swamp floor and understory. Where not obstructed by berms, a view of the interior swamp is presented. Pipelines and utility lines in the swamp are

maintained as linear right of ways devoid of trees but thickly vegetated with emergent plants. At the intersection of pipelines and canals, long views down the pipeline are possible.

The rapid deterioration of the swamp has affected its aesthetic qualities. Subsidence of the forest floor results in flooding for greater periods of time which changes the visual composition of the understory. The lack of baldcypress regeneration has led to an open midstory. As canopy trees die, the forest is becoming more open and in places is trending towards fresh marsh with few trees. Consequently, much of the visual complexity within the swamp is lost in these areas.

The surrounding areas near the transmission canals and diversion uptake locations are a mix of residential, commercial, agricultural, and industrial uses. Sugar cane fields are prevalent and are separated by drainage ditches that vary widely in size. Views of surrounding areas are limited when the sugar cane is mature. Industrial plants are the most prominent structure in the landscape, as they are expansive, several stories tall, and dominate their surroundings. Numerous conveyors and pipes move materials over State Route 44 and the eastbank levee to and from river barges. Views of the Mississippi River are obstructed by the levee.

4.2.13.1 Scenic Rivers and Streams

The Louisiana Natural and Scenic River System is one of the Nation's largest, oldest, most diverse and unique state river protection initiatives. The LDWF administers the Louisiana Natural and Scenic Rivers system, which was established in 1970 for the purpose of preserving, developing, reclaiming and enhancing the wilderness qualities, scenic beauties, and ecological regime of designated free-flowing water bodies. There is one designated scenic stream, the Blind River, within the study area. Louisiana Natural and Scenic River designation is applied to its expanse from the river's origin in St. James Parish to its outlet at Lake Maurepas. The Blind River and its tributaries are used for recreational activities such as boating, fishing, and canoeing.

4.2.14 Recreation

This resource is institutionally significant because of the Federal Water Project Recreation Act of 1965, as amended, and the Land and Water Conservation Fund Act of 1965, as amended. Recreational resources are technically significant because of the high economic value of recreational activities and their contribution to local, state, and national economies. Recreational resources are publicly significant because of the high value that the public places on fishing, hunting, and boating, as measured by the large number of fishing and hunting licenses sold in Louisiana, and the large per-capita number of recreational boat registrations in Louisiana.

Historic Conditions

The study area includes 17,079 acres (6,912 ha), approximately half of the 37,163-acre (15,039 ha) Maurepas Swamp Wildlife Management Area (WMA) Western Tract. The tract was established in August 2001 and is managed by the LDWF. According to the LDWF, the site has supported a wide-range of recreational activities: fishing, hunting, camping, boating, sightseeing, hiking, bird watching, and trapping have all been common. Sporting game hunted in the project have historically included deer, raccoon, squirrel, rabbit, and waterfowl. Common sport fisheries pursued have included largemouth bass, bream, perch, catfish, sac-a-lait (crappie), garfish, and choupique (bowfin). Additional recreational activities allowed annually in the WMA and the study areas are contract trapping for alligators and permit trapping for nutria.

The St. James Boat Club, established off of US 61 in 1966, has since served as the starting point for the majority of boating activities in the area. From here, unobstructed access is provided to the lower reaches of Blind River and navigation into Lake Maurepas. Boat access to the headwaters of Blind River and the southwestern portion of the study area from the north was impeded by construction of the Kansas City Southern Railway in 1858. Grand Point Canal Public Boat Launch at the northern terminus of LA 642 provides the main entry point for recreation in this area.

Existing Conditions

The area combines natural and outdoor opportunities with those of the area's cultural heritage. Despite the presence of numerous roadways transecting and surrounding the Study Area, the majority of the area is accessible only by boat due to the nature of the swamp. The Maurepas Swamp WMA – Eastern and Western Tracts – encompasses approximately 67,712 acres (27,402 ha) that are managed by the LDWF. The WMA has provisions for camping with tent sites, trailer sites, and six boat ramps, two of which the St. James and Grand Point Boat Ramps, are in the project site area. Recreational activities in the WMA include hunting for deer, squirrels, rabbit, and raccoons; fishing for largemouth bass, bream, and crappie; and trapping alligators and nutria. Some waterfowl hunting occurs in the vicinity of the Study Area; however, impairment of waterfowl habitat by invasive plant species has reduced waterfowl harvests with respect to past conditions. According to the LDWF, in the 2007-2008 season, there were an estimated 9,442 users of the WMA. Two permitting stations, located at the boat ramps within the Study Area, are maintained by LDWF; the stations allow the public to self-obtain required permits to enter the WMA.

Recreational activities and uses currently permitted in the area year-round include boating, fishing, hunting, sightseeing, and birding. Other recreational activities permitted seasonally include deer hunting during winter months with restricted access to the hunting sites. Consideration has been given to developing walking trails and for reviving the swamp to make it more accessible to the public for walking and sightseeing. The LDWF is currently involved in the initial phase of

developing WMA-specific management directives to maintain and enhance the WMA in such a way that will continue to be compatible with its current uses. The LDWF is in the midst of erecting and monitoring wood duck nesting boxes, and has future plans to build a public swamp walk.

The 2009-2013 Louisiana Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides a statewide inventory of recreation resources and identifies recreational needs. The majority of the Small Diversion at Convent/Blind River Study Area fits within the larger SCORP Region 3. The portions of the Study Area within Ascension Parish fall within SCORP Region 2. As part of the SCORP-development process, a residential household survey was completed in order to determine recreation participation throughout the state. The activities rated as most important to the residents of Regions 2 and 3 are: fishing, visiting natural places, walking/hiking, and public access to state waters. In addition, within the two regions, the recreational activities enjoying the highest participation rates include driving for pleasure, fishing, camping and swimming. Recreation needs were then prioritized with regards to the survey results. Priorities in these regions are determined to include providing and improving public access to the area's natural resources for recreational purposes, developing support amenities for existing recreation facilities, coordinating recreation opportunities across multiple jurisdictions, and implementing a statewide and parish-wide trail system.

Figure 4-19 depicts the general location of the Study Area in relation to wildlife management areas, boat launches that provide primary access to these areas, and self-clearing permitting stations.

4.2.15 Socioeconomics and Human Resources

This resource is institutionally significant because of the National Environmental Policy Act of 1969; the Estuary Protection Act; the Clean Water Act; the River and Harbors Acts; the Watershed Protection and Flood Protection Act; and the Water Resources Development Acts. Of particular relevance is the degree to which the proposed action affects public health, safety, and economic well-being; and the quality of the human environment. This resource is technically significant because the social and economic welfare of the nation may be positively or adversely impacted by the proposed action. This resource is publicly significant because of the public's concern for health, welfare, and economic and social well-being from water resources projects.

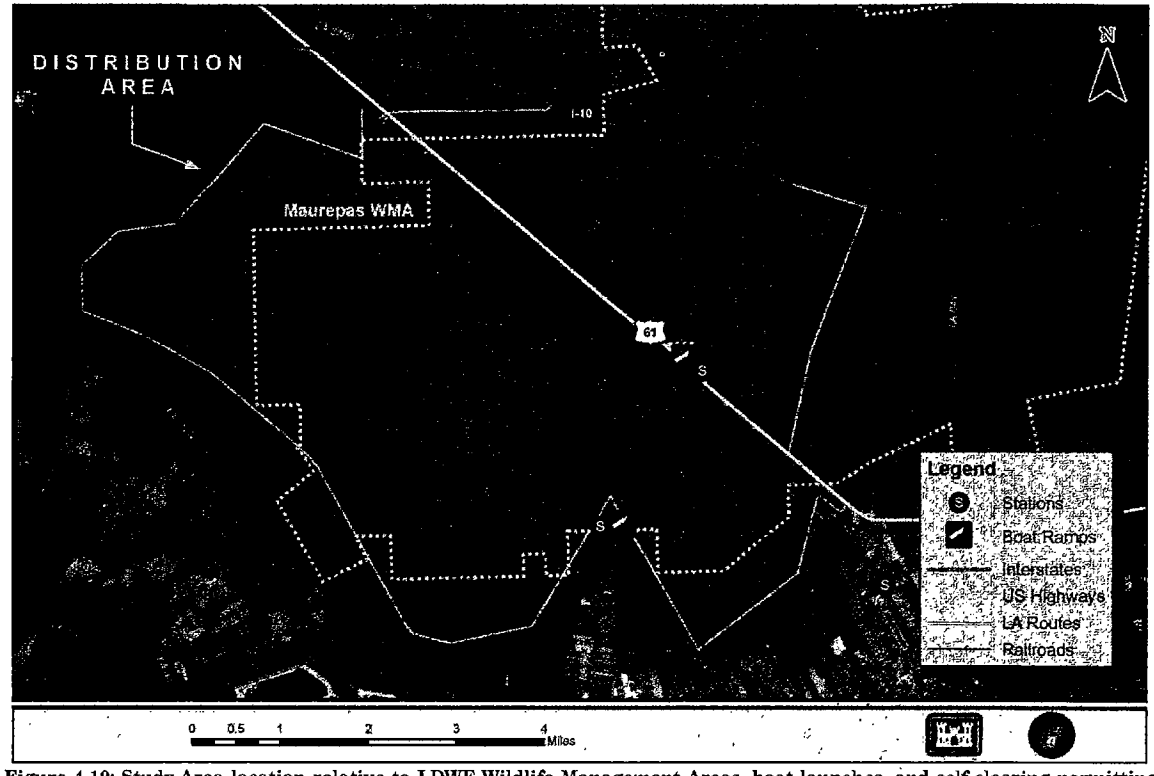


Figure 4-19: Study Area location relative to LDWF Wildlife Management Areas, boat launches, and self-clearing permitting stations.

4.2.15.1 Displacement of Population and Housing

Historic Conditions

The distribution area is located in remote and uninhabited coastal wetlands within Ascension and St. James parishes. Historic population trends from 1900 to 2008 are presented in **Figure 4-20** for the parishes of Ascension and St. James. Ascension Parish lost population from 1900 to 1930 and then slowly increased in population until the parish surpassed 1900 population levels in 1960. The parish's population continued to increase, more than doubling from 1980 to 2008. St. James Parish's population reached its peak population in 1910 before declining sharply until 1930. Although the parish's population has increased in recent decades, it has yet to reach 1910 levels.

Historic housing trends from 1900 to 2008 are presented in **Figure 4-21** for Ascension and St. James parishes. The number of housing units within Ascension Parish and St. James Parish has kept pace with the population within the parishes. In Ascension Parish, the housing units decreased from 1900 to 1930 before increasing sharply. In St. James Parish, the number of housing units reached its nadir in 1930 and then began to increase steadily.

Existing Conditions

McElroy, an incorporated community within St. James Parish is located within the study area. In St. James Parish, the closest towns to the study area include Lutcher and Gramercy, located to the southeast of the project site; Paulina, Belmont and Vacherie located to the south; and Convent located to the southwest. The closest communities to the study area in Ascension Parish are Burnside to the west and Sorrento to the northwest. **Table 4-15** provides recent population trends recorded within these parishes between 2000 and 2008.

St. James and Ascension Parish both experienced an increase in housing from 2000 to 2008, yet St. James Parish remains considerably less dense than Ascension Parish. The housing density within St. James and Ascension Parishes are presented below in **Table 4-16**.

According to the U.S. Census Bureau, Ascension Parish had a population of 101,789 in 2008, an increase of more than 25,000 people since 2000. St. James Parish's growth has been much more modest during that timeframe, increasing by just 15 individuals to 21,231 in 2008. The Louisiana Parish Population Projections Series, 2010-2030, published by the State of Louisiana Office of Electronic Services, predicts that Ascension Parish will continue to grow at a rapid rate, whereas St. James will begin to lose population by 2015. Within the distribution area, there are no permanent residents and no new residences are permitted within the WMA, which comprises much of the study area. Therefore, no growth within the study area is anticipated.

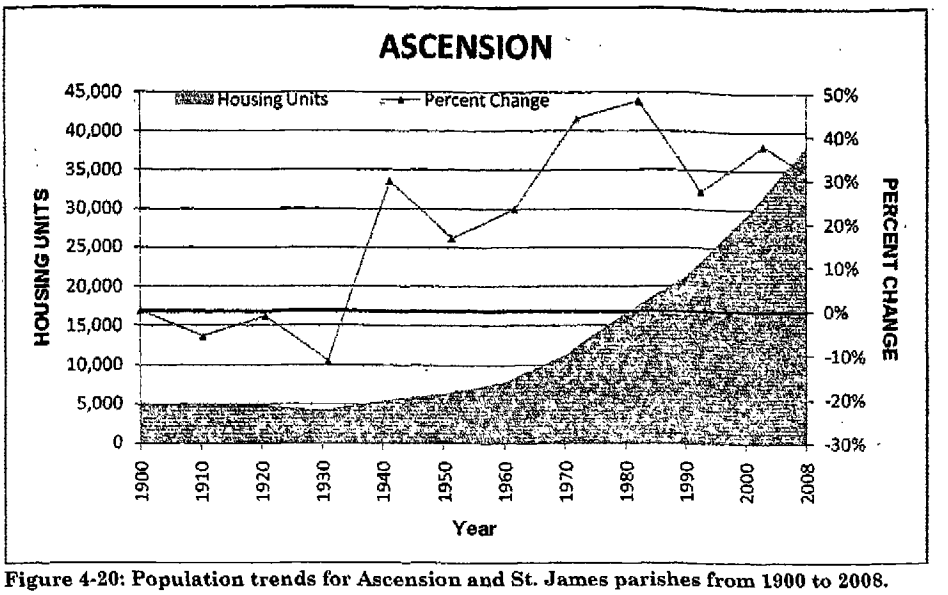


Figure 4-20: Population trends for Ascension and St. James parishes from 1900 to 2008.

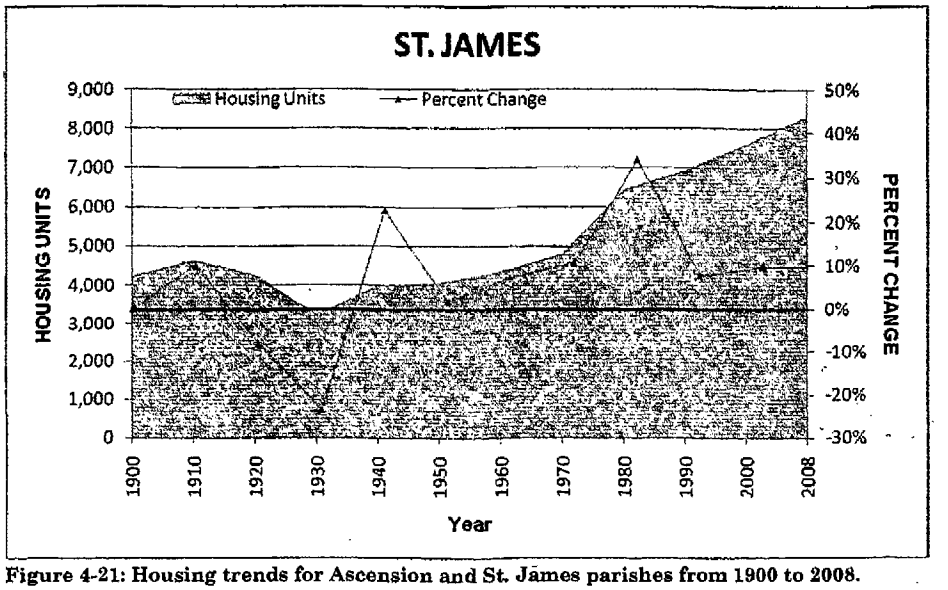


Figure 4-21: Housing trends for Ascension and St. James parishes from 1900 to 2008.

Table 4-15: Population trends from 2000 to 2008 for St. James and Ascension Parishes, Louisiana.

Parish	Population in 2000	Population in 2008	Population Change (%)	Land Area (sq. mi.)	Population Density 2008 (persons/sq. mi.)
St. James	21,216	21,231	0.58	246.13	86.3
Ascension	76,627	101,789	23.35	291.53	349.2
Source: U.S. Census Bureau, Census 2000; U.S. Census Bureau 2006-2008 American Community Survey, 3-Year Estimates.					

Table 4-16: Housing trends from 2000 to 2008 for St. James and Ascension Parishes, Louisiana.

Parish	Total Housing Units 2000	Total Housing Units in 2008	Housing Unit Change (%)	Land Area (sq. mi.)	Housing Density 2008 (persons/sq. mi.)
St. James	7,605	8,333	8.7%	246.13	33.86
Ascension	29,172	38,228	23.7%	291.53	131.13
Source: U.S. Census Bureau, Census 2000; U.S. Census Bureau 2006-2008 American Community Survey, 3-Year Estimates.					

4.2.15.2 Employment, Business, and Industrial Activity

Historic Conditions

St. James Parish and Ascension Parish are strategically positioned between New Orleans and Baton Rouge, encompassing an area that includes a 15-mile expanse along both sides of the Mississippi River in St. James Parish and a 19-mile expanse in Ascension Parish. Historically, agriculture has been a major industry within both parishes. For instance, in the 1940 census agriculture employed nearly 54 percent and 52 percent of all workers in Ascension Parish and St. James Parish, respectively. Manufacturing, food and dairy products, and among women domestic service, were all major industries and occupations within the parishes.

Existing Conditions

Due to St. James Parish's location and diversified transportation access, which includes the Port of South Louisiana along the Mississippi River, various industries are present and business and industrial activity continues to grow. Dominant sectors include manufacturing; retail; educational services; and healthcare and social assistance. Sharp declines have been experienced since 2000 in finance, insurance, real estate, rental and leasing, and wholesale trade. Conversely, retail trade, construction, manufacturing, and most other industries have been growth sectors for the parish. Major area business and industrial activities are associated with the entities listed in **Table 4-17**. Nucor Steel also is currently evaluating a

site within the parish, adjacent to the study area. Employment characteristics for St. James Parish in 2000 and 2008 are presented in

Table 4-17: Major businesses in St. James Parish, Louisiana.

ST. JAMES PARISH BUSINESSES AND INDUSTRIES	
ADM Grain Company	Motiva Enterprises
AEP-Elmwood Marine	Noranda Alumina
Air Products	Nustar Logistics
America Styrenics	Occidental Chemicals
El Dupont	Plain's Marketing
Ergon-St. James	RAIN CII Carbon
IC Rail Marine Terminal	St. James Stevedoring
Imperial Sugar	Shell Pipeline/Sugarland
Lafarge North America	Valero Marketing
LOCAP Pipeline	William's Field Services
Louisiana Pipe and Steel	YARA North America
Mosaic (Faustina)	Zapp's
Mosaic (Uncle Sam)	Zen-Noh Grain Company
Source: St James, LA "Economic Development: Business Statistics." Accessed: 10/23/2009, http://www.stjamesla.com/PageDisplay.asp?p1=2799	

Table 4-18: Employment characteristics and change from 2000 to 2008 for St. James Parish.

ECONOMIC CHARACTERISTIC	2000	2008	CHANGE (%)
Population 16 years and over	**15,660**	**16,378**	**4.58%**
In labor force	8,556	10,063	17.61%
Civilian labor force	8,548	10,063	17.72%
Employed	7,679	9,573	24.66%
Unemployed	869	490	*-43.61%*
Percent Unemployed	10.2	3.0	*-70.59%*
Armed Forces	8	0	*-100%*
Not in labor force	7,104	6,315	*-11.11%*
Females 16 years and over	**8,205**	**8,607**	**4.90%**
In labor force	4,103	5,050	23.08%
Civilian labor force	4,103	5,050	23.08%
Employed	3,589	4,807	33.94%
Own children under 6 years	**1,657**	**1,640**	***-1.03%***
All parents in family in labor force	1,112	1,338	20.32%
Own children 6 to 17 years	**NA**	**3,536**	**NA**
All parents in family in labor force	NA	2,597	NA
OCCUPATION			
Civilian employed population 16 years	**7,679**	**9,573**	**24.66%**
Management, professional, and related occupations	1,821	2,233	22.62%
Service occupations	1,234	2,171	75.93%
Sales and office occupations	1,695	1,731	2.12%
Farming, fishing, and forestry occupations	113	12	*-89.38%*
Construction, extraction, maintenance and repair	928	1,209	30.28%

ECONOMIC CHARACTERISTIC	2000	2008	CHANGE (%)
Production, transportation, and material moving	1,888	2,217	17.43%
INDUSTRY			
Agriculture, forestry, fishing and hunting, and mining	201	184	*-8.46%*
Construction	611	721	18.00%
Manufacturing	2,012	2,780	38.17%
Wholesale trade	197	96	*-51.27%*
Retail trade	708	1,047	47.88%
Transportation and warehousing, and utilities	581	772	32.87%
Information	46	74	60.87%
Finance and insurance, and real estate and rental	308	135	*-56.17%*
Professional, scientific, and management, and	405	402	*-0.74%*
Educational services, and health care and social	1,527	1,857	21.61%
Arts, entertainment, and recreation, and	409	607	48.41%
Other services, except public administration	276	460	66.67%
Public administration	398	438	10.05%
CLASS OF WORKER			
Private wage and salary workers	6,168	7,709	24.98%
Government workers	1,311	1,561	19.07%
Self-employed workers in own not incorporated	183	303	65.57%
Unpaid family workers	17	0	*-100%*

Source: U.S. Census Bureau, Census 2000; U.S. Census Bureau 2006-2008 American Community Survey, 3-Year Estimates; *Italics* indicate observed decrease between 2000 and 2008; NA stands for not available.

The distribution area to the northeast of St. James proper in Ascension Parish is primarily associated with oil and gas pipelines. Oil and gas infrastructure include wells, rig platforms, refineries, gas plants, and pipelines located within or near the study area. Notably, the Sorrento Gas and Oil Field is located to the north of the study area in Ascension Parish.

Dominant industry sectors in Ascension Parish include manufacturing, construction, retail trade, educational services, and healthcare and social assistance. Since 2000, only the information industry has experienced decline. In particular, the chemical industry is a significant growth industry for the Parish, with more than 20 chemical manufacturing facilities currently operating. Major area business and industrial activities are associated with the entities listed in **Table 4-19.** Employment characteristics for Ascension Parish in 2000 and 2008 are presented in **Table 4-20.**

Table 4-19: Major businesses in Ascension Parish, Louisiana.

ASCENSION PARISH BUSINESSES AND INDUSTRIES	
Westlake Chemical	Cabela's
St. Elizabeth Hospital	International Marine Tank Liquid Terminal
Turner Industries	BASF
Rubicon	Motiva Enterprises
Oxychem	Shell Chemical
Honeywell	EATEL
Chemtura	
Source: Ascension Chamber of Commerce. "2009 Membership Directory and Community Profile." Accessed: http://www.ascensionchamber.com/	

From 2000 to 2008, the economic growth of St. James Parish and Ascension Parish are reflected in the income of residents. Fewer households, families, and individuals were within lower income brackets in 2008 than in 2000, and substantial growth occurred at higher income levels. More so, the percentage of individuals living below the poverty level generally declined during this period. Income statistics for St. James Parish and Ascension Parish are presented in Table **4-21** and **Table 4-22** respectively.

Table 4-20: Employment characteristics and change from 2000 to 2008 for Ascension Parish.

ECONOMIC CHARACTERISTIC	2000	2008	CHANGE (%)
Population 16 years and over	**56,116**	**73,893**	**31.68%**
In labor force	37,203	50,825	36.62%
Civilian labor force	37,148	50,646	36.34%
Employed	35,151	48,093	36.82%
Unemployed	1,997	2,553	27.84%
Percent Unemployed	5.4	3.5	*-35.19%*
Armed Forces	55	179	225.45%
Not in labor force	18,913	23,068	21.97%
Females 16 years and over	**28,880**	**38,108**	**31.95%**
In labor force	16,554	22,872	38.17%
Civilian labor force	16,530	22,872	38.37%
Employed	15,544	21,192	36.34%
Own children under 6 years	**6,950**	**9,129**	**31.35%**
All parents in family in labor force	4,177	6,299	50.80%
Own children 6 to 17 years	**NA**	**17,606**	**NA**
All parents in family in labor force	NA	11,993	NA
OCCUPATION			
Civilian employed population 16 years	**35,151**	**48,697**	38.54%
Management, professional, and related occupations	9,244	15,179	64.20%
Service occupations	4,392	6,469	47.29%
Sales and office occupations	9,805	13,345	36.10%
Farming, fishing, and forestry occupations	108	90	*-16.67%*
Construction, extraction, maintenance and repair	5,702	6,645	16.54%
Production, transportation, and material moving	5,900	6,365	7.88%
INDUSTRY			
Agriculture, forestry, fishing and hunting, and mining	367	483	31.61%
Construction	4,656	6,140	31.87%
Manufacturing	6,409	7,046	9.94%
Wholesale trade	1,413	2,120	50.04%
Retail trade	4,176	5,255	25.84%
Transportation and warehousing, and utilities	1,851	2,356	27.28%
Information	657	539	*-17.96%*
Finance and insurance, and real estate and rental	2,114	3,598	70.20%
Professional, scientific, and management,	2,342	4,631	97.74%
Educational services, and health care and social	5,881	8,416	43.10%
Arts, entertainment, and recreation, accommodation,	2,061	3,611	75.21%
Other services, except public administration	1,694	1,740	2.72%
Public administration	1,530	2,158	41.05%
CLASS OF WORKER			
Private wage and salary workers	29,050	40,152	38.22%
Government workers	4,466	5,588	25.12%
Self-employed workers in own not incorporated	1,572	2,319	47.52%
Unpaid family workers	63	34	*-46.03%*

Source: See Table 4-20.

Table 4-21: Income statistics and change from 2000 to 2008 for residents of St. James Parish.

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
INCOME AND BENEFITS			
Total households	**6,999**	**7,462**	**6.62%**
Less than $10,000	1,149	653	*-43.17%*
$10,000 to $14,999	570	443	*-22.28%*
$15,000 to $24,999	902	805	*-10.75%*
$25,000 to $34,999	860	754	*-12.33%*
$35,000 to $49,999	980	1,218	24.29%
$50,000 to $74,999	1,382	1,472	6.51%
$75,000 to $99,999	700	837	19.57%
$100,000 to $149,999	377	938	148.81%
$150,000 to $199,999	35	240	585.71%
$200,000 or more	44	102	131.82%
Median household income (dollars)	$35,277	$47,102	33.52%
Mean household income (dollars)	NA	$60,468	NA
With earnings	5,296	5,727	8.14%
Mean earnings (dollars)	$46,242	$64,482	39.44%
With Social Security	1,878	2,469	31.47%
Mean Social Security income (dollars)	$10,787	$13,424	24.45%
With retirement income	1,188	1,644	38.38%
Mean retirement income (dollars)	$11,878	$15,938	34.18%
With Supplemental Security Income	446	318	*-28.70%*
Mean Supplemental Security Income (dollars)	$6,372	$7,526	18.11%
With cash public assistance	176	81	*-53.98%*

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
Families (continued)			
Median family income (dollars)	$41,751	$58,246	39.51%
Mean family income (dollars)	NA	$69,812	NA
Per capita income (dollars)	$14,381	$21,229	47.62%
Nonfamily households	**NA**	**1,744**	**NA**
Median nonfamily income (dollars)	NA	$25,775	NA
Mean nonfamily income (dollars)	NA	$28,803	NA
Median earnings for workers (dollars)	NA	$26,878	NA
Median earnings for male full-time, year-round workers (dollars)	$37,487	$41,352	10.31%
Median earnings for female full-time, year-round workers (dollars)	$21,712	$25,644	18.11%
POVERTY STATUS (% Below Poverty Level)			
All families	**18.00%**	**13.10%**	***-27.22%***
With related children <18 years	25.00%	18.30%	*-26.80%*
With related children <5 years only	22.80%	4.30%	*-81.14%*
Married couple families	NA	3.60%	NA
With related children <18 years	NA	2.60%	NA
With related children <5 years only	NA	0.00%	NA
Families with female householder, no husband present	**48.70%**	**38.20%**	***-21.56%***
With related children <18 years	58.40%	47.40%	*-18.84%*
With related children <5 years only	64.70%	10.80%	*-83.31%*
All people	20.70%	16.00%	*-22.71%*
Under 18 years	NA	25.70%	NA
Related children <18 years	27.70%	25.70%	*-7.22%*

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
income			
Mean cash public assistance income (dollars)	$1,836	$741	*-59.64%*
With Food Stamp benefits in the past 12 months	NA	1,312	
Families	**5,564**	**5,718**	**2.77%**
Less than $10,000	683	314	*-54.03%*
$10,000 to $14,999	409	277	*-32.27%*
$15,000 to $24,999	642	494	*-23.05%*
$25,000 to $34,999	675	345	*-48.89%*
$35,000 to $49,999	804	920	14.43%
$50,000 to $74,999	1,221	1,303	6.72%
$75,000 to $99,999	677	822	21.42%
$100,000 to $149,999	382	901	135.86%
$150,000 to $199,999	30	240	700.00%
$200,000 or more	41	102	148.78%

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
Related children <5 years	NA	23.80%	NA
Related children 5 to 17 years	28.10%	26.40%	*-6.05%*
18 years and over	17.80%	12.60%	*-29.21%*
18 to 64 years	NA	11.50%	NA
65 years and over	15.10%	18.00%	19.21%
People in families	NA	14.80%	NA
Unrelated individuals 15 years and over	34.10%	27.10%	*-20.53%*

Source: U.S. Census Bureau, Census 2000; and U.S. Census Bureau 2006-2008 American Community Service, 3-Year Estimates

Italics indicate observed decrease between 2000 and 2008.
NA stands for not available.

300

Table 4-22: Income statistics and change from 2000 to 2008 for residents of Ascension Parish.

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
INCOME AND BENEFITS			
Total households	**26,773**	**34,478**	**28.78%**
Less than $10,000	2,627	1,751	*-33.35%*
$10,000 to $14,999	1,689	1,945	*15.16%*
$15,000 to $24,999	2,809	3,218	*14.56%*
$25,000 to $34,999	3,236	3,637	*12.39%*
$35,000 to $49,999	4,357	3,953	-9.27%
$50,000 to $74,999	6,446	6,399	-0.73%
$75,000 to $99,999	3,397	5,465	60.88%
$100,000 to $149,999	1,809	5,510	204.59%
$150,000 to $199,999	197	1,713	769.54%
$200,000 or more	206	887	330.58%
Median household income (dollars)	$44,288	$60,293	36.14%
Mean household income (dollars)	NA	$72,094	NA
With earnings	22,648	29,442	30.00%
Mean earnings (dollars)	$52,843	$74,300	40.61%
With Social Security	4,590	7,216	57.21%
Mean Social Security income (dollars)	$10,395	$13,949	34.19%
With retirement income	3,372	5,309	57.44%
Mean retirement income (dollars)	$12,772	$16,090	25.98%
With Supplemental Security Income	1088	1,451	*33.36%*
Mean Supplemental Security Income (dollars)	$6,230	$6,521	4.67%

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
Families (continued)			
Median family income (dollars)	$50,626	$68,482	35.27%
Mean family income (dollars)	NA	$80,374	NA
Per capita income (dollars)	$17,858	$25,997	45.58%
Nonfamily households	**NA**	**8,676**	**NA**
Median nonfamily income (dollars)	NA	$30,694	NA
Mean nonfamily income (dollars)	NA	$44,246	NA
Median earnings for workers (dollars)	NA	$31,858	NA
Median earnings for male full-time, year-round workers (dollars)	$41,109	$52,282	27.18%
Median earnings for female full-time, year-round workers (dollars)	$23,054	$32,305	40.13%
POVERTY STATUS (% Below Poverty Level)			
All families	**10.70%**	**9.00%**	***-15.89%***
With related children <18 years	13.70%	12.00%	*-12.41%*
With related children <5 years only	15.50%	10.80%	*NA*
Married couple families	**NA**	**2.90%**	**NA**
With related children <18 years	NA	3.80%	NA
With related children <5 years only	NA	0.70%	NA
Families with female householder, no husband present	**36.50%**	**31.90%**	***-12.60%***
With related children <18 years	43.00%	40.80%	*-5.12%*
With related children <5 years only	54.60%	53.40%	*-2.20%*
All people	12.90%	10.90%	*-15.50%*
Under 18 years	NA	15.10%	NA

301

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
With cash public assistance income	590	365	*-38.14%*
Mean cash public assistance income (dollars)	$1,826	$2,953	*61.72%*
With Food Stamp benefits in the past 12 months	NA	4,235	NA
Families	**21,002**	**25,802**	**22.85%**
Less than $10,000	1,471	992	*-32.56%*
$10,000 to $14,999	933	904	*-3.11%*
$15,000 to $24,999	1,970	1,781	*-9.59%*
$25,000 to $34,999	2,425	2,462	*1.53%*
$35,000 to $49,999	3,486	2,974	-14.69%
$50,000 to $74,999	5,689	4,867	-14.45%
$75,000 to $99,999	3,033	4,524	49.16%
$100,000 to $149,999	1,602	5,062	215.98%
$150,000 to $199,999	197	1,407	614.21%
$200,000 or more	196	829	322.96%

SELECTED ECONOMIC CHARACTERISTIC	2000	2008	% CHANGE
Related children <18 years	16.30%	14.90%	*-8.59%*
Related children <5 years	NA	17.10%	NA
Related children 5 to 17 years	16.30%	14.00%	*-14.11%*
18 years and over	11.40%	9.20%	*-19.30%*
18 to 64 years	NA	9.30%	NA
65 years and over	15.40%	8.70%	-43.51%
People in families	NA	9.30%	NA
Unrelated individuals 15 years and over	24.20%	21.70%	*-10.33%*

Source: U.S. Census Bureau, Census 2000; and U.S. Census Bureau 2006-2008 American Community Survey, 3-Year Estimates

Italics indicate observed decrease between 2000 and 2008.

NA stands for not available

302

4.2.15.3 Availability of Public Facilities and Services

Historic Conditions

The public facilities and services within St. James and Ascension Parishes are designed to support and serve their constituents. Public service infrastructure includes utilities, emergency services, and education. Both Ascension and St. James Parish were established in 1807. Public facilities and services became established and expanded upon throughout the 19th century, particularly during Reconstruction following the Civil War. As technology advanced throughout the 20th century, the public services in the parishes advanced as well.

Existing Conditions

The existing public service infrastructure within St. James and Ascension Parishes are presented in **Table 4-23.**

Table 4-23: Public Service Infrastructure present in St. James Parish and Ascension Parish, Louisiana.

Infrastructure	St. James Parish	Ascension Parish
Utilities		
Electricity	Entergy	Entergy Demco
Gas	St. James Parish Utilities Atmos Energy of LA	City of Gonzales** Atmos Energy of LA
Water	Town of Lutcher Town of Gramercy St. James Parish Utilities	Ascension Water Co
Sewage Treatment	Town of Lutcher Town of Gramercy	City of Donaldsonville City of Gonzales**
Emergency Services		
Medical Services	St. James Parish Hospital Ravenlands Healthcare Center	Promise Hospital of Gonzales Prevost Hospital St. Elizabeth Hospital St. James Behavioral Health Hospital
EMS	Acadian Ambulance Service	Acadian Ambulance Service
Fire	Served by 6 Volunteer Fire Depts*	Served by 11 Fire Departments
Police	St. James Parish Sheriff's Parish Office Gramercy Police Dept. Lutcher Police Dept	Ascension Parish Sheriff's Dept. Sorrento Police Dept. Gonzales Police Dept.
Education		
School	11 public schools 1 Catholic school	28 public schools** 5 private schools
Library	2 branches	3 branches

* Unincorporated areas are not treated.

** An additional elementary school is set to open in 2010.

4.2.15.4 Transportation

Historic Conditions

Historically, the transportation within St. James and Ascension Parishes has been tied to the water and to rail. Steam ferries traveled along the Mississippi River, transporting goods and services, and individuals up and downstream. Daily train service served the area following the Civil War. Intermodal transportation, including water-based and rail travel, continued to expand throughout the 19th and 20th centuries. The Sunshine Bridge, connecting St. James Parish and Ascension Parish opened in 1964. The Louisiana Regional Airport, a general aviation airport located in Gonzales, opened in 1992.

Existing Conditions

Transportation modes within St. James and Ascension Parishes include air, road, rail, and waterways. The parishes are served by the Louisiana Regional Airport, managed by the Ascension-St. James Airport and Transportation Authority. The major roadways within the parishes are I-10, U.S. Highway 61 (Airline Highway), and a number of state highways including LA 30, LA 44, LA 70, LA 73, LA 405, LA 3127 and LA 3125. Rail includes the Kansas City Southern Railway (formerly the Louisiana Railway & Navigation Railroad and later the Louisiana and Arkansas Railway), the Canadian National Railway (formerly the Yazoo & Mississippi Valley Railroad and later the Illinois Central Railway), and the Union Pacific Railway (formerly the Missouri Pacific Railroad). The Mississippi River runs through both parishes. In addition, the Port of South Louisiana is partly located in St. James Parish.

According to the Louisiana Department of Transportation and Development (LA DOTD), I-10, US 61, LA 30, LA 73 and LA 44 were the most traveled roadways within Ascension Parish and I-10, US 61, LA 70, LA 3125 and LA 3274 are the most traveled roadways within St. James Parish. Although US 61 runs through the study area, the most traveled segments of the roadway do not.

Two railways run through the study area. The Kansas City Southern Railway transects the distribution area and parallels U.S. HWY 61 to the south. The Canadian National Railway extends to the south of the distribution area and would be transected by the Romeville and South Bridge transmission canals.

St. James Parish manages a transit service, which operates Monday through Friday, along LA 44 and LA 18. Ascension Parish operates a paratransit service (or demand response service) for its residents. Unless specifically requested by a rider, neither service runs through the study area.

Visitors within the distribution area travel either by foot or by boat.

4.2.15.5 Disruption of Desirable Community and Regional Growth (including Community Cohesion)

Historic Conditions

Desirable community and regional growth means acting at the community level and fostering economic, social, and cultural growth. Community Cohesion is defined as "[w]working towards a society in which there is a common vision and sense of belonging by all communities; the diversity of people's backgrounds and circumstances is appreciated and valued; similar life opportunities are available to all; and strong and positive relationships exist and continue to be developed in the workplace, in schools and the wider community" (UK Department for Children, Schools and Families, 2007).

Historically, the areas surrounding the study area included well established plantation-run agricultural areas dating back to the 1700s. Culturally the region is known as Plantation Country. Community cohesion was driven by agriculturally based lifestyles. The advancement of pull-boat logging allowed extensive harvest of baldcypress. Railways, roads, and other infrastructure were constructed within and surrounding the study area as the population grew. Community and regional growth gradually developed in the area with influence from the oil and gas industry as well as increased trade along the Mississippi River. In spite of industrial growth and infrastructure development, the surrounding swamp areas continued to be used extensively for fishing and hunting.

Existing Conditions

Existing conditions today include communities in the area that rely heavily on business and industrial activity while still maintaining support to agricultural interests, particularly sugarcane farming. Waterborne commerce along the Mississippi River has spurred economic growth in the area with support to landside business and oil and gas related industries. Regional growth is projected to be two percent per year as residential development progresses from Baton Rouge to New Orleans. Land sites in the area that are available for industrial development are actively being marketed with tax incentives to foster business and community alliances that will continue to support economic development in the area. Although wetlands in the Pontchartrain Basin have degraded over time as a result of urban encroachment and human modifications, these areas still support diverse recreation activities. However, the continued degradation and loss of forested swamp threaten its integrity as a desirable area for these endeavors and the continuation of these activities that support the culture in this area.

4.2.15.6 Tax Revenues and Property Values

Historic Conditions

According to the U.S. Census Bureau, historic property values within St. James Parish have been consistently lower than in adjacent Ascension Parish, and in turn, property values in these parishes have been consistently lower than in the United States as a whole. Beginning in 1980, Ascension Parish's median home value rose above the State of Louisiana's and has since remained so. Conversely, the median

home value for St. James Parish has remained lower than the state's except in 1980 when it was slightly higher. **Table 4-24** below displays median owner-occupied home values from 1930 to 2000.

Table 4-24: Median owner-occupied home values from 1930 to 2000.

Location	1930	1940	1950	1960	1970	1980	1990	2000
Ascension Parish	$783	$513	$2,355	$7,300	$12,600	$46,000	$61,000	$103,800
St. James Parish	$638	$380	$2,254	$7,200	$11,900	$43,900	$57,100	$81,500
Louisiana	$2,730	$1,414	$5,141	$10.700	$14,600	$43,000	$58,500	$85,000
United States	$4,778	$2,938	$7,354	$11,900	$17,000	$47,200	$79,100	$119,600

Source: U.S. Census Bureau, Accessed 11/14/2009.

The study area encompasses a portion of the Maurepas Swamp WMA. The area was once owned by the Lutcher and Moore Cypress Lumber Company. The Richard King Mellon Foundation in coordination with The Conservation Fund secured the site in 2000, after which it granted the area to the LDWF. Prior to state acquisition, the distribution area was privately owned and therefore on the parish, state, and Federal tax roll.

Existing Conditions

The proposed study area includes a portion of the Maurepas Swamp WMA, a state-managed property. Thus, the majority of the study area is not subject to state and local taxation. The remaining parcels, located along the southern, western and northern edge of the project site boundary, are privately owned and subject to taxation.

The U.S. Census Bureau estimates the 2008 median house value of owner-occupied units as $158,600 within Ascension Parish and $112,500 within St. James Parish, representing a 34.6 percent and a 27.6 percent increase respectively from the median house values in 2000.

4.2.15.7 Infrastructure

Historic Conditions

Infrastructure present in the study area includes federal, state, parish, municipal, and private facilities including (but not limited to) physical structures for housing, energy (transmission lines, transformers, and substations), telecommunications, oil and gas pipelines, flood control and protection (levees, drainage, channel improvement and stabilization), and transportation (roads, railways, bridges). Information provided below supplements descriptions within respective sections for each resource.

The area was settled by French colonists in 1700s who surveyed the property lines upon which many of the roadways are based. Flood protection and utility infrastructure developed throughout the 19th and 20th centuries. Railways began operation in 1884 with the Yazoo & Mississippi Valley Railroad (later the Illinois Central, presently Canadian National) and in 1906 with the Louisiana Railway & Navigation Rail Road (later the Louisiana and Arkansas, presently Kansas City Southern) (St. James Parish Development Board, 1954). As part of the Louisiana Highway Commission's road modernization efforts, U.S. Highway 61 (Airline Highway) was constructed in the early 1930s.

Existing Conditions

Transportation infrastructure within or near the distribution area includes the Kansas City Southern Railroad, US Highway 61 and I-10, and their associated bridges and culverts (US 61: 5 bridges / no culverts; I-10: 2 bridges / 10 culverts). The Romeville and South Bridge transmission canals would cross LA 44, the Canadian National Railway, and LA 3125. Two boat landings are present in the distribution area: one is located at the north terminus of LA 642 with access to Grand Point Canal, and the other is located at the St. James Boat Club on US Hwy 61 with access to Blind River. Telecommunication and energy infrastructure within the study area are described in **Table 4-25**.

Table 4-25: Telecommunication and energy infrastructure within the study area.

Company Name	Description	Utility Size	Type
Entergy			
Convent to Frisco	Transmission	230 kV	Aerial
Convent to Romeville	Transmission	230 kV	Aerial
Lutcher to Sorrento	Transmission	230 kV	Aerial
Panama to Dutch Bayou	Transmission	230 kV	Aerial
Romeville to Panama	Transmission	230 kV	Aerial
MCI Telecommunications	Fiber Optic Backbone	24 F Count	Buried
Level 3 Communications	Primary Fiber Optic	96F Count, 170F Count	Buried
AT&T Telecommunication	Proprietary	Proprietary	Aerial & Buried

4.2.15.8 Environmental Justice

Environmental Justice (EJ) is institutionally significant because of Executive Order 12898 of 1994 (E.O. 12898) and the Department of Defense's Strategy on Environmental Justice of 1995, which direct Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of Federal actions to minority and/or low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, and Pacific Islander. A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or

is meaningfully greater than in the general population. Low-income populations as of 2000 are those whose income is $22,050.00 for a family of four and are identified using the Census Bureau's statistical poverty threshold. The Census Bureau defines a "poverty area" as a Census tract with 20 percent or more of its residents below the poverty threshold and an "extreme poverty area" as one with 40 percent or more below the poverty level. This is updated annually at http://aspe.hhs.gov/poverty/09poverty.shtml. This resource is technically significant because the social and economic welfare of minority and low-income populations may be positively or disproportionately impacted by the proposed actions. This resource is publicly significant because of public concerns about the fair and equitable treatment (fair treatment and meaningful involvement) of all people with respect to environmental and human health consequences of federal laws, regulations, policies, and actions.

A potential disproportionate impact may occur when the percent minority (50 percent) and/or percent low-income (20 percent) population in an EJ study area are greater than those in the reference community. For purposes of this analysis, all Census Block Groups within a one mile radius of the project footprint are defined as the EJ study area. Ascension and St. James Parishes, of which the Louisiana Coastal Area (LCA) Small River Diversion at Convent/Blind River project is located, is considered the reference community of comparison, whose population is therefore considered the EJ reference population for comparison purposes. Parish figures were used for unincorporated areas located within one mile of the proposed project footprint.

The methodology, consistent with E.O. 12898, to accomplish this Environmental Justice analysis includes, identifying low-income and minority populations within the LCA Convent/Blind River project area using up-to-date economic statistics, aerial photographs, 2000 U.S. Census records, Environmental Systems Research Institute, Inc. (ESRI) estimates, as well as conducting community outreach activities such as public meetings. Despite the 2000 U.S. Census being nine years old, it serves as a logical baseline of information and is the primary deciding variable per data accuracy and reliability for the following reasons:

Census 2000 data is the most accurate source of data available due to the sample size of the Census decennial surveys. With one of every six households surveyed, the margin of error is negligible.

The Census reports data at a much smaller geographic level than other survey sources, providing a more defined and versatile option for data reporting.

Census information sheds light upon the demographic and economic framework of the area pre-Hurricane Katrina. By accounting for the absent population, the analysis does not exclude potentially low income and minority families that wish to return home.

Due to the considerable impact of Hurricane Katrina upon the New Orleans metropolitan area, and the likely shift in demographics and income, the 2000 Census data are supplemented with more current data, including 2007 and 2008 estimates provided by ESRI. The 2007 and 2008 estimates are utilized for reference purposes only to show changing trends in population since 2000.

Historic Conditions

The concept of "environmental justice" is rooted in Title VI of the Civil Rights Act of 1964, which prohibited discrimination based on race, color and national origin, and other nondiscrimination statutes as well as other statutes including the National Environmental Policy Act of 1969, the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970, and 23 U.S.C Section 109 (h). In 1971, the Council on Environmental Quality's (CEQ) annual report acknowledged racial discrimination adversely affects the environment of the urban poor. During the next ten years, activists maintained that toxic waste sites were disproportionately located in low-income and areas populated by "people of color." By the early 1980s, the environmental justice movement had increased its visibility and broadened its support base (Commission for Environmental Equality 2009).

This led to the United Church of Christ (UCC) undertaking a nationwide study and publishing Toxic Waste and Race in the United States (UCC 1987). This eventually gained the attention of the federal government and in 1992 the U.S. Environmental Protection Agency's (EPA's) Office of Environmental Equity was established. In 1994, EJ was institutionalized within the federal government through Executive Order 12898 (EPA 1995a), which focused federal attention on human-health and environmental conditions in minority and low-income communities (EPA 1995a, 1995b, 1995c, 1995d).

Executive Order 12898 requires greater public participation and access to environmental information in affected communities. The results of early efforts and research (UCC 1987) into EJ suggested that environmental amenities and toxic waste sites were not uniformly distributed among income groups, classes, or ethnic communities. Disparities of this nature may have been and continue to be the result of historical circumstances, lack of community participation, or simply inadequate

or inappropriate oversight. Consequently, dialogue with some community groups were not conducted and their concerns not considered in the decision making process on local or federal actions.

The study area is located in Ascension and St. James Parishes. The proportion of the population considered a racial minority in these parishes from 1900 to 2000 are included in **Table 4-26** below.

Table 4-26: Minority populations from 1900 to 2000.

Location	YEAR										
	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Ascension Parish	49.9%	47.1%	42.8%	38.4%	37.5%	37.3%	31.9%	27.1%	23.0%	24.7%	23.8%
St. James Parish	43.8%	57.2%	54.7%	49.4%	49.6%	46.5%	49.3%	47.3%	47.4%	50.1%	50.3%

Source: U.S. Census Bureau, Census of Population and Housing, Decennial Censuses. Accessed: www.census.gov/prod/www/abs/decennial/index.htm

Excluding a slight increase from 1980 to 1990, the minority population within Ascension Parish has declined steadily throughout the century. A similar trend has not occurred in St. James Parish, where the minority population has remained relatively constant at approximately half of the population.

Poverty was not defined until the mid-1960s, when the Federal government established the poverty thresholds. At the parish level, Census data is provided from 1990 to the present. **Table 4-27** demonstrates the proportion of those living below the poverty level in Ascension and St. James Parish from 1990 to 2000.

Table 4-27: Proportion of the population living below the poverty line from 1990 to 2000.

Location	YEAR	
	1990	2000
Ascension Parish	17.5%	13.0%
St. James Parish	25.3%	20.7%

Source: U.S. Census Bureau, American FactFinder.

The low-income populations within both Ascension and St. James Parishes decreased proportionately from 1990 to 2000. Although Ascension Parish has historically not breached the thresholds established by federal environmental justice guidelines, St. James Parish has. Therefore, in general, all proposed

activities within St. James Parish have had the potential for environmental justice concerns.

Existing Conditions

The proposed LCA Convent/Blind River project area is located in St. James and Ascension Parishes in Louisiana. The total population of these two parishes, according to the U.S. Census Bureau's 2008 estimates, is 123,020. This figure reflects a more than 25 percent increase in population since 2000, with the overwhelming majority of this projected growth concentrated in Ascension Parish.

According to the 2000 U.S. Census, the LCA Convent/Blind River project boundary in Ascension Parish is located within Census Tracts 303 and 305, Block Groups 1 and 3. In St. James Parish, the project boundary falls within Census Tracts 401, 403 and 404; Block Groups 1, 2 and 3. The 2000 Census demographic profile records indicate that the minority population in Louisiana was 38.7 percent of the total population and the low-income population was 19.6 percent of the total population. In comparison, the minority population in Ascension Parish was 25.3 percent and the low-income population was 13.0 percent. For St. James Parish, the 2000 U.S. Census demographic profile records indicate that the minority population was 50.3 percent and the low-income population was 20.7 percent (http://censtats.census.gov., accessed November 6, 2009).

Table 4-28 presents the environmental justice populations of the study area as compared to Ascension and St. James Parishes as a whole.

Table 4-28: Demographic Data for Proposed Study area from 2000 U.S. Census

Parameter	Louisiana	Ascension Parish	St. James Parish	Study Area		
				Block Group 3, Census Tract 303; Block Group 1, Census Tract 305, Ascension Parish	Block Group 3, Census Tract 401; Block Group 1, Census Tract 403; Block Group 2, Census Tract 404, St. James Parish	Total
Total population	4,468,976	76,627	21,216	3,817	3,522	7,339
Total minority population[1]	1,674,585	18,249	10,678	987	1,272	2,259
	37.5%	23.8%	50.3%	25.9%	36.1%	30.8%
Percentage of population below poverty level	19.6%	13.0%	20.7%	16.1%	15.5%	15.8%

[1]Persons not "white alone" within the "Not Hispanic or Latino" subgroup.
Source: 2000 U.S. Census, American FactFinder

Analyses of the above information show that the percentage of the population that is minority and low-income in Ascension Parish is lower than state figures. While the percentage of the population that is minority in St. James Parish is significantly higher than state figures and the low-income population is slightly lower than state figures. Based on these figures, and field visits conducted in October 2009 to the proposed project area, it has been determined that the proposed LCA Convent/Blind River project area is a minority and low income population, therefore there are potential concerns for Environmental Justice per Executive Order 12898.

4.2.15.9 Water Use and Supply

Historic Conditions

Fresh groundwater and surface water is abundant in southern Louisiana. Prior to the 1900s, water used for most purposes was from surface sources. Many households collected rainwater for domestic uses and farmers generally relied on rainfall and irrigation ditches to provide water to their crops. During the late 1800s, water wells began to come into common usage and quickly proliferated in areas where fresh groundwater was available. The use of groundwater allowed farmers to plant crops in areas where sources of fresh surface water were unreliable or unavailable. In coastal areas of southeastern Louisiana, groundwater supplies are generally limited and surface water is primarily used. Elsewhere, a large supply of fresh groundwater is generally available, and therefore, used for most purposes.

Existing Conditions

Water use within Ascension and St. James Parishes has relied heavily on surface water resources. Extraction from the Mississippi River Mainstream has provided for almost all of current water use demands.

Other water sources include the Chicot Equivalent Aquifer System, the Mississippi River Alluvial Aquifer, the Evangeline Equivalent Aquifer System, the Mississippi River Delta Surface Water Basin, and the Lake Pontchartrain-Lake Maurepas Surface Water Basin, in order of decreasing supply respectively.

No surface water uptakes are in direct proximity to the proposed diversion uptake locations.

In 2005, for example, surface water sources supplied for 92 percent of water use, while groundwater sources provided for only eight percent. Combined water use in Ascension and St. James parishes increased from 1960 to 1980; after which time, overall water use has remained relatively stable. Though, a notable increase in water use was observed in St. James Parish from 2000 to 2005 due to increased industrial demand. Within the study area, the greatest water use has occurred in St. James Parish, followed by Ascension Parish, with demand driven by industrial use and other sectors constituting minor additions

Various industry groups are present within the vicinity of the study area, including petroleum refining, primary metals, food products, lumber, and chemicals. The latter constitutes the primary industrial water use group. Additional water use sectors in the vicinity of the study area are in decreasing order (as of 2005) aquaculture, public supply, rural domestic, livestock, and general irrigation.

Table 4-29: Water use in millions of gallons per day in 2005 for surface water and groundwater resources by water source for Ascension and St. James Parishes.

Water Source	Ascension	St. James
Surface Water		
Lake Pontchartrain-Lake Maurepas Surface-Water Basin	0.03	--
Mississippi River Mainstream	188.77	365.60
Mississippi River Delta Surface-Water Basin	1.53	--
Groundwater		
Mississippi River Alluvial Aquifer	1.00	3.34
Chicot Equivalent Aquifer System	10.65	19.30
Evangeline Equivalent Aquifer System	--	--

-- Denotes no use of water source by parish;
Source: Sargent (2007).

The LA DOTD online registry of water wells ttp://www.dotd.louisiana.gov/intermodal/wells/) was queried to identify wells within the vicinity of the study area. In the distribution area, four wells are present: two plugged test wells owned by LA DOTD Public Works and Water Resources and two commercial, public supply wells—one owned by St. James Boat Club and the other by Shell Oil. Eleven additional water wells are within a half-mile radius of the project distribution area, including active and inactive wells: four plugged, abandoned, or destroyed wells, one private domestic well, one commercial public supply well, two monitoring wells, and three classed for "other" uses. No water wells lie within the transmission channels. Four plugged or abandoned wells are registered within 1,000 feet of the Romeville transmission canal. Seven water wells are registered within 1000-feet of the South Bridge transmission canal: three owned by Ancient Domain under Entergy, Inc. (one stock irrigation well and two abandoned domestic wells) and four monitoring wells owned by Star Enterprise, Inc.

Table 4-30: Annual water withdrawals (millions of gallons per day) from 1960 through 2005 for St. James and Ascension parishes.

Water Use	Water Source	Year									
		1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
Aquaculture	GW	0	0	0	0	0	0	0.12	0.08	0.07	22.13
	SW	0	0	0	0	22.66	18.6	51.35	10.09	11.75	0
	Total	**0**	**0**	**0**	**0**	**22.66**	**18.6**	**51.47**	**10.17**	**11.82**	**22.13**
General Irrigation	GW	0.05	0.91	0.40	1.34	0.01	0	0	0.03	0.06	0.04
	SW	0.07	0.51	0.45	7.91	0	0	0	0	0	0.01
	Total	**0.12**	**1.42**	**0.85**	**9.25**	**0.01**	**0**	**0**	**0.03**	**0.06**	**0.05**
Industrial	GW	6.53	10.62	8.71	7.65	11.67	11.15	17.64	13.36	12.63	6.05
	SW	44.40	20.31	328.53	390	466	358	404.92	438.52	426.79	551.87
	Total	**50.93**	**30.93**	**337.24**	**397.65**	**477.67**	**369.15**	**422.56**	**451.88**	**439.42**	**557.92**
Livestock	GW	0.31	0.23	0.19	0.16	0.07	0.06	0.05	0.11	0.09	0.11
	SW	0.01	0.01	0.02	0.02	0.01	0.01	0.03	0.02	0.02	0.03
	Total	**0.32**	**0.24**	**0.21**	**0.18**	**0.08**	**0.07**	**0.08**	**0.13**	**0.11**	**0.14**
Power Generation	GW	0	0	0	0	0	0	0	0	0	0
	SW	0	0	0	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Public Supply	GW	0.30	0.47	0.5	0.67	0.72	1.77	1.82	2.62	2.57	2.64
	SW	1.37	3.05	1.72	2.80	3.79	4.22	4.01	4.35	5.24	4.01
	Total	**1.67**	**3.52**	**2.22**	**3.47**	**4.51**	**5.99**	**5.83**	**6.97**	**7.81**	**6.65**
Rice Irrigation	GW	0	0	0	0	0	0	0	0	0	0
	SW	0	4.62	0	0	0	0	0	0	0	0
	Total	**0**	**4.62**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Rural Domestic	GW (Total)	**0.6**	**0.83**	**0.8**	**0.7**	**2.2**	**1.97**	**2.27**	**2.42**	**2.81**	**3.3**

4.2.15.10 Navigation

Historic Conditions

The Rivers and Harbors Act of 1899 and the General Bridge Act of 1946 give the U.S. Coast Guard (USCG) the authority to protect navigable waters of the United States. Navigable waters are those waters that at some time, in the past, present, or future, are used to transport interstate or foreign commerce. Protection of navigable waters is accomplished by regulating bridge-related activities and other activities that may affect navigation or the mooring of vessels on navigable waterways. The Eighth Coast Guard District regulates activities for the study area within the State of Louisiana.

Navigable waters within the study area include the Lower Mississippi River and the Blind River and its tributaries. Historically, these waterbodies have served as important conduits for navigation and commerce. Infrastructure developed to promote commerce along the Mississippi River in proximity of the study area includes the Ports of Baton Rouge, South Louisiana, and New Orleans and their associated structures.

Existing Conditions

Annual U.S. port tonnage statistics consistently rank the Ports of South Louisiana, New Orleans, and Baton Rouge among the top fifteen in the country. For 2007, these ports along the Mississippi River were respectively ranked first, eighth, and fourteenth nationally and constituted 46.0 percent, 15.3 percent, and 11.0 percent of the annual statewide port tonnage (USACE 2009). Primary inbound cargos at the Port of South Louisiana are crude oil and petroleum products, while corn, wheat, and animal feed dominate the port's exports. Primary inbound cargos at the Port of Baton Rouge are petroleum and chemicals. Outbound cargos are grain, chemicals, and petroleum products. At the Port of New Orleans, principal inbound cargos consist of steel, crude, and refined petroleum products and outbound cargos include grain, forest products, and steel. The ports of South Louisiana, New Orleans, and Baton Rouge line 172 miles (277 km) of both banks of the Lower Mississippi River.

The USCG reviews and comments on environmental documentation for Environmental Impact Statements (EIS), Environmental Assessments (EA), and in some particular cases Categorical Exclusions (CE) where navigable waters of the U.S. may be impacted. Coordination with the USCG dated December 2, 2009, indicates that at this time their organization does not find any problems associated with the proposed diversion uptake locations along the Mississippi River (personal communication, Daphne Coffman, LTJG, 2009).

4.2.15.11 Land Use Socioeconomics

Agriculture

Historic Conditions

Agriculture has been a historically important component of coastal Louisiana's economy. The rich deltaic soil and mild climate are conducive to the production of a wide variety of crops. Early settlers were primarily subsistence farmers during the

colonial period, but subsequent times brought the expansion of commercial exploits. Before its decline at the end of the eighteenth century, indigo was the primary commercial crop near the study area. Sugar cane and cotton soon took its place, the former of which attained and still maintains prevalence. Other common crops included corn, rice, squash, pumpkin, varieties of peas and beans, and tobacco, most notably perique tobacco which worldwide is only produced in St. James Parish.

In 1950, there were 124,181 farms in Louisiana totaling over 11.2 million acres of farmland (US Census, 1950). The value of crops sold in Louisiana at this time exceeded $180 million. By 1997, statewide acreage in farmland had been reduced to 8.4 million acres, but the total value of crops sold had risen to over $1.4 billion (Farmland Information Center, 2006).

Based on the USDA Census of Agriculture, Ascension and St. James Parishes had 1,455 and 406 farms, respectively, in 1950. At this time, the total acreage of farms was 112,800 acres in Ascension Parish and 69,503 acres in St. James Parish.

Existing Conditions

Agriculture is still an important component of Louisiana's economy. In 2007, the acreage of farms in Louisiana was over 8.1 million acres, from which the total value of crops sold exceeded $1.6 billion (USDA 2007). Approximately 20 percent of the Nation's rice and 37 percent of the Nation's sugar are produced in Louisiana (USDA 2007). Production is largely concentrated in coastal Louisiana, much of which is experiencing land loss from RSLR or increasing salinities of waters serving as irrigation sources.

The USDA's National Agricultural Statistics Service (NASS) conducts agricultural censuses every five years. According to the 2007 survey, sugarcane is the primary crop in both Ascension and St James Parishes and accounts for approximately 38 percent and 56 percent of total farmland acreage within the parishes, respectively. Other major agricultural industries in the parishes include forage land, cattle, hogs and pigs, and other livestock. St James Parish also has a number of vegetable farms, while Ascension Parish has a small number of soybean farms. Both parishes also have a small number of orchards.

Between 2002 and 2007, declines in the number of farms and land in farms occurred in both Ascension and St. James Parish. In 2007, there were 45,455 acres in farmland in Ascension Parish while there were 43,251 acres in farmland in St. James Parish. The total market value of crops sold in 2007 was $17.3 million for Ascension Parish, an increase from 2002. In St. James Parish, the total market value of crops sold was $22.6 million in 2007 which was a decrease from 2002.

The study area contains approximately 163 acres of agricultural lands based on USGS NCLD 2004 data. Agricultural lands appear to be limited to cultivated areas between LA 44 and just north of LA 3125 and are impacted by the transmission canal routes. Farmlands along these corridors primarily consist of sugar cane plantations.

Forestry

Historic Conditions

Early settlers viewed the swamps as inhospitable and dangerous, yet inexhaustibly abundant. An estimated 15 million board feet of baldcypress grew in the delta swamps at the time of settlement (Kerr 1981). Baldcypress timber served as the primary cash crop for French settlers across the Lower Mississippi Valley in the eighteenth century, who traded in timbers for imported goods until the advent of sugar cane's profitability in the 1790s (Moore 1967). Harvesting methods were primitive during this period, and transport of timbers was often achieved by floating logs along manmade ditches from the swamp to the Mississippi River as spring floodwaters retreated to the river where sawmills were located, which limited operations to five months at most (Moore 1967, Eisterhold 1972, Prophet 1982). Small levees were often constructed to impound wetlands and facilitate lumber transport (Conner and Toliver 1990).

Large-scale commercial deforestation of baldcypress-tupelo forests did not begin until the late 19th century. The repeal of the Homestead Act of 1866 and passage of the Timber Act of 1876 made swamplands formerly deemed unattainable available for private purchase at low prices (25-50 cents/acre or 60 cents-$1.25/ha) (Davis 1975). The introduction of pull-boat logging in the 1890s and later the overhead-cableway skidder enabled increased harvest volumes and access to areas further from the navigable waters (Conner and Bulford 1998). Commercial harvests thrived in Louisiana from 1890 to 1925, with production reaching its peak in 1913, at which time more than 700 million board feet of lumber were processed in 94 mills (Mattoon 1915; **Figure 4-22**). Overexploitation and the onset of the Great Depression brought the decline of the cypress lumber industry in Louisiana, with the last old-growth harvested in the 1920s and the closure of the last baldcypress logging operation in 1956 (Conner and Toliver 1990). A mere artifact of a past booming industry, smaller logging operations continued harvests, with Mancil (1980) observing the last pull-boat logging along the Blind River in 1961.

Though harvests of baldcypress-tupelo forests declined, commercial harvests of addition timber species provided financial benefits to Louisiana. In 1965, the total value of timber sold in the state was $27.2 million (LFC 1966). Timber sales in Ascension and St. James Parishes at this time were $46,329 and $42,839, respectively. Experiencing substantial statewide and parish-level growth, the total value of timber sold in Louisiana, Ascension Parish, and St. James Parish in 2003 was $605.3 million, $765,547, and $164,356, respectively (LADAF 2004).

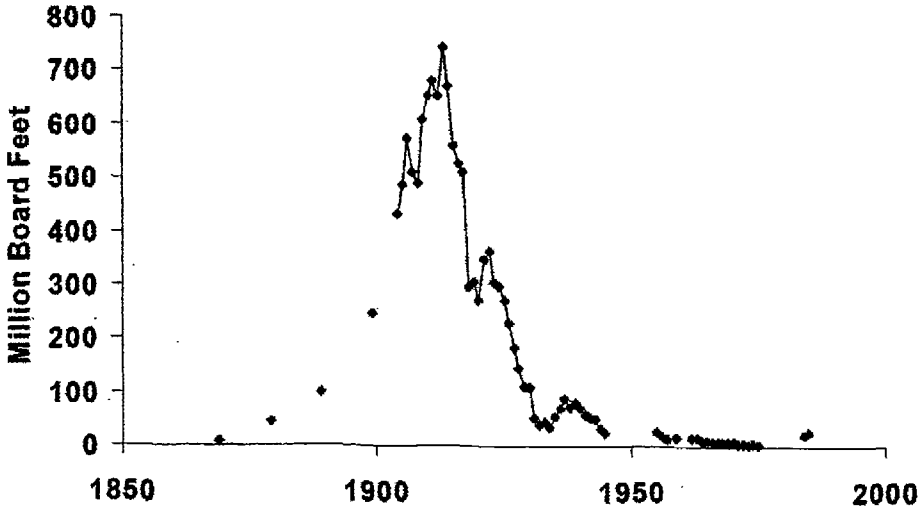


Figure 4-22: Historic volume of cypress cut in the state of Louisiana (Louisiana Department of Conservation 1943; Louisiana Forestry Commission, 1957; Louisiana Forestry Commission Progress Reports 1956-76; Mistretta and Bylin 1987 compiled in Chambers et al. 2005).

Existing Conditions

Forestry remains an important sector of Louisiana's economy with total sales of timber products in the state exceeding $471 million and providing tax revenue of $14 million (LADAF 2009). The statewide importance of the timber industry is reflected in the parishes surrounding the study area. In 2008, the total stumpage value of timber products in Ascension Parish was $344,209 and provided tax revenue of $10,142 (LADAF 2009). This included 864,022 board feet of sawtimber and 4,910 cords of pine and hardwood pulpwood. For St. James Parish in 2008, the total stumpage value of timber products was $222,657 and provided tax revenue of $6,644. This included 616,568 board feet of sawtimber and 3,497 cords pine and hardwood pulpwood.

Renewed interest has arisen for timber harvests of baldcypress-tupelo forests as second-growth forests reach economic maturity. Substantial concern exists regarding the ability of these forests to regenerate post-harvest. Therefore, the Louisiana governor has convened a Science Working Group on Coastal Wetland Forests to synthesize scientific information available on regeneration, growth, and potential harvesting effects on coastal wetland forests, and to develop science-based,

interim guidelines for the conservation and utilization of coastal wetland forests (Chambers et al. 2005, Faulkner et al. 2007).

Currently, state restrictions prohibit the cutting of baldcypress trees in designated state water bottoms, as specified in Louisiana Revised Statute 41:1009 with certain exemptions for rights of way. Louisiana Revised Statute 41:1701 defines state water bottoms as "[t]he beds and bottoms of all navigable waters and the banks or shores of bays, arms of the sea, the Gulf of Mexico, and navigable lakes" and establishes the management and protection of the resources Lake Maurepas and Blind River are designated as a state water bottoms.

Public Lands

Historic Conditions

Public lands constitute all land areas managed by Federal, state and local government agencies. The U.S. Commission on Fish and Fisheries, established in 1871 to study, manage and restore fish, was the first federal conservation agency. The Bureau of Biological Survey followed in 1885, with the organizational purpose of studying birds, plants and animals. The U.S. Fish and Wildlife Service (USFWS) emerged from a merging of the Commission and Bureau in 1939. Subsequent Federal legislation led to the National Wildlife Refuge System, which strives to conserve, manage, and restore natural resources and habitats, and is managed by the USFWS.

State fish and wildlife agencies manage their state's similarly-minded WMA program. In 1909, the Louisiana Board of Commissioners for the Protection of Birds, Game and Fish was established and later evolved into the LDWF in 1975. The LDWF manages the WMA program for the State of Louisiana.

Existing Conditions

The study area includes 17,079 acres (6,912 ha), or approximately half, of the 37,163-acre (15,039 ha) Maurepas Swamp WMA Western Tract. The WMA was established in August 2001 and is managed by the LDWF. Much of the WMA was acquired through a philanthropic donation of approximately 62,518 acres (25,300 ha) by the Richard King Mellon Foundation in 2001. Historic and current activities within the WMA are detailed under **Section 4.2.14.**

Future management plans within the WMA include the erection of 200 duck boxes to enhance breeding habitat, construction of a board walk for public access and enjoyment, development of an invasive species management plan, and continued collaboration on restoration projects proposed to revive the swamp.

4.2.15.12 Man-Made Resources

Oil, Gas, Utilities

Historic Conditions

Since the discovery of oil and gas deposits in coastal Louisiana during the early 1920s, a vast network of canals, pipelines, and production facilities have been created

to service the industry. Today, an estimated 9,300 miles (14,967 kilometers) of oil and gas pipelines crisscross the coastal wetlands of Louisiana. Additionally, there are approximately 50,000 oil and gas production facilities located in the Louisiana coastal area. Canals that stretch from the Gulf of Mexico inland to freshwater areas allow saltwater to penetrate much farther inland, particularly during droughts and storms, which has had severe effects on freshwater wetlands (Wang 1987 and 1988). Dredged material banks, which are much higher than the natural land surface, and the many smaller canals dredged for oil and gas exploration alter the flow of water across wetlands. Hydrologic alterations alter important hydrogeomorphic, biogeochemical, and ecological processes, including chemical transformations, sediment transport, vegetation health, and migration of organisms.

Because of the presence of dredged material banks, partially impounded areas have fewer but longer periods of flooding and reduced water exchange when compared to non-impounded marshes (Swenson and Turner 1987). This results in increased water-logging and frequently in plant death. Importantly, dredged material banks also block the movement of sediment resuspended in storms, which play a major role in sustaining land elevations (Reed et al. 1997). By altering salinity gradients and patterns of water and sediment flow through wetlands, canal dredging, which mostly occurred between 1950 and 1980, not only directly changed land to open water, but also indirectly changed the processes essential to a healthy coastal ecosystem.

Existing Conditions

Data from the LDNR Strategic Online Natural Resources Information System (SONRIS) indicate that the southeastern Maurepas Swamp has undergone extensive oil and gas exploration activities, most of which occurred in the early to mid-twentieth century. Exploration efforts have occurred primarily to the north and south of the Study Area, with the north experiencing more concentrated activities. Based on SONORIS data, 16 wells are near the Study Area: twelve are abandoned, three are active, and one has an expired permit Figure 4-25). Of these, only two wells are located within the Study Area and both are plugged and abandoned. Further description of oil and gas wells within the study area is provided in **Table 4-31**.

Additional data archived by SONRIS include directional well bottom hole point and well bore locations, depicted as straight lines extending from the top hole location to the bottom hole location. Review of this dataset does not support the presence of these features within the Study Area. Immediately outside of the Study Area, two well bores are recorded, one to the north and one to the south, with their statuses listed as dry and plugged. The exact location of these well bores is provided in **Figure 4-23.**

Table 4-31: Oil/gas wells within or adjacent to the study area.

Serial No.	Owner Name	Longitude	Latitude	Status	Status Date	Depth (ft)
158492	Texas Gulf Equipment, Inc.	-90.7403	30.0533	Producing Well	6/1/1991	11100
63286	F.A. Callery, Inc.	-90.8322	30.1261	P&A Dry Hole	12/4/1956	11802
54107	**Inactive Operator**	**-90.8192**	**30.1366**	**P&A Dry Hole**	**4/28/1955**	**15117**
98324	F.A. Callery, Inc.	-90.8322	30.1261	P&A Dry Hole	11/17/1963	11518
123319	Chevron U.S.A., Inc.	-90.8192	30.1366	Temporarily	3/5/1968	10433
138727	**Inactive Operator**	**-90.7729**	**30.0626**	**P&A Dry Hole**	**3/23/1972**	**11734**
167321	Texas Gulf Equipment, Inc.	-90.7364	30.0551	Producing Well	1/22/1995	11303
124257	P.R. Rutherford	-90.7281	30.0534	P&A Dry Hole	5/25/1968	11888
166991	Brock Exploration Corporation	-90.7259	30.0554	P&A Dry Hole	3/17/1980	12184
121176	Texaco, Inc.	-90.7986	30.1410	P&A Dry Hole	1/21/1968	11000
122145	Inactive Operator	-90.7757	30.0541	P&A Dry Hole	12/10/1967	11693
161462	Texas Gulf Equipment, Inc.	-90.7403	30.0533	WRSC	5/24/1989	11100
60013	Inactive Operator	-90.7898	30.1472	P&A Dry Hole	3/22/1956	9406
25073	Inactive Operator	-90.7792	30.1468	P&A Dry Hole	2/4/1941	9680
162124	ETC Oil Corp	-90.7312	30.0548	P&A Oil	5/9/1989	11320
154181	Brock Exploration Coporation	-90.7296	30.0511	PE	12/9/1976	NA

Notes: P&A- Plugged and Abandoned. PE- Permit expired. WRSC- Wells reverted to single completion (gas and condensate).
Wells located within the study area are denoted by **bold** font.

Table 4-32: Well bottoms and bores within or near the study area.

Serial No.	Owner Name	Product	Status	Status Date	Depth (ft)
121176	Texaco, Inc.	Unspecified	Dry & Plugged	1/21/1968	11000
166991	Brock Exploration Corporation	Unspecified	Dry & Plugged	3/17/1980	12184

321

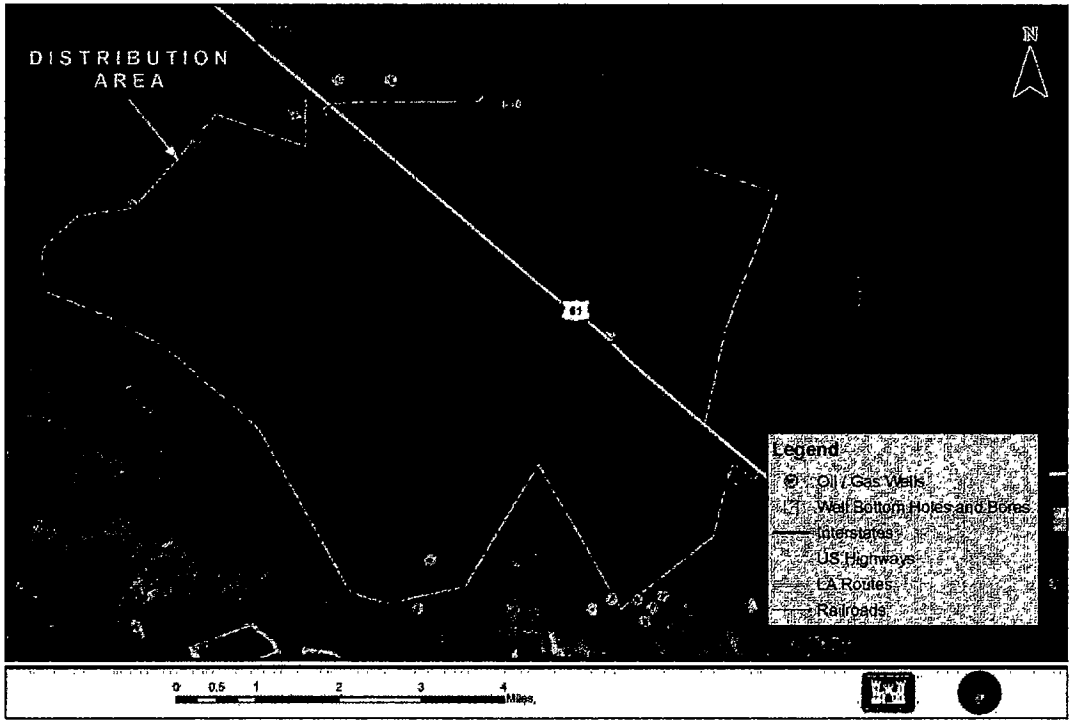


Figure 4-23: Oil and Gas well and well bottoms near Study Area.

322

Location data for gas transmission and hazardous liquid pipelines, liquefied natural gas (LNG) plants, and breakout tanks throughout the United States are compiled by the United States Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) based on contributions from pipeline operators. Geospatial data are archived in the National Pipeline Mapping System (NPMS), with the most recent iteration issued January 2004. Furthermore, in accordance with the 1988 Louisiana Damage Prevention Law, excavators and demolishers are required to contact a regional notification center—LA One Call—at least forty-eight hours before digging, and owners/operators of underground facilities are required to mark locations or provide information that will enable these entities to locate underground facilities and utilities. An initial query was performed of the NPMS which was then cross-referenced to updated records of underground structures attained through LA One Call for the Study Area. Locations of pipelines within the Study Area are provided in **Table 4-33**, and pipeline attributes are further described in **Table 4-34**.

Table 4-33: Summary of Pipeline Information in Study Area

Company	Installation Date	Product
Acadian Pipelines; Cypress Gas Pipeline	16" - 1957 4" - 1976	Natural Gas
Air Products	1992	Hydrogen Gas
Chevron Pipeline	Varies (earliest is 1965)	Natural Gas, NGL Propane Natural Gas Natural Gas Natural Gas, NGL, Propane
Gulf South Pipeline Company, LP	1990	Natural Gas
Marathon Pipeline, LLC	1978	Refined Products: Gasoline, Diesel, Jet Fuel
Petrologistics Olefins, LLC	1980	Ethylene
Williams Gas Pipeline	1971	Natural Gas
Shell Pipeline	1967	Ethylene

Table 4-34: Summary of Aboveground and Belowground Transmission Lines in Study Area

TELECOMMUNICATIONS & ELECTRICITY			
Company Name	**Description**	**Utility Size**	**Type**
Entergy			
Convent to Frisco	Transmission	230 kV	Aerial
Convent to Romeville	Transmission	230 kV	Aerial
Lutcher to Sorrento	Transmission	115 kV	Aerial
Panama to Dutch Bayou	Transmission	230 kV	Aerial
Romeville to Panama	Transmission	230 kV	Aerial
Verizon (MCI Telecommunications)	Fiber Optic Backbone	24 F Count	Buried
Level 3 Communications	Primary Fiber Optic	96F Count, 170F Count	Buried
AT&T Telecommunication	Proprietary		Aerial & Buried

Flood Control and Hurricane Protection

Historic Conditions

Efforts to control the frequent floods of the Mississippi River began shortly after French settlement. Bienville, the founder of New Orleans, initiated construction of the first manmade levee system, which began in the city in 1717 and was completed by 1727. Private landowners were responsible for extending the levee system, which by 1735 advanced along both banks of the river from approximately 30 miles (48 km) above to 12 miles (19 km) below New Orleans (USAED 1976). French colonial government decree in 1743 required private landowners along the river to complete and maintain their levees within the year or surrender their land (Gunter 1952). A period of expansive levee building followed, over which by 1844 the levee system extended along the west bank of the river from 20 miles (32 km) below New Orleans to the Arkansas River—a distance of about 600 miles—and to Baton Rouge along the east bank (Barry 1997). Levee building in the Pontchartrain Basin begin in 1812 and by 1895 had completely severed the basin from the river (Davis 2000, Lopez 2003).

Early flood protection systems were simply devised by building up the natural levee and, whether due to low structural integrity, abandonment, or neglect, were prone to breaching in flood events—an event known as crevassing (Davis 1993). More than 1,000 crevasses compromised the Lower Mississippi River's levees from 1850 to 1927 (Davis 1993). A breach of the east bank levee in the flood of 1890 allowed maximum flows of 408,520 ft^3 sec-1 (11,568 m^3sec^{-1}) through the 3,104-foot (946-meter) Nita Crevasse at Romeville and into the study area for 122 days (Mills 1894). Though states became involved with flood protection through direct funding and creation of levee boards in the 1830s, Federal responsibility and directive for a coordinated levee system for the entire Lower Mississippi River did not begin until the establishment of the Mississippi River Commission (MRC) in 1897 (USACE 2009). The Flood Control Act of 1917 authorized the MRC to construct an extensive program of flood protection with cost-sharing by states and local interests. The flood of 1927—the most disastrous in the history of the Lower Mississippi Valley—led to the strengthening of this initiative through the passage of the Flood Control Act of 1928. The legislation authorized the MR&T Project, which incorporates levees, floodways, channel improvement and stabilization, and tributary basin improvements.

Inland from the levee, flood control structures included parish maintained ditches and canals. The lateral drainage system of ditches conveys flow from the adjacent uplands into canals in the distribution area. Construction of the St. James Parish canal network occurred in the 1950s and 1960s and provided direct connection with Blind River (personal communication, Jody Chenier—St. James Parish Director of Operations, 2009). Disposal of dredged material along canals created elevated spoil banks (berms) into which gaps were cut to facilitate water distribution (**Figure 4-24**). Berms vary in dimension, but their elevation typically ranges from 4 to 12 feet NAVD 88.

Existing Conditions

Existing flood control structures in the study area include the east bank levee of the Mississippi River and parish maintained ditches and canals. Built by the federal government under the MR&T Project, the east bank levee is maintained by the Pontchartrain Levee District (PLD) and contributes to the 2,203-mile (3,545-km) main stem levee system (USACE 2009). Levee elevation is approximately 38 feet NAVD 88 in the study area. The PLD St. James Hurricane Protection Levee and Study Project include potential alignments both within and near the study area. Presently in the feasibility stage, the final conceptual levee route has been chosen and will be aligned along the northeast bank of I-10.

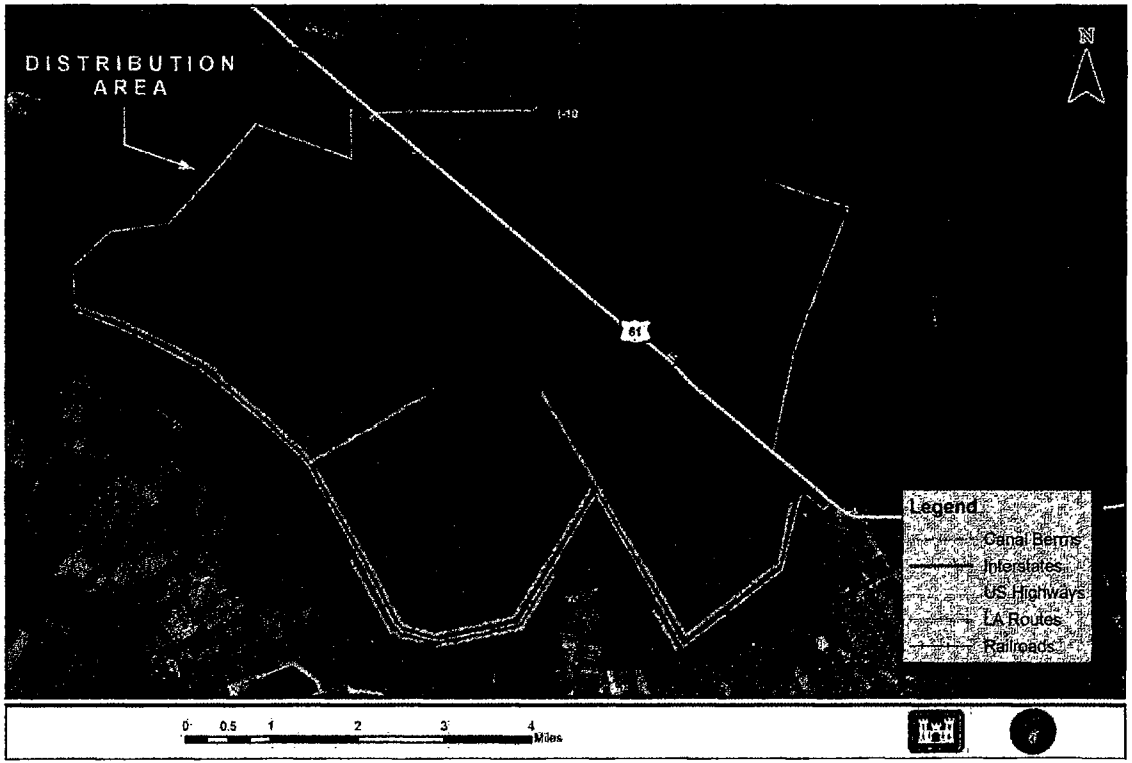


Figure 4-24 Location of berms within the distribution area.

Flood control structures in the study area include parish maintained canals within the distribution area. St. James Parish has presently completed approximately 50 percent of maintenance efforts to clear berms and re-dredge drainage canals to their original depths. Available light detection and ranging (LIDAR) imagery for the study area provides high accuracy, remotely attained elevation data acquired in 2001 (USACE, 2001). Based on preliminary analysis of this imagery, approximately 163 berm cuts exist along parish canals in the study area. Maintenance operations do not include re-dredging of berm cuts, and field observations indicate that these features have limited internal conveyance due to sediment buildup and revegetation. As present, these features restrict the distribution of water into and out of the swamp, which negatively impacts forest health and productivity.

4.2.15.13 Natural Resources

Commercial Fisheries

Historic Conditions

Commercial fisheries have been a historically important part of Louisiana's economy, supporting the livelihood of many residents. Across the state, the industry has experienced significant growth. The total value of commercial fisheries statewide was $23.6 million in 1950 compared to a near ten-fold increase ($201.7 million) in the industry by 2006 (NMFS 2007).

The LDWF's Trip Ticket Program provides a collection system for commercial landings and associated information. Individuals who purchase a wholesale/retail seafood license, fresh product license, or crab shedders license are legally required to report this information. Data have been collected since January 1, 1999. Annual total landings and their values by species were provided by LDWF (2009) for Lake Maurepas and the surrounding drainages where at least three commercial fishermen or wholesale/retail dealers provided information at the lowest level of analysis. The reported total value of commercial fisheries from 1999 to 2007 averaged $178,963 annually and included an average of 214,654 annual landings during this time (LDWF, 2009). By species, the majority of landings consisted of blue crab. Blue catfish, channel catfish, alligator gar, and brown and white shrimp also contributed to commercial landings in the area.

Among the many species commercially harvested in Louisiana, shrimp have historically constituted an important part of the state's commercial fisheries by value. Based on annual fisheries data from 1950 to 1998 for Louisiana, shrimp composed only 10 percent of average annual landings by weight but contributed to an overwhelming 56 percent of the average annual value of commercial fisheries in this period (LADWF 2000). Interestingly, the value of shrimp to Louisiana's commercial fisheries has historically increased while the number of shrimpers has declined. The total value of shrimp landings increased substantially from 1950 ($16 million) to 1998 ($156 million). Despite the high value of the fishery, the number of licensed commercial shrimpers in Louisiana declined from 16,505 to 6,694 from 1989 to 2005. This trend was also observed in Ascension and St. James parish with the number of licensed resident shrimpers declining by almost 66 percent in both

parishes during this time period. In 2005, there were fifty licensed shrimpers in St. James Parish and thirty in Ascension Parish.

Existing Conditions

Louisiana's coastal wetlands are the richest estuaries in the country for fisheries production, and commercial fisheries support the livelihood of many residents. Commercially and recreationally important species, such as brown and white shrimp, blue crabs, eastern oysters, and menhaden, are abundant in the state, but these species' populations are threatened by trends of habitat degradation. Louisiana has historically been an important contributor to the Nation's domestic fish and shellfish production and is one of the primary contributors to the Nation's food supply for protein. While Louisiana has long been the Nation's largest shrimp and menhaden producer, it has also recently become the leading producer of blue crabs and oysters.

Louisiana ports produce a catch comparable to that of the entire Atlantic seaboard, and more than triple that of the remaining Gulf States (NMFS, 2001). Four Louisiana ports have ranked among the top ten in value of commercial fisheries landings throughout the U.S. since 1981 (NMFS, 2003). Louisiana's commercial landings have been over one billion pounds per year (454 million kg) for over 20 years. In 2006, commercial fisheries accounted for 26,915 jobs statewide, $1.8 billion in retail sales, and $170.5 million in state and local tax revenues, with a total economic effect of $2.4 billion (Southwick 2006). White shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and Gulf menhaden (*Brevoortia patronus*) account for the majority of commercial harvest by value.

The total value of commercial fisheries for Louisiana in 2008 was $274.8 million (NMFS, 2009). In 2008, the reported total value of commercial fisheries for Lake Maurepas and the surrounding drainage was $120,680 with 126,100 landings (LDWF, 2009). Blue crab and white shrimp made up over 97 percent of these landings.

Based on correspondence with the NMFS dated February 20, 2009, foraging and nesting habitat for economically important, estuarine-dependent fishery species is present within the study area. Important species include blue crab, striped mullet, and Gulf menhaden.

Oyster Leases

Historic Conditions

No oyster leases historically occurred within the study area.

Existing Conditions

No oyster leases presently occur within the study area.

4.2.16 Hazardous, Toxic, and Radioactive Wastes

The USACE is obligated under ER 1165-2-132 to assume responsibility for the reasonable identification and evaluation of all HTRW contamination within the vicinity of the proposed action. ER 1165-2-132 identifies the USACE policy to avoid the use of project funds for HTRW removal and remediation activities. Costs for necessary special handling or remediation of wastes (e.g., those regulated by the RCRA), pollutants and other contaminants, which are not regulated under the CERCLA, will be treated as project costs if the requirement is the result of a validly promulgated Federal, state, or local regulation.

HTRW investigations facilitate early identification and consideration of HTRW problems. The Civil Works Project Plan routinely includes a phased and documented review to provide for early identification of HTRW potential at project sites. ER 1165-2-132 requires that viable options to avoid HTRW problems be determined and a procedure for resolution of HTRW concerns be established. A Phase I ESA was conducted on the study area in accordance with ER 1165-2-132.

This Phase I ESA was conducted in a manner consistent with customary practice and in general conformance with the scope and limitations of the American Society for Testing and Materials (ASTM) Designation E 1527-05, Standard Practice for Environmental Site Assessments: Phase I ESA Process (ASTM 1527); ASTM Designation E 2247-08 Standard Practice for Environmental Site Assessments: Phase I ESA Process for Forestland and Rural Property, and the U.S. Environmental Protection Agency's All Appropriate Inquiry (AAI) standards Rule, 40 CFR Part 312. The purpose of this ESA was to identify and investigate recognized environmental conditions on the subject property and surrounding properties that may constitute actual or potential sources of environmental risk or liability that may have resulted from past or present land uses, construction activities, site management or operations.

Based upon the database information reviewed, walk-through observations of property conditions, interviews with representative property owners, and review of property ownership no recognized environmental concerns were identified within the southeastern Maurepas Swamp, the Blind River, or the proposed Romeville diversion route that would be expected to impact the subject property. An underground storage tank was identified during the database search adjacent to the transmission canal location for the South Bridge diversion route.

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5.0 ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of implementing alternative plans considered for freshwater diversion and nutrient and sediment introduction to the Maurepas Swamp. The following analysis compares the No Action Alternative to the alternatives carried over for detailed analysis: alternative plans 2, 4, 6, and 4B. Plan 2 was the TSP which was later confirmed as the Recommended Plan. Diversion alternatives for freshwater, nutrient, and sediment introduction are described in Chapter 3.0 Alternatives.

A comparison of the direct, indirect, and cumulative impacts for freshwater diversion and nutrient and sediment introduction opportunities is presented herein. Direct impacts are those effects that are caused by the proposed action and occur at the same time and place (Section 1508.8(a) of 40 CFR Parts 1500-1508). For example, increased inflow of freshwater would be a direct impact of diverting water from the Mississippi River into Maurepas Swamp.

Indirect impacts are those effects that are caused by the action and occur later in time or further removed in distance, but are still reasonably foreseeable (Section 1508.8(b) of 40 CFR Parts 1500-1508). Indirect impacts of project implementation would include an increase in hydrologic connectivity throughout the system which would increase the flow of water out of the swamp and the frequency of dry out conditions necessary for tree seedling survival. This would allow for increased recruitment of baldcypress and water tupelo. Freshwater, nutrient and sediment introduction would increase productivity and accretion (swamp building) and reduce or offset the effects of RSLR (eustatic sea level rise and subsidence). Additionally, pulsing of the system would further enhance circulation, productivity and nutrient assimilation in the swamp and thereby improve water quality and reduce salinity in the swamp and in Blind River. Increases in productivity and accretion that increase swamp building provide stability in areas that would otherwise erode. Increases in productivity in the swamp would benefit wading bird populations by restoring diminishing suitable swamp forest habitat and increasing abundance of forage fish and crayfish in the study area. Overall, birds would benefit in the longer term from the healthier swamp forest ecosystem that would provide better food sources and nesting sites than currently exist.

Cumulative impacts would be the aggregate of impacts to the environment resulting from the proposed action in combination with other ongoing actions, and actions being considered within the reasonably foreseeable future. Cumulative impacts are the effects on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from actions that individually are minor, but collectively result in significant actions taking place over time (Section 1508.7 40 CFR Parts 1500-1508). For example, increased ecosystem health and the prevention of degradation could significantly modify an entire basin's diversity of

habitats and species assemblages. The cumulative impact analysis followed the 11-step process described in the 1997 report by the Council of Environmental Quality entitled "Considering Cumulative Effect Under the National Environmental Policy Act." **Table 5-1** summarizes cumulative impacts for all important resources.

This environmental analysis evaluates and compares, from a qualitative and quantitative perspective, the alternative plans and the No Action Alternative carried over for detailed analysis. Impact analysis described in this chapter is based on a combination of scientific and engineering analyses, professional judgment, and previously compiled information.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Soils	*US:* Institutional recognition of importance of soils with formation of Soil Conservation Service. *LA:* Louisiana coastal land loss of over 1.22 million acres since 1956. *SA:* Loss of 1,600 acres in Amite/Blind River mapping unit between 1932 and 1990 (LCWCRTF and WCRA 1999). Land area in *SA* generally stable, since 1985 (USGS 2009).	*US, LA, and SA:* Continued institutional recognition; continued loss of soil resources. *US:* Natural processes of parent material, climate, organisms, relief, and time factors in soil formation. *LA:* Continued land loss of over 25 square miles per year. *SA:* Continued stability of land area.	*US & LA:* Continued institutional recognition; continued loss of soil resources. *SA:* Increased flood duration, stage, and salinity would persist throughout resulting in continued stress and reduced productivity. Over the 50-year period of analysis, there would be conversion of approximately 11,229 acres (4,544 ha) of forested swamp to fresh marsh or open water.	US & LA: Continued institutional recognition and programs for soil conservation to reduce soil losses. *ALT2*: This alternative would have positive synergistic effects on soil resources when combined with other Federal, state, local, and private restoration efforts. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

**Includes Spatial/Geographic Extent (Continental United States [U.S.], Louisiana [LA], and Study Area [SA], and Temporal (Past, Present, and Future with the No-Action Alternative). This cumulative impact analysis follows the 11-step process described in the 1997 report by the Council of Environmental Quality entitled "Considering Cumulative Effect Under the National Environmental Policy Act".*

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Water Bottoms	*US, LA, & SA:* Water bottoms develop in response to natural and manmade conditions. *SA:* Construction of Mississippi river levees prevents exchange between the River and the swamp. Direct construction within swamp and along River impacts water bottoms.	*US & LA:* Continued land loss results in increasing acreage of shallow open water and water bottoms. *SA:* Increased flood duration and stage causes degradation of swamp habitat towards freshwater marsh and open water. Soil increases in organic matter content, is saturated for longer durations, and resembles soils of fresh marsh and shallow water bottoms.	*US & LA:* Increased acreage of shallow water bottoms in response to wetland loss. *SA:* Conversion of swamp to freshwater marsh and open water with RSLR would convert swamp soils to shallow water bottoms. The availability of nutrients and detritus from the decomposing swamp vegetation would initially increase, and then decrease.	*US & LA:* Increased acreage of shallow water bottoms in response to wetland loss. *ALT2*: This alternative would have positive synergistic effects on water bottoms when combined with other Federal, state, local, and private restoration efforts. Reestablishing hydrologic connection would aid in restoring swamp habitat and would decrease the acreage of water bottoms within the swamp. Functional existing water bottoms of Blind River and canals would increase in contribution to downstream trophic webs. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Hydrology Resources – Flow and Water Levels	*U.S., LA*: Flows and water levels respond to natural conditions. Increased runoff due to increased urbanization. *SA:* Decreased freshwater flows into and out of swamp and increased estuarine influences due to elimination of Mississippi River flood input with construction of levees. Flow and water levels altered by canal, ditch, and spoil bank construction.	U.S. & LA: Increased flows and water levels with increased runoff due to increasing urbanization and wetland loss. Rate of RSLR increasing over historic conditions. *SA:* Increased impoundment, water levels, and estuarine influence due to RSLR and human modifications, coastal wetland loss, and increased runoff due to increased urbanization of the Pontchartrain Basin.	US & LA: Increased flows and water levels with increased urbanization and associated runoff and increased wetland loss. Rate of RSLR rise increasing over historic conditions. *SA:* Increased impoundment, water levels, and estuarine influence due to RSLR and human modifications, coastal wetland loss, and increased runoff due to increased urbanization of the Pontchartrain Basin.	US & LA: Increased flows and water levels with increased urban runoff from increasing urbanization and increased wetland loss. *ALT2*: This alternative would have positive synergistic effects on water levels and flows when combined with other Federal, state, local, and private restoration efforts. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

335

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Hydrology Resources – ***Sedimentation & Erosion***	*U.S.*: Decreasing sedimentation due to reduction of erosion on land, reservoirs, and bank stabilization. *LA & SA*: Flood Control Act of 1928 ended sediment delivery from Mississippi River by crevasses.	*U.S.*: Decreasing sedimentation due to reduction of erosion on land, reservoirs, and bank stabilization. *LA & SA*: Inflow of suspended sediments by Mississippi River prevented by construction of levees; sediment deficiencies limit wetland accretion and increase RSLR; coastal wetland loss. *SA*: Decreased redistribution of sediments into and out of the swamp due to channelization and spoil banks; swamp deteriorating due to insufficient sediment supply.	*US*: Continued decreasing sedimentation due to reduction of erosion on land, reservoirs, and bank stabilization efforts. *LA*: Sediment supply does not offset coastal land loss. *SA*: Some redistribution of sediments to and from the swamp during storm events. Swamp will continue to deteriorate due to insufficient sediment supply and RSLR.	US & LA: Continued decreasing sedimentation due to reduction of erosion on land, reservoirs, and bank stabilization. *ALT2*: This alternative would have positive synergistic effects on hydrology and sediment accumulation when combined with other Federal, state, local, and private restoration efforts. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Hydrology Resources – Groundwater	*US, LA & SA:* Potential net decrease in groundwater resources due to increasing demand by growing population and saltwater intrusion. *SA:* Groundwater supply is primarily from Chicot Equivalent Aquifer System.	*US, LA, & SA:* Potential net decrease in groundwater resources due to increasing demand by growing population and saltwater intrusion. *SA:* Groundwater is primarily from the Chicot Equivalent Aquifer System.	*US, LA, &SA:* Potential net decrease in groundwater resources due to increasing demand by growing population and saltwater intrusion. *SA:* Groundwater is primarily from the Chicot Equivalent Aquifer System.	US & LA: Potential net decrease in groundwater resources due to increasing demand by increasing populations. *ALT2*: This alternative would result in minor variations in groundwater seepage due to head gradients created by the diversion and improved drainage of Maurepas Swamp. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.
Water Quality	*U.S., LA, SA:* CWA (1977), NEPA (1969), CZMA and Estuary Protection Act provide institutional recognition to restore and protect water bodies, especially with respect to point sources. Non-point sources still unregulated. *SA:* Development of lands adjacent to the study area and within its contributing area. Canal construction increases drainage into study area.	*U.S. & LA:* Continued institutional recognition. Increasing human populations and industrialization result in increased potential for water quality problems. *SA:* Wastewater and polluted runoff from urban areas enters the *SA* through drainage and tidal action. Both suspended particles and nutrients exceed the applicable criteria. Continued loss of emergent wetlands impacts the marshes ability to absorb and reduce air and water pollutants.	*US, LA, & SA:* Continued institutional recognition. Increasing human populations and industrialization result in increased potential for water quality problems. *SA:* Increasing human populations and industrialization result in increased potential for water quality problems. Increased potential for accidental discharges due to exposure of infrastructure from wetland losses.	*US & LA:* Continued institutional recognition. Increasing human populations and industrialization result in increased potential for water quality problems *ALT2*: This alternative would have positive synergistic effects on water quality when combined with other Federal, state, local, and private restoration efforts in the Blind River and Maurepas Swamp. There would be temporary negative impacts (e.g., increased turbidity, decreased dissolved oxygen) during construction. Minimal cumulative impacts on Lower Mississippi River water quality would result. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Water Quality-Salinity	*US, LA, SA:* Increase in salinity levels inland due to saltwater intrusion from sea level rise, human alterations, and wetland losses. *SA:* Reduced freshwater input and flows due to human-modifications allow higher salinity levels in study area surface waters and soil, reducing forest health.	*US , LA, & SA:* Increases in salinity levels inland due to saltwater intrusion from sea level rise, human alterations, and wetland losses. *SA*: Reduced freshwater input and impoundment due to human-modifications allow higher salinity levels in study area surface waters and soil, reducing forest health.	*US, LA, & SA:* Increases in salinity levels inland due to saltwater intrusion from sea level rise, human alterations, and wetland losses. *SA:* RSLR and reduced freshwater input and impoundment due to human-modifications allow higher salinity levels in study area surface waters and soil, reducing forest health.	*US & LA:* Increase in salinity levels inland due to salt water intrusion from wetland loss and reductions in freshwater inflow. *ALT2*: This alternative would have synergistic effects on salinity when combined with other Federal, state, local, and private restoration efforts decreasing concentrations in the Blind River, Maurepas Swamp, and Lake Maurepas. This alternative is unlikely to affect salinity in the Lower Mississippi River. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Noise	*U.S., LA & SA:* Institutional recognition via Noise Control Act of 1972. *SA:* Development along ridges and water bodies accompanied by rail, automobile, and boat traffic.	*U.S. & LA:* Continued institutional recognition; continued human population growth and development causes some noise pollution. *SA:* Ambient noise from automobile, train, and motorboat traffic and other human activities may cause some minimal and temporary disturbances in the study area.	*US, LA, and SA:* Continued institutional recognition; continued human population growth and development would generate more noise exposure. *SA:* Localized noise exposure from automobile, train, and motorboat traffic produce temporary and infrequent disturbances in the study area.	U.S. & LA: Continued institutional recognition; continued human population growth and development would cause some noise pollution. *ALT* 2: This alternative would cause localized and temporary increases in noise during construction activities. Long term benefits include wetland building processes and maintenance and growth of the forest canopy which would act as a buffer to noise in the study area. *ALT* 4A: Cumulative impacts would be similar to *ALT* 2. *ALT* 6: Cumulative impacts would be similar to *ALT* 2. *ALT* 4B: Cumulative impacts would be similar to *ALT* 2.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Air Quality	*U.S., LA & SA:* Institutional recognition via Clean Air Act of 1963. *LA & SA:* Institutional recognition via Louisiana Environmental Quality Act of 1983. Formation of USEPA and LDEQ. *SA:* Development along ridges and water bodies.	*U.S., LA, & SA:* Continued institutional recognition; deterioration of air quality in the region due to increases in human populations and industry, coupled with loss of wetlands and air filtration services they provide. *SA:* Development of surrounding areas. In non-attainment area for ozone.	*US, LA, & SA:* Continued institutional recognition; air quality would likely decline due to continued population growth and increased industrialization. Loss of LA coastal resources would reduce air filtration services provided by this resource.	*U.S. & LA:* Continued institutional recognition; however, air quality would likely decline due to continued population growth and increased industrialization. *ALT 2*: This alternative would have positive synergistic effects on air quality when combined with other Federal, state, local, and private restoration efforts. This alternative would restore wetland building processes which may filter air and improve air quality. *ALT 4A*: Cumulative impacts would be similar to ALT 2. *ALT 6*: Cumulative impacts would be similar to ALT 2. *ALT 4B*: Cumulative impacts would be similar to ALT 2.

340

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Vegetation Resources	*US, LA, and SA*: Natural processes form coastal vegetation resources. Invasive plant species, intentionally and unintentionally released and displace native vegetation in some habitats *LA and SA:* Extensive overharvest of old growth forests primarily from 1890-1925. *SA*: Regeneration of primarily baldcypress-tupelo forests. Although there were no significant shifts in habitat type since 1956, the swamps have become increasingly stressed.	*U.S., LA, & SA:* Deterioration and loss of wetlands nationwide and statewide. Spread of invasive plant species. *SA:* Present vegetation resources include approximately 20,188 acres of baldcypress-tupelo swamp, 1,823 acres of bottomland hardwood forest, 253 acres of bottomland scrub-shrub, 146 acres fresh marsh, and 27 acres of aquatic floating bed. Although there have been no significant shifts in habitat type, the swamps have become increasingly stressed.	*U.S. & LA:* Continued deterioration and loss of vegetated wetland habitat acreage due to natural and human-induced processes. *SA:* Continued degradation and loss of existing wetland vegetative habitats, in concert with insufficient freshwater, nutrient, and sediment inflows to sustain the interdependent processes of plant production and vertical maintenance necessary for persistence of a stable ecosystem. Small Diversion at Hope Canal would reduce the risk of saltwater intrusion but fail to ameliorate problems related to increased flood duration, stage, and impoundment.	*US & LA:* Continued deterioration and loss of vegetated wetland habitat and further introduction and spread of invasive plant species. Wetland protection, creation, and restoration, as well as invasive species control, reduce these trends somewhat. *ALT2*: This alternative would prevent a shift to fresh marsh and open water thus having positive synergistic effects on coastal vegetation resources when combined with other Federal, state, local, and private restoration efforts. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

341

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Wildlife Resources	*U.S., LA & SA*: Wetland dependent wildlife populations respond primarily to natural population-regulating mechanisms.	*U.S., LA, and SA:* Continued nationwide degradation and loss of wetlands leads to decline of wetland-dependent wildlife populations. *SA:* Continued wetland degradation and loss leads to increased competition between local wetland-dependent wildlife populations for decreasing resources; displacement to other more suitable wetland areas; and localized decline in wetland-dependent wildlife populations.	*U.S., LA:* Nationwide degradation and loss of wetlands continues to adversely impact wetland-dependent wildlife populations. *SA:* An expected 9,836 acres of wetlands lost from the *SA* at a rate of 1,167 acres per year over the next 50 years leads to increased competition between local wetland-dependent wildlife populations for decreasing resources; displacement to other more suitable wetland areas; and localized decline in wetland-dependent wildlife populations.	US & LA: Nationwide degradation and loss of wetlands continues to adversely impact wetland-dependent wildlife populations. *ALT2*: Creation, restoration, and protection of wetlands leads to increased habitat for wetland-dependent wildlife; decreased competition for resources; localized stabilization or improvement in wetland-dependent wildlife populations. *ALT4*: Cumulative impacts would be similar to *ALT2* with potentially more adverse construction impacts initially due to the South Bridge diversion. *ALT6*: Cumulative impacts would be similar to *ALT4*. *ALT4B*: Cumulative impacts would be similar to *ALT4*.

342

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Fisheries	*U.S. & LA:* Reduction in fisheries habitat while catches increased, placing greater pressure on fishery resources. Formation of the National Marine Fisheries Service. *SA:* Levee construction and channelization reduced freshwater input; as a result, increased impoundment and limited circulation degraded habitat suitability for fish species.	*U.S. & LA:* Regulated catch; habitat loss decreased somewhat by coastal restoration efforts; yet continued net habitat loss. *SA:* Degraded habitat conditions lead to low species evenness and frequent fish kills.	*U.S., LA & SA*: Continued loss of fishery resources unless intensified efforts to protect them locally, statewide, and nationally. Small Diversion at Hope Canal would enhance fishery resources in the lower reaches of the Blind River.	*US & LA:* Continued loss of fishery resources unless intensified efforts to protect them locally, statewide, and nationally. *ALT2*: This alternative would have positive synergistic effects on fishery resources when combined with other Federal, state, local, and private restoration efforts increasing fish populations in the Blind River and Maurepas Swamp. Additionally, decreases in salinity in Lake Maurepas from other diversion projects could increase fresh water fish species in the area which may increase populations in the Blind River and Maurepas Swamp *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

343

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Aquatic Resources-Plankton	*US & LA:* Populations respond to natural conditions. *SA:* Construction of Mississippi River levees prevented the exchange of organisms and water between the MS River and swamp.	*US:* Populations respond to natural and human-induced perturbations. *LA:* Populations in LA are shifting towards more saline-oriented species as land loss and saltwater intrusion into interior regions continues. *SA:* Plankton population changes associated with conversion of swamp habitat to freshwater marsh and open water.	*US:* Populations continue to respond to natural and human-induced perturbations. *LA:* Populations in LA are shifting towards more saline-oriented species as land loss and saltwater intrusion into interior regions continues. *SA:* Conversion of swamp to fresh marsh and open water may shift populations.	*US & LA:* Continued nationwide loss of vegetated wetlands continues to adversely impact plankton populations. *ALT2*: This alternative would have positive synergistic effects on plankton resources when combined with other Federal, state, local, and private restoration efforts. Wetland creation and nourishment would result in greater resources for plankton organisms due to the export of dissolved organic compounds. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Aquatic Resources - Benthic Resources	*US, LA, & SA:* Benthic populations respond to natural and manmade conditions. *SA:* Construction of Mississippi River levees prevent exchange of benthic organisms and water between the River and the swamp.	*US & LA:* Benthic populations respond to natural and human-induced perturbations with shift towards more saline-oriented species as land loss and saltwater intrusion into interior regions continues *SA:* Benthic population changes associated with conversion of swamp habitat to freshwater marsh and open water. The amount of habitat available for use by benthic species assemblages that typically utilize swamp or marsh edge habitats is reduced due to degraded conditions. Limited availability of nutrients and detritus from the decomposing swamp vegetation due to low productivity.	*US & LA:* Benthic populations respond to natural and human-induced perturbations with shift towards more saline-tolerant species as land loss and saltwater intrusion into interior region continues. *SA:* Conversion of swamp to freshwater marsh and open water may shift benthic populations. The amount of habitat available for use by benthic species assemblages that typically utilize swamp or marsh edge habitats would decrease. The availability of nutrients and detritus from the decomposing swamp vegetation would initially increase, and then decrease.	*US & LA:* Benthic populations respond to natural and human-induced perturbations with shifts towards more saline-oriented species as land loss and saltwater intrusion into interior regions continues. *ALT2*: This alternative would have positive synergistic effects on benthic resources when combined with other Federal, state, local, and private restoration efforts. Wetland restoration and nourishment would result in greater resources for benthic organisms due to the export of dissolved organic compounds and detritus from wetlands. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

345

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Essential Fish Habitat (EFH)	*U.S., LA & SA*: General decrease in quality of EFH beginning in the mid 1900s. Institutional recognition of decline in EFH quality; passage of Magnuson-Stevens Fishery Conservation and Management Act.	*U.S. & LA*: Continued institutional recognition; continued wetland loss and decline in quality of EFH. *SA*: There is no EFH in the SA. CWPPRA shoreline protection projects such as PO-30 and other restoration projects protect some existing EFH. Continued wetland loss converts high-quality EFH to lower quality categories (e.g., emergent wetlands to open water bottoms).	*U.S. & LA*: Continued institutional recognition; continued wetland loss and decline in quality of EFH. *SA*: There is no EFH in the SA. CWWPRA shoreline protection projects such as PO-30 and other restoration projects protect some existing EFH. Continued wetland loss converts high quality EFH to lower quality categories (e.g., emergent wetlands to open water bottoms).	*US & LA:* Continued loss of EFH. *ALT2*: There is not EFH in the SA. The diversion may result in a shift or decrease in EFH in Lake Maurepas. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

346

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Threatened and Endangered Species	*US, LA, SA*: Institutional recognition of decline in listed species via the Endangered Species Act. Decrease in some animal and plant populations and their critical habitat including loss of wetlands.	*U.S LA.*: Continued institutional recognition of decline in listed species; continued wetland loss. *SA*: Continued loss of wetlands that are used by many listed species.	*U.S.*: Continued institutional recognition of decline in listed species; continued loss of wetlands. *LA & SA*: Continued coastal land loss and deterioration of critical coastal habitats is anticipated to impact all associated listed species.	US & LA: Continued institutional recognition of decline in listed species; continued loss of wetlands and critical coastal habitats. *ALT2*: USFWS guidelines will be followed and there will be no impacts to the Gulf sturgeon, manatee, or bald eagle. There may be impacts to pallid sturgeon. *ALT*4: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT*4B: Cumulative impacts would be similar to *ALT2*.
Cultural & Historic Resources	*U.S., LA & SA:* Institutional recognition via National Historic Preservation Act (and others). Historic and cultural resources subjected to natural processes and man-made actions.	*U.S., LA & SA:* Continued institutional recognition. Human activities as well as natural processes can potentially degrade or destroy historic and natural resources. *SA:* Increased water levels, human activities, and impoundment potentially degrade or destroy these resources.	*US, LA, & SA:* Continued institutional recognition. Potential loss of resources due to natural and human causes. *SA:* Increased impoundment, water levels, and swamp degradation threaten the preservation of these resources.	U.S. & LA: Potential loss of resources due to natural and human causes. *ALT 2*: This alternative would provide additional restorative and regenerative ecological potential for the Blind River and Maurepas Swamp, which would continue to provide protection to the cultural resources in the project area. *ALT4A*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Aesthetics	*U.S., LA & SA:* Technical recognition via 1988 USACE Visual Resources Assessment Procedure. Institutional recognition via Wild and Scenic Rivers Act, Scenic Byways and others. *LA & SA:* Visual aesthetics shaped by human activities (e.g., development, flood control and forestry) and natural alterations (e.g., hurricanes) to the landscape.	*U.S., LA & SA:* Continued institutional recognition. Visual resources have been destroyed, enhanced, or preserved by human activities and natural processes. *LA & SA:* Continued wetland loss may have an adverse effect on the visual complexity of the swamp.	*US, LA, & SA*: Continued institutional recognition. US & LA: Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve visual resources. *SA:* Increasing rates of swamp degradation and periods of impoundment could diminish the value of the viewscape.	US & LA: Continued institutional recognition. Preservation of existing swamp aesthetics in some areas, improvement of swamp aesthetics in some of the degraded areas, and potentially continued degradation of the swamp in any areas not benefitted by the project. *ALT2*: This alternative would have positive synergistic effects on aesthetics when combined with other Federal, state, local, and private restoration efforts. There would be minimal visual impact in the areas of the diversion culverts and canal. This alternative would provide additional restorative and regenerative ecological potential for the Blind River and the Maurepas Swamp, which would continue to provide benefits to aesthetics in the study area. *ALT4A*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Recreation Resources	*U.S. & LA, SA:* Public lands institutionally recognized by Federal Water Project Recreation Act, Land and Water Conservation Act, and National Wildlife Refuge System Acts. *SA:* Recreation activities in study area based on ecosystem services. A portion of the Maurepas Swamp WMA is located within the SA.	U.S. & LA: Continued institutional recognition. increased recreational activities impact national and state wetlands. *SA:* Recreation activities in study area based on ecosystem services. Ecosystem degradation impedes ability to provide some services at historical levels.	*US, LA, & SA:* Continued institutional recognition. Potential inability to provide ecosystem services to support recreation due to degradation and loss of freshwater swamp.	*U.S. & LA:* Loss of recreational resources due to continued wetland and coastal degradation. *ALT2*: This alternative would have positive synergistic effects on recreation resources when combined with other Federal, state, local, and private restoration efforts, including the Hope Canal and Amite River diversions. The proposed action would preserve and enhance natural habitats, and thereby enable the continuation and even expansion of existing recreational activities within the SA and region as a whole. *ALT4A*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.
Socioeconomic and Human Resources ***Displacement of Population and Housing***	*U.S.:* Population increasing in some areas and decreasing in others. *LA:* Hurricanes Katrina and Rita adversely affected populations throughout state. *SA:* Development along ridges and water bodies. Populations within Ascension and St. John the Baptist increasing and St. James relatively stable.	*U.S.:* Increasing population with over 300 million people. *LA:* Slight decrease (3.9%) in population from 2000-2007. *SA:* Study area remote and uninhabited. Adjacent populations are increasing in St. John the Baptist and Ascension Parishes, with rapid growth in the latter.	*U.S. & LA:* Increasing populations worldwide. *SA:* Study area should remain uninhabited. Populations are projected to rise in Ascension Parish and decline in St. James Parish. Nearby populations would be adversely impacted by continued habitat degradation and conversion to fresh marsh and open water.	*U.S. & LA*: Continued wetland and coastal degradation could lead to population shifts. Population growth expected. *ALT2*: There would be no cumulative impacts to populations from this alternative. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Employment, Business, and Industrial Activity	*U.S. & LA:* Increased habitation, employment and tourism. *LA:* Slight increase in employment in Louisiana. Hurricanes Katrina and Rita have an adverse effect on employment and personal income. Rebuilding efforts provide some new job opportunities. *SA:* Area remote and uninhabited. Employment and income provided through timber, railroad, oil and gas, and other infrastructure related industries.	*U.S. & LA:* Increasing population growth and employment and personal income opportunities. Economic activity related to wetland resources negatively affected by loss of these resources. *SA:* Development along ridges and water bodies. Employment and income resources are primarily in manufacturing and education services, and health care and social assistance.	*U.S. & LA:* Increasing population growth and employment and income opportunities. Economic activity related to wetland resources would be adversely affected by the degradation and loss of these resources. *SA:* Development along ridges and water bodies. Total employment and income in St. James Parish expected to increase.	*U.S. & LA:* Continued wetland degradation would adversely impact the economic activities tied to the fish and wildlife found within the natural wetland habitats. *ALT2*: This alternative would have positive synergistic effects on employment, business, and industrial activity when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area and to protect and enhance fish and wildlife habitats. Economic activities dependent upon such habitats, and the fish and wildlife it supports, would be maintained and possibly increased, leading to a rise in fishery and wildlife-related employment and income. *ALT4A*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

350

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources-- ***Public Facilities and Services***	*US & LA:* Increasing population growth increases demand on public facilities and services. *SA:* Public facilities and services generally serve residents and recreational visitors.	*US & LA:* Increasing population growth increases demand on public facilities and services. *SA:* Public facilities and services generally serve residents and recreational visitors.	*US & LA:* Increasing population growth increases demand on public facilities and services. *SA:* Public facilities and services generally serve residents and recreational visitors. However, as the wetland habitat continues to degrade, the lure for recreational visitors, as well as residents, will decrease, lowering demand on public facilities and services.	*US & LA:* Continued population growth increases demand on public facilities and services. *ALT2*: This alternative would have synergistic effects on public facilities and services, when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. The lure for recreational visitors and renters would be maintained, thereby sustaining the demand on public facilities and services within the SA. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

351

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources– Transportation	*US & LA:* Increasing population growth increases demand on the transportation network. *SA:* Hwy 61/I-10 runs through the project area, as does the Kansas City Southern Railway and the Blind River. Travel within the study area has generally been done by boat or by foot.	*US & LA:* Increasing population growth increases demand on the transportation network. *SA:* Hwy 61 / I-10 runs through the project area, as does the Kansas City Southern Railway and the Blind River. Travel within the study area is generally done by boat or by foot.	*US & LA:* Continued population growth increases demand on the transportation network. *SA:* Wetland land loss would potentially lead to a population shift, which would increase demand on the transportation network that runs through the SA. In addition, the continued habitat degradation would hamper pedestrian or water travel within the SA.	*US & LA:* Continued population growth increases demand on the transportation network. *ALT2*: This alternative would have synergistic effects on transportation , when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area, facilitating foot and boat travel within the study area. In addition, the proposed action would serve to protect and enhance essential natural habitats and coastal lands. Thus, the potential population shift as a result of land loss could be lessened, leading to a proportionately lesser degree of demand on the existing transportation network. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

352

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources– ***Disruption of Desirable Community and Regional Growth (including Community Cohesion)***	*US:* Increasing population leads to greater community and regional growth. Community cohesion is affected by community and infrastructure development. *LA:* Increasing population increases community and regional growth. Hurricanes Katrina and Rita adversely affected community cohesion in southern portions of the state. Community cohesion is affected by infrastructure development. *SA:* The SA is sparsely populated.	*US:* Increasing population leads to greater community and regional growth. Community cohesion is affected by community and infrastructure development. *LA:* Hurricanes Katrina and Rita adversely affected community and regional growth in southern portions of the state. Infrastructure development has affected community cohesion. *SA:* The SA is sparsely populated.	*US & LA:* Increasing population leads to greater community and regional growth. Community cohesion will continue to be affected by infrastructure and community development. *SA:* The SA will continue to be sparsely populated with several rental and seasonal properties. However, as the wetland habitat continues to degrade, the lure for seasonal visitors and renters will decrease, adversely impacting community development.	*US & LA:* Increasing populations nation- and statewide will in turn increase opportunity for infrastructure and community development. *ALT2*: This alternative would have synergistic effects on community and regional growth, when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. The lure for seasonal visitors and renters would be maintained. In addition, the proposed action would serve to protect and enhance essential natural habitats and coastal lands. Thus, the potential population shift as a result of land loss could be lessened, leading to a proportionately lesser degree of community and regional growth. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources– ***Tax Revenue and Property Values***	*US & LA & SA:* Increasing population growth increases tax revenue and property values.	*US & LA & SA:* Increasing population growth increases tax revenue and property values.	*US & LA:* Increasing population growth increases tax revenue and property values. *SA:* The property value of the private lands within the SA could decline due to the allowance of the continued degradation of the wetland habitat.	*US & LA:* Continued population growth increases tax revenue and property values. *ALT2*: This alternative would have synergistic effects on tax revenues and property values, when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area, which would maintain or potentially increase the property values of the private lands within the SA. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

354

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – ***Infrastructure***	*U.S. & LA:* Increasing population growth and supporting infrastructure in the form of roads, bridges, pipelines, homes and businesses, and decreases in coastal and other wetlands. *SA:* Federal and state roads, active and relict railroad grades, overhead distribution lines, and underground pipelines and telecommunications lines traverse the study area.	*U.S.:* Increasing population growth and supporting infrastructure contributes to degradation and loss of coastal and other wetlands, which contribute to increased maintenance costs of infrastructure. However, loss of wetlands due to infrastructure should be mitigated. *LA:* Extensive damages to infrastructure due to Hurricanes Katrina and Rita which is still being repaired. *SA:* Federal and state roads, active and relict railroad grades, overhead distribution lines, and underground pipelines and telephone lines traverse the study area.	*U.S. & LA:* Continued population growth and supporting infrastructure contributes to degradation and loss of coastal and other wetlands. Wetland degradation and loss contribute to increased maintenance costs of infrastructure. *SA:* Wetland loss potentially threatens infrastructure passing through area and results in increased maintenance.	*U.S. & LA*: Continued population growth and supporting infrastructure contributes to degradation and loss of coastal and other wetlands. Degradation and loss of wetlands contribute to expansion of infrastructure as well as increased maintenance costs. *ALT2*: This alternative would have positive synergistic effects on infrastructure when combined with other Federal, state and local restoration efforts. This proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats and coastal lands. Thus, the potential population shift as a result of land loss could be lessened, leading to a proportionally lesser demand on the area's infrastructure as well as lessening the maintenance costs due to substrate deterioration. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – ***Environmental Justice***	*US:* Institutional recognition via Executive Order 12898. *LA:* Hurricanes Katrina and Rita adversely affected Environmental Justice resources in the state. *SA:* Population in the vicinity is 30.8% minority and 15.8% below poverty level.	*US & LA:* Continued institutional recognition; increasing Environmental Justice resources as a result of increase in population and decrease in economic output from 2000-2009. *SA:* Environmental Justice resources in the vicinity of the swamp appear stable.	*US & LA:* Continued institutional recognition; potential increase in Environmental Justice resources as a result of continued economic recession. *SA:* There may be further construction and an increase in the population near the study area. Environmental Justice resources may increase; these resources would be adversely impacted by continued habitat degradation and conversion.	*U.S. & LA*: Continued wetland degradation would adversely impact the economic activities tied to the fish and wildlife found within the natural wetland habitats, which in turn could lower the income levels of local residents. *ALT2*: This alternative would have positive synergistic effects on employment and income, and thereby environmental justice populations, when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. The proposed action would serve to protect and enhance fish and wildlife habitats. Economic activities dependent upon such habitats, and the fish and wildlife it supports, would be maintained and possibly increased, leading to a rise in fishery and wildlife-related employment and income levels. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

356

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Navigation	*U.S., LA & SA*: Navigation interests have historically been a critical factor to national, state, and local interests. Growth of port facilities and inland waterways and traffic. *LA & SA:* Hurricanes Katrina and Rita impact navigation infrastructure and investments. Public and private reinvestment to rebuild navigation, port facilities, and inland waterways. *SA:* One federal navigation channel, the Blind River, exists within the study area.	*U.S., LA & SA*: Continued investment in port facilities and inland waterways. Navigation continues to be an important part of the national transportation and commerce activities. *SA:* Blind River is primarily used for recreational navigation.	*US, L.A. & SA:* Continued investment in port facilities and inland waterways. Navigation continues to be an important part of the national transportation and commerce activities. *SA:* Blind River will likely continue to primarily be used for recreational navigation.	U.S. & LA: Continued investment in port facilities and inland waterways. Navigation continues to be important part of the national transportation and commerce activities. *ALT2*: This alternative would have positive synergistic effects on navigation when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. The proposed action would serve to protect and enhance wetland in the study area which would in turn protect the Blind River and navigation channels. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Land Use ***Agriculture***	*US & LA:* Agriculture is important to the economy of the US and coastal Louisiana. *LA:* Important crops include sugar cane, rice, and soybeans. *SA:* The study area includes agricultural areas along the diversion routes.	US & LA: Agriculture continues to be important to the economy of the US and coastal Louisiana. *LA:* Important crops include sugar cane, rice, and soybeans. *SA:* The study area includes agricultural areas along the diversion routes.	*US & LA:* Agriculture will continue to be important to the economy of the US and Coastal Louisiana. *SA:* The study area includes agricultural areas along the diversion routes.	*U.S. & LA*: Continued importance of agriculture to the economy of the US and coastal Louisiana. Agricultural lands may be adversely impacted by habitat conversion and land loss. *ALT2*: This alternative would result in small loss of land currently in agricultural production. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2* with the following exceptions. There would be a slightly larger loss of a small amount of land currently in agricultural production associated with the two diversion routes. *ALT4B*: Cumulative impacts would be similar to *ALT2*.
Socioeconomic and Human Resources – Land Use ***Forestry***	*US & LA:* Timber production is important to the economy of the US and Louisiana. *LA:* Timber has historically been important to the economy of Ascension and St. James Parishes. *SA:* The study area was harvested extensively before 1940.	*US & LA:* Timber production continues to be important to the economy of the US and Louisiana. *LA:* Timber continues to be important to the economy of Ascension and St. James Parishes. *SA:* Increased interest in harvesting within the study area in recent years, but no harvesting is currently occurring.	*US & LA*: Timber production will continue to be important to the economy of the US and Louisiana. *LA:* Timber will continue to be important to the economy of Ascension and St. James Parishes. *SA*: Limited timber harvesting will likely take place in the future in the study area. Continued habitat degradation will negatively affect timber resources.	*U.S. & LA*: Continued importance of timber production to the economy of the US and Louisiana. Timber lands may be adversely impacted by habitat conversion and land loss. *ALT2*: This alternative would have positive synergistic effects on forestry when combined with other Federal, state, local, and private restoration efforts. Proposed action would preserve and enhance forested wetlands within the study area. However, it is unlikely that these forests will be harvested in the future. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

358

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Land Use ***Public Lands***	*US&LA:* Institutional recognition through Forest Reserve Act of 1891, Organic Act of 1897, and others; creation of National Forest Service, National Park Service, U.S. Fish &Wildlife Service, Bureau of Land Management and others. Expansion of the federal public land system. *LA:* Designation since 1959 of nearly 462,000 acres as state Wildlife Management Areas, managed by LDWF. *SA:* LDWF incorporated 17,079 acres of *SA* into Maurepas Swamp WMA in August 2001.	*US&LA:* Continued institutional recognition and expansion of the federal public land system. *LA:* Continued management and growth of state owned public lands. *SA:* Continued management of 17,079 acres of *SA* as Maurepas Swamp WMA.	*US&LA:* Continued institutional recognition and expansion of the federal public land system. *LA:* Continued management and growth of state owned public lands. Potential loss of coastal areas due to RSLR and land loss. *SA:* Conversion of portions of *SA* from swamp land to open water degrades value of area to people and wildlife.	*U.S. & LA*: Loss of public lands due to continued wetland and coastal degradation. *ALT2*: This alternative would have positive synergistic effects on public land when combined with other Federal, state, local, and private restoration efforts. Proposed action would preserve and enhance the public lands within the study area and region as a whole. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

359

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Water Supply & Use	*US & LA:* Public use of surface waters is important to the US and LA. *SA:* No significant public use of surface waters (other than for recreation) has been identified in the study area.	*US & LA:* Public use of surface waters continue to be important to the US and LA. *SA:* There is still little significant public use of surface waters (other than for recreation) in the study area.	*US & LA:* Public use of surface waters will still be important to the US and LA. *SA:* There will still be little significant public use of surface waters (other than for recreation) in the study area.	*U.S. & LA*: Continued increasing demands on surface water use and supply due to increasing human populations, agriculture, and industry uses. *ALT2*: This alternative would have positive synergistic effects water supply and use when combined with other Federal, state and local restoration efforts. Alternative 2 would improve water quality in the study area by assimilating nutrients. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.
Socioeconomic and Human Resources – Man-Made Resources Oil, Gas and Utilities	*U.S., LA & SA:* Development of extensive network of oil and gas pipelines in mid-1900s. *SA:* Western Maurepas swamp experiences significant oil and gas exploration, primarily northwest of the study area.	*U.S., LA & SA:* Increasing operations and maintenance (O&M) costs as well as increasing investment for oil and gas production facilities and pipelines due to increasing vulnerability to widespread coastal wetland loss.	*U.S., LA, & SA:* Increasing O&M costs as well as increasing investment in oil and gas production facilities and pipelines; increasing vulnerability of pipelines and other infrastructure due to widespread coastal wetland loss.	*U.S. & LA*: Continued investment in oil, gas, utilities, and pipelines. *ALT2*: This alternative would have positive synergistic effects on oil, gas, and utilities when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation in the study area. This would protect oil, gas and utilities from future storm surges. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

360

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Man-Made Resources ***Flood Control & Hurricane Protection***	*US & LA:* Flood of 1927 initiated national construction of hurricane and flood control levees, pump stations and control structures. Hurricanes Katrina and Rita caused significant widespread damages to existing hurricane and flood control structures. *SA:* Municipal and parish flood control measures, including drainage canals, are present in the study area.	*U.S. & LA:* Largest national restoration effort of hurricane and flood control in nation's history. *SA:* Municipal and parish flood control measures, including drainage canals, are present in the study area.	*US & LA:* As populations continue to migrate to coastal communities, increasing investment in hurricane and flood control levees, pump stations, and other flood control facilities. *SA*: Continued degradation of wetlands will result in localized storm surge and storm wave increases. Municipal and parish flood control measures, including drainage canals are present in the study area.	*U.S. & LA:* Continued loss of flood control and hurricane protection due to continued coastal and wetland degradation and loss. *ALT2:* This alternative would have positive synergistic effects on flood control and hurricane protection when combined with other Federal, state, local, and private restoration efforts. The proposed action would nourish and enhance swamp that is currently converting to open water and will leave adjacent areas less vulnerable to storm surges. *ALT4:* Cumulative impacts would be similar to *ALT2*. *ALT6:* Cumulative impacts would be similar to *ALT2*. *ALT4B:* Cumulative impacts would be similar to *ALT2*.

361

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Natural Resources ***Commercial Fisheries***	*U.S., LA & SA:* Institutional recognition, formation of NMFS and LDWF; Magnusson-Stevens Fishery Conservation amendments. Reduction in fisheries habitat, increased commercial catches, catch regulations. *LA:* Commercially important species, including brown and white shrimp, blue crabs, eastern oysters, and menhaden abundant. *SA:* Study area may provide some habitat for striped mullet, menhaden and blue crab but no commercial fishery present.	U.S., LA & *SA*: Continued institutional recognition and regulation of commercial fisheries maintains a billion dollar industry. About 90% of the world's seafood resources have been depleted in the past century; 38% of the depleted species have declined by more than 90 percent; 7% of the species of fish studied by researchers have become extinct (Worm et al. 2006). *SA*: Study area provides habitat for striped mullet, blue crab, and menhaden but no commercial fishery present.	*U.S.:* Continued institutional recognition; commercial fisheries decline expected as overfishing and habitat degradation and loss continues unless concerted efforts to protect, restore and regulate a sustainable industry. *LA & SA:* Loss of commercial fishery habitat due to loss of wetland habitats and salinity changes.	U.S. & LA: Institutional recognition continues; commercial fisheries decline expected as overfishing and habitat degradation and loss continues unless concerted efforts to protect, restore, and regulate a sustainable industry. *ALT 2*: This alternative would have positive synergistic effects on commercial fisheries when combined with other Federal, state and local restoration efforts. Alternative 2 would serve to slow or reverse the trend of swamp degradation in the study area and increase productivity. This would increase fisheries populations in the area and consequently increase commercial fisheries. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6:* Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.

Table 5-1: Comparison of Cumulative Impacts*.

Significant Resource	Past Actions (Historic Conditions)	Present Actions (Existing Conditions)	The No-Action Alternative (Future Without Project)	Cumulative Impacts (Comparison of Future With Proposed Action Impacts)
Socioeconomic and Human Resources – Natural Resources ***Oyster Leases***	*US, LA:* General increase in acreage leased, production limited by saltwater intrusion in areas with no freshwater introduction. *SA:* No oyster leases are in the study area.	*US, LA & SA*: Production has been stable for the last 50 years. Long-term sustainability threatened by reductions of marsh habitat. *SA:* No oyster leases are in the study area.	*US:* Only major leasing program is in LA. *LA:* Production from leases would likely decline due to loss of habitat. *SA:* No oyster leases are in the study area.	*US:* Only major oyster leasing program is in LA. *LA:* Production from leases would likely decline due to loss of habitat. *ALT2*: This alternative would have no cumulative impacts on oyster leases. *ALT4*: Cumulative impacts would be similar to *ALT2*. *ALT6*: Cumulative impacts would be similar to *ALT2*. *ALT4B*: Cumulative impacts would be similar to *ALT2*.
Hazardous, Toxic, and Radioactive Wastes	*US, LA, & SA:* Institutional recognition under ER 1165-2-132. Establishment of the USEPA and LDEQ agencies. *SA:* Few potential HTRW sites are located near or within the study area.	*US, LA, & SA:* Continued institutional recognition. Increasing human populations and industrialization result in increased potential for HTRW problems. *SA:* Few potential HTRW sites are located near or within the study area.	*US, LA, & SA:* Continued institutional recognition. Increasing human populations and industrialization result in increased potential for HTRW problems.	*US & LA:* Continued potential for HTRW issues. *ALT2:* The potential for cumulative impacts is low under this alternative *ALT4:* Cumulative impacts would be similar to *ALT2* except for potential underground storage tank issues along the South Bridge diversion. *ALT6:* Cumulative impacts would be similar to *ALT4*. *ALT4B:* Cumulative impacts would be similar to *ALT4*.

363

5.1 Soils and Water bottoms

5.1.1 No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on soil resources. Existing conditions would persist, including no net vertical accretion of soil deposition and continued subsidence over the 50-year period of analysis.

Indirect

The indirect impacts of the No Action Alternative would be the advanced degradation of soils within the distribution area. Soils within the distribution area would remain nutrient poor and exhibit atypically low bulk densities for forested wetlands due to insufficient sediment content. With increased duration of flooding and impoundment, net primary productivity within the Study Area would continue to decline, and existing wetland vegetation would continue to diminish. Declines in primary productivity would reduce organic matter accretion rates and thus exacerbate subsidence. Increased physiological stress would make plants more susceptible to further damage by biotic (e.g., herbivory and infection) and abiotic (e.g., wind damage) factors. Eventual mortality of woody and herbaceous vegetation and the accompanying decomposition of belowground biomass would further elevate subsidence rates and result in a change in habitat from vegetated wetlands to open water.

Cumulative

Cumulative impacts of the projected loss of soil resources from the Study Area would be in addition to the loss of soil resources throughout Louisiana. The LCA Study (LCA 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,671 ha/year) over the next 50 years. It is estimated that an additional net loss of 328,000 acres (132,737 ha) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands. However, these wetland soil losses in the Louisiana Study Area would be offset to some extent by other Federal, state, local, and private restoration efforts as described in the 2004 LCA Report.

In addition, more recent restoration efforts would also cumulatively interact to help offset losses of soil resources in the Study Area including the following:

- LCA Small Diversion at Hope Canal (1,000 – 5,000 cfs)
- LCA Amite River Diversion Canal Modification Project (Volume II)

Although these projects will help offset losses of soil resources in the Upper Pontchartrain Sub-basin, the resulting benefits to soil resources will be localized and will not affect processes within the Study Area.

5.1.2 Alternative 2

Direct

Direct impacts of Alternative 2 include increased delivery of sediments to the swamp that will enhance accretion (swamp building) and benefit soils within the study area. There would be 106.9 acres of permanent impact to prime and unique farmland based on NRCS data. These areas would be loss due to the construction of the Romeville Transmission Pathway.

Indirect

Indirect impacts of Alternative 2 include increases in overall accretion rates that would prevent the conversion of swamp to fresh marsh and open water and thus prevent an increase in acreage of water bottoms. Nutrient content and bulk density of the soils within the distribution areas would increase. Increased primary productivity within the study area would increase organic matter accretion rates and thus decrease subsidence. Day et. Al. (2006) estimated a net gain in elevation between 15 and 30 cm over the next 50 years for Maurepas Swamp based on diversions associated with the LCA Small Diversion at Hope Canal. Based on vertical accretion data from a swamp system that received sewage effluent in another basin in Louisiana, if river water is diverted into the area south of Lake Maurepas, accretion will likely increase to levels greater than the rate of relative water level rise so that the area will become progressively less flooded (Day et al. 2006) Under Alternative 2, soils and waterbottoms in the distribution area would benefit from the restoration of 21,369 acres of swamp.

Cumulative

Cumulative impacts would be the synergistic effects of implementing the No Action Alternative combined with the beneficial impacts of other Federal, state, local and private restoration efforts as detailed in Section 5.1.2. including CWPPRA 33,690 acres (13,634 ha); Parish Coastal Wetlands Restoration Project 14 acres (6 ha) state 2,543 acres (1,029 ha); Mitigation Civil Works 4,990 acres (2,019 ha); Mitigation Regulatory Permits 6,411 acres (2,594 ha); Vegetation 535 acres (217 ha); Section 204/1135, Beneficial Use 226 acres (92 ha); WRDA 16,000 acres (6,475 ha), for a total of 64,409 acres (26,065 ha) (Table 5-2).

Alternative 2 would work synergistically with other projects within the general area to benefit soil resources and restore and protect the Maurepas Swamp to a greater extent than would be expected from the individual efforts.

5.1.3 Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be 121.7 acres of impacts to prime and unique farmland due to the construction of the Sunshine Bridge Transmission Pathway.

Indirect
The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exception. Under Alternative 4 soils and waterbottoms in the distribution area would benefit from the restoration of 21,206 acres of swamp.

Cumulative
The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.1.4 Alternative 6

Direct
The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions there would be a total of 228.6 acres of impacts to prime and unique farmland due to the construction of dual transmission pathways.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions Under Alternative 6 soils and water bottoms in the distribution area would benefit from the restoration of 21,243 acres of swamp.

Cumulative
The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.1.5 Alternative 4B

Direct
The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect
The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions Under Alternative 4B, soils and waterbottoms in the distribution area would benefit from the restoration of 21,243 acres of swamp.

Cumulative
The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Table 5-2: Net Acres Created, Restored, and/or Protected by Other Federal, State, Local, and Private Restoration Efforts (USACE, 2004).

	Subprovince 1 (acres)	Subprovince 2 (acres)	Subprovince 3 (acres)	Subprovince 4 (acres)	Totals (acres)
Breaux Act CWPPRA[1]	33,690	44,913	25,057	30,486	134,146
State	2,543	9,043	5,200	1,972	18,758
PCWRP[2]	14	41	371	31	457
Mitigation Civil Works Projects[3]	4,990	0	5,000	0	9,990
Mitigation Regulatory Permits[1]	6,411	3,199	2,635	2,983	15,228
Vegetation[4]	535	878	1,785	1,931	5,129
Section 204/1135, Beneficial Use	226	414	1,293	3,525	5,458
WRDA[5]	16,000	33,000	0	0	49,000
Other[6]	0	2,000	50,000	3,226	55,226
TOTALS	64,409	93,488	91,341	44,154	293,392

Source: The state, parish, FEMA, vegetation, WRDA, Sections 1135/204, and beneficial use are from Belhadjali, Robertson, and Balkum (2002), Coastal Restoration Division Annual Project Reviews: December 2002. CWPPRA (Breaux Act) acres are from the District's November 2003 Task Force book and have been furnished by USFWS. Permit mitigation is from the District's Regulatory Branch database. Civil works mitigation is from the District's files. Other is 50,000 acres (20,234 ha) of non-mitigation land bought in fee in the Atchafalaya Basin by the District.

1 - CWPPRA acreages are based upon 20-year project life; all other acreages are 50 years.

2 – PCWRP = Parish Coastal Wetlands Restoration Program ("Christmas Tree Program").

3 - In the best-case scenario, compensatory mitigation (for civil works projects and regulatory permits) results in no net loss of wetlands. Hence, it is not the intent to imply that compensatory mitigation acreages would contribute to a net increase in wetlands as a result of the Clean Water Act Section 404 program. Rather, these figures represent an accounting of the various cumulative impacts to coastal wetlands from Federal, state, local, and private restoration efforts.

4 – Vegetation = LDNR/NRCS/Soil and Water Conservation Committee Vegetation Planting Program.

5 – WRDA = Completed Federal Water Resources Development Act projects, including the Davis Pond and Caernarvon diversions.

6 - Includes 30,558 acres (12,366 ha) restored and 340,348 (137,734 ha) acres enhanced by North American Wetlands Conservation Act (NAWCA), administered by the USFWS; unable to determine exact locations.

5.2 Hydrology

5.2.1 Flow and Water Levels

5.2.1.1 Lower Mississippi River

No Action Alternative (Future without Project Conditions)
Direct, Indirect, Cumulative

Under the No Action Alternative for this study, no direct or indirect impacts on flows and water levels in the Lower Mississippi River would occur.

Alternative 2

Direct

The direct impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the flow in the Mississippi River at this intake location because the amount of diverted flow is a small portion of the flow in the Mississippi River at this location. Based on data from 1978 to 2008, the average annual, spring, and summer-fall discharge rates at Tarbert Landing are 566,123 ± 306,846, 813,333 ± 283,377, and 283,925 ± 113,984 cfs (Mean ± SD), respectively, vs. a diversion rate of 3,000 cfs. The small decrease in flow at this intake location will have no impact on water levels in the Mississippi River at this intake location because the amount of diverted flow is a small portion of the flow in the Mississippi River at this location.

Indirect

The indirect impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the flow in the Mississippi River downstream of this intake location because the amount of diverted flow is a small portion of the flow in the Mississippi River downstream of this intake location. The small decrease in flow at this intake location will have no impact on water levels in the Mississippi River downstream of this intake location.

Cumulative

The cumulative impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the flow further downstream in the Mississippi River because the amount of diverted flow is a small portion of the flow in the Mississippi River at this location. The small decrease in flow at this intake location will have no cumulative impact on water levels further downstream in the Mississippi River. Combined withdrawal of Mississippi River water from this diversion and LCA Small Diversion at Hope Canal would have minimal impacts on Mississippi River flow and water levels.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.1.2 Blind River and Maurepas Swamp

No Action Alternative (Future Without Project Condition)

Direct

Under the No Action Alternative, not implementing a freshwater diversion into the southeastern Maurepas Swamp would have no direct impacts on flow or water levels within in Blind River and Maurepas Swamp.

Indirect

Indirect impacts of the No Action Alternative would result in the persistence of existing conditions, including a limited ability to for the swamp to drain and persistent flooding that conflicts with historic drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Blind River and Maurepas Swamp would continue to deteriorate. Minimal soil building and moderately high subsidence rates that resulted in a net lowering of ground surface elevation would continue and the swamp will continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue. Under the existing conditions the frequency of dryout conditions (water levels below 0.5 ft) would occur only 1 percent of the time. This occurrence would limit seedling survival and recruitment.

The No Action Alternative would allow the existing swamp to function with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the swamp ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Current guidance for incorporating the direct and indirect physical effects of projected future sea level change in all aspects of USACE projects (i.e., managing, planning, engineering, designing, constructing, operating, and maintaining) is established by Circular No. 1165-2-211, dated July 1, 2009. Under this direction, the no-action and action alternatives must be evaluated under "low," "intermediate," and "high" projected rates of future sea level change. Scenarios differ in whether and how eustatic sea level rise accelerates over time. Accordingly, the low estimate is based on an extrapolation of the historic rate of RSLR for the Study Area. Based on daily stage data from 1959 to 2009 for the West End at Lake Pontchartrain Gauge (85625), the estimated historic rate of relative sea level rise for the project area is 0.0302 ft yr^{-1} (9.20 mm yr^{-1}) with a standard error of 0.65 ft (198.12 mm). Intermediate and high rates are based on modified NRC curves I and III, respectively (NRC 1987), in which the current global mean sea level change is set at 0.00558 ft yr^{-1} (1.7 mm yr^{-1}) (IPCC, 2007). The following formula is used to estimate the total rise in eustatic sea level for the intermediate and high rate scenarios of sea level rise over the project life:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,

t1 is the time in years between the project's construction date and 1986,

and

t2 is the time between a future date at which one wants an estimate for sea level rise and 1986.

Eustatic estimates are then added to the historic local subsidence rate (0.0246 ft yr-1 or 7.50 mm yr-1) to calculate the total RSLR for the intermediate and high rate scenarios. All scenarios were evaluated at 5-year increments over the 50-year project life (2012-2062). Direct, indirect, and cumulative effects for future without project conditions were evaluated for the intermediate scenario. Projected RSLR over the 50-year period of analysis for low, intermediate, and high scenarios is presented in Table 5-3 and Figure 5-1.

Table 5-3: Projected relative sea level rise (feet) over the project life (2012-2062) in 5-year increments for low, intermediate, and high scenarios in the project area based on West End at Lake Pontchartrain tide gauge daily stage data from 1959-2009 and USACE Circular No. 1165-2-211 (2009)

	RSLR (feet)		
YEAR	LOW	INTERMEDIATE	HIGH
2012	0	0	0
2017	0.15	0.17	0.24
2022	0.30	0.35	0.51
2027	0.45	0.53	0.78
2032	0.60	0.72	1.08
2037	0.75	0.90	1.39
2042	0.91	1.10	1.72
2047	1.06	1.29	2.06
2052	1.21	1.49	2.42
2057	1.36	1.70	2.80
2062	1.51	1.90	3.19

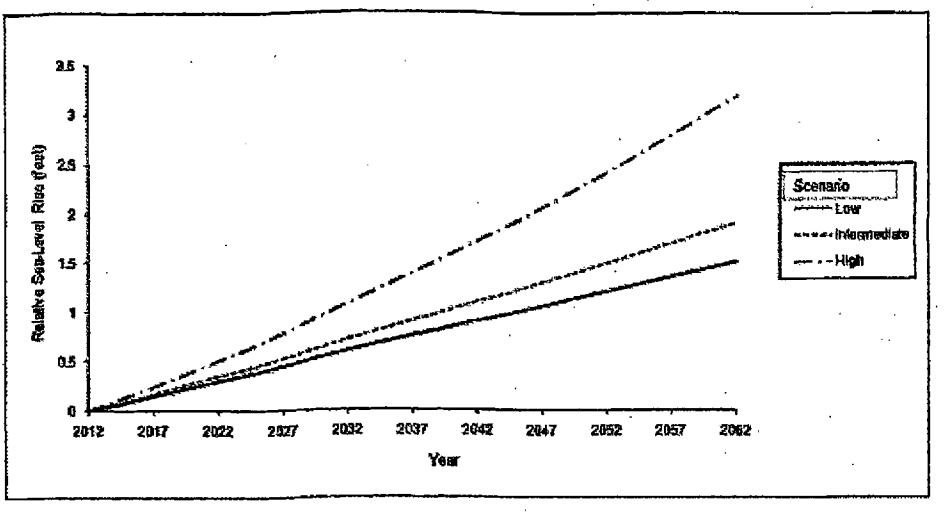


Figure 5-1: Projected relative sea level rise (feet) over the project life (2011-2061) in 5-year increments for low, intermediate, and high scenarios.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on flow and water levels with the additive combination of similar wetland degradation and wetland loss impacts to flow and water levels throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal swamp restoration projects in the vicinity. The Small Diversion at Hope Canal would freshen the surrounding waters, albeit to an unknown extent, and slightly alter the flow patterns in and near the Study Area, but would not likely affect water levels in the Study Area. Development patterns indicate increased urbanization that may increase the total volume of freshwater input into the Study Area from runoff.

Alternative 2

Direct

The direct impact of Alternative 2 includes berm gaps that would allow greater connectivity and water exchange between the St. James Parish canal system and the swamp at lower flows. However, the connectivity would allow greater backflow from the lake to enter the swamp when inflows to the swamp are low.

Four hydrologic metrics were evaluated in Blind River and Maurepas Swamp (**Appendix L.2.10**); freshwater throughput (ac-ft), annual average water depth (ft), backflow prevention (%), and frequency of dry-out conditions (%). Diversion occurs when the swamp stage is less than the lake stage and the lake stage is greater than

0.5 ft. The analysis was performed for the low, intermediate, and high sea level rise scenarios for 20-years, 30-years and 50-years. The results for annual average water depth (ft), backflow prevention (%), and frequency of dry-out conditions (%) are presented in **Table 5-4** for the FWOP and the TSP/Recommended Plan.

Table 5-4. Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) over 20, 30 and 50 years for the entire project site [FWOP=Future Without Project, FWTSP = Future with TSP (Alt 2)]

		Low SLR		Intermediate SLR		High SLR	
	Project Life (yr)	FWOP	FWTSP	FWOP	FWTSP	FWOP	FWTSP
Average Annual Water Depth (ft)	20	1.74	1.46	1.75	1.54	1.79	1.79
	30	1.76	1.67	1.79	1.80	1.94	2.26
	50	1.88	2.11	2.02	2.42	2.77	3.46
Frequency of Dryout Conditions (%) (< 0.5ft)	20	1%	8%	1%	6%	1%	2%
	30	1%	4%	1%	2%	1%	1%
	50	1%	1%	1%	1%	1%	0%
Backflow Prevention (%)	20	55%	38%	49%	36%	30%	33%
	30	38%	34%	29%	33%	9%	29%
	50	13%	31%	7%	28%	2%	21%

The net freshwater throughput is calculated as the total inflow minus the inflow volume attributed to backflow from Lake Maurepas. The direct impact of the diversion of water from the Mississippi River at Romeville would be an increase in throughput. The results indicate that Alternative 2 can substantially increase throughput over the range of potential relative sea level rise conditions. Total system throughput is slightly higher for Alternative 2 because more frequent diversions are required to counter backflow.

The direct impact of the diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp.

The direct impact of the diversion of water from the Mississippi River at Romeville for the low, intermediate, and high sea level rise scenarios would be a reduction in

backflow prevention relative to the existing condition in the Blind River and Maurepas Swamp for 20 years. For 30 and 50 years there would be an increase in backflow prevention for the three sea level rise scenarios. The results indicate that Alternative 2 can prevent backflow over the range of potential relative sea level rise scenarios.

The direct impact of the diversion of water from the Mississippi River at Romeville for the low and intermediate sea level rise scenarios would be an increase in frequency of dry out relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years, and for the high seas level rise scenario for 20 years. The results indicate that Alternative 2 can provide dryout conditions for the range of potential relative sea level rise conditions but as sea level rises, this potential is expected to diminish over time.

Indirect

The indirect impact of Alt. 2 would be increased hydrologic connectivity throughout the system. Excavation of berm gaps would increase the flow of water out of the swamp and reduce water levels during low stage periods in Lake Maurepas, at which time diversion inflow would be halted. Under this alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur from 8% after 20 years and would reduce to 1% after 50 years. . With accretion these percentages will increase. This would allow for increased recruitment of baldcypress and water tupelo. Additionally, pulsing of the system would enhance productivity and nutrient assimilation in the swamp and thereby improve water quality in Blind River. Increased delivery of freshwater to the swamp will provide nutrients and sediments to the swamp that will enhance productivity and accretion (swamp building). It will also increase circulation of water in the swamp and in Blind River.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 in combination with the impacts and benefits for overall net wetland acres improved and protected by Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** The Small Diversion at Hope Canal would freshen the surrounding waters, albeit to an unknown extent, and slightly alter the flow patterns in and near the study area, but would not likely affect water levels in the study area.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Under this alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur less than for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions: Under the alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur less than for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.1.3 Lake Maurepas

No Action Alternative (Future without Project Conditions)
Direct, Indirect

Under the No Action Alternative no direct or indirect direct impacts on flows and water levels in Lake Maurepas would occur.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on flow to and water levels in Lake Maurepas as increased runoff in the watersheds that drain into the lake from increased future development would likely lead to an increase in water levels in Lake Maurepas. LCA Small Diversion at Hope Canal will result in a significant freshening of the Lake and approximately double the turnover rate (Lee Wilson & Associates et al. 2001).

Alternative 2

Direct

Under Alternative 2 there would be no direct impacts to flows and water levels in Lake Maurepas.

Indirect

The indirect impacts of Alternative 2 include berm gaps and the diversion would decrease the backflow in Blind River from Lake Maurepas which could lead to a slight increase in the water level in the lake. The average volume of Lake Maurepas is 533,741 acre-feet and the freshwater replacement time is 2.65 months (Battelle 2005) Estimates of the decrease in the freshwater replacement time of Lake Maurepas with a 1,500 cfs diversion are 1.83 months (Battelle 2005). Thus alternative 2 would likely result in a further decrease in the freshwater replacement time.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with the implementation of other projects (Amite River and Hope Canal) that will affect backflow in Blind River and in turn flow to and water levels in Lake Maurepas to an unknown extent.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.2 Sedimentation and Erosion

5.2.2.1 Lower Mississippi River

No Action Alternative (Future without Project Conditions)
Direct, Indirect, Cumulative

Under the No Action Alternative, no direct or indirect impacts on sedimentation and erosion in the Lower Mississippi River would occur.

Alternative 2

Direct

The direct impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the sediment load in the Mississippi River at this intake location. Based on water year 2002 through 2008, the average daily measured suspended sediment load at this location was 334,000 tons/day; the daily measured suspended sediment load varies from 39,000 to 119,000 tons/day.

Indirect

The indirect impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the flow in the sediment load in the

Mississippi River downstream of this intake location because the amount of diverted sediment load is a small portion of the load in the Mississippi River downstream of this intake location. The small decrease in sediment load at this intake location will have no impact on sedimentation and erosion in the Mississippi River downstream of this intake location.

Cumulative

The cumulative impact of the diversion of water from the Mississippi River at Romeville would be a very small decrease in the load further downstream in the Mississippi River because the amount of diverted load is a small portion of the load in the Mississippi River at this location. The small decrease in load at this intake location will have no cumulative impact on water levels further downstream in the Mississippi River.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The direct impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.2.2 Blind River and Maurepas Swamp

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative would have no direct impacts on flow or water levels within in Blind River and Maurepas Swamp.

Indirect

Indirect impacts of the No Action Alternative would result in the persistence of existing conditions, including a limited ability of the swamp to drain and persistent flooding that conflict with historic drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Under the No Action Alternative (not implementing a freshwater diversion into the Study Area in southeast Maurepas Swamp) Blind River and Maurepas Swamp would continue to deteriorate. Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the Mississippi River that brought freshwater, sediment and nutrients to the swamp. Minimal soil building and moderately high subsidence rates that resulted in a net lowering of ground surface elevation would continue and the swamp will continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue.

The No Action Alternative would allow the existing swamp to function with minimal circulation of water, nutrients, and sediment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the swamp ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on flow and water levels with the additive combination of similar wetland degradation and wetland loss impacts to flow and water levels throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal swamp restoration projects in the vicinity.

Alternative 2

Direct

The direct impact of Alternative 2 on sedimentation and erosion would include increases in sediment in the Blind River and Maurepas Swamp. Based on estimates from 3,000 cfs diversion supplying 16 kg/s of sediment continuously throughout the year, the annual estimate of sediment load to Blind River and Maurepas Swamp would be approximage 505,000,000 kg/yr. Because the diversion would not be operated continuously, this estimate is higher than the sediment load under the likely diversion operation schedule.

Indirect

The indirect impact of Alternative 2 would include increases in productivity and sediment accretion that would increase swamp building in the distribution area. These increases in productivity would provide stability in areas that would otherwise erode. There could potentially be erosion in areas near the diversion entry point into the distribution area where sediment control measures could be used. The reduction in erosion due to increases in productivity would be small.

Cumulative

Cumulative impacts would e the synergistic effects of implementing the No Action Alternative combined with the beneficial impacts of other Federal, state, local and private restoration efforts as detailed in Section 5.1.2.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.2.3 Lake Maurepas

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no diversion into the southeastern Maurepas Swamp) no direct impacts on sedimentation and erosion in Lake Maurepas would occur.

Indirect

Under the No Action Alternative (no diversion into the southeastern Maurepas Swamp) no indirect impacts on sedimentation and erosion in Lake Maurepas would occur.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on sedimentation and erosion in Lake Maurepas as increased runoff in the watersheds that drain into the lake from increased future development would likely lead to an increase in sedimentation in Lake Maurepas.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on sedimentation and erosion in Lake Maurepas.

Indirect

There would be no indirect impacts of Alternative 2 on sedimentation and erosion in Lake Maurepas.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of the implementation of other projects as discussed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.2.3 Groundwater

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no diversion into the southeastern Maurepas Swamp), no direct impacts to groundwater would occur.

Indirect

Under the No-Action Alternative, no indirect impacts to groundwater would occur.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative combined with the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on groundwater.

Indirect

Indirect impacts of Alternative 2 include minor variations in groundwater seepage due to head gradients created by the diversion and improved drainage of Maurepas Swamp. These changes would be within the range of ambient conditions and therefore would have little effect on groundwater seepage.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.3 Water Quality and Salinity

5.3.1 Lower Mississippi River

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no diversion into the southeastern Maurepas Swamp), no direct impacts to water quality of the Mississippi River would occur.

Indirect

Indirect impacts of not implementing a freshwater diversion into the southeastern Maurepas Swamp would result in the persistence of existing conditions with the Mississippi River continuing to carry high nutrient loads that contribute to the Gulf of Mexico "dead zone" due to eutrophication.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative combined with the wetland loss and increased runoff due to increased urbanization of the Pontchartrain Basin, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2**. Water quality trends could continue along the current trajectory with minimal effects on water quality in the Lower Mississippi River from other wetland restoration project in the region

Alternative 2

Direct

The direct impacts of this alternative include the construction and installation of intake structures and the reduction in discharge in the Lower Mississippi River during active diversion periods. During construction there would be increases in turbidity, suspended sediments, BOD and a decrease in DO. These impacts from construction would be temporary and localized to the construction area. Water quality would return to ambient conditions quickly after the termination of construction. The diversion of river water would result in minimal decreases in the load of nutrients, sediments, and pesticides in the Lower Mississippi River. The diversion of water is unlikely to change the concentrations of water quality parameters in the Lower Mississippi River. This minimal decrease in the load of sediments in the Lower Mississippi River indicated that additional modeling for river shoaling was not required.

Indirect

Because of the relatively small percentage of water that would be diverted from the Mississippi River, there would be minimal if any indirect impacts to water quality in the Lower Mississippi River. Over the long term, total loads of nutrients, sediments, and pesticides transported by the Lower Mississippi River would be reduced compared to without a diversion. The relatively small quantity of water diverted from the Mississippi River represents a small portion of the total discharge

and would most likely have a negligible effect on offshore hypoxia (Day et al. 2004). These reductions would have minimal impacts on the concentration of water quality parameters. The diversion would not be expected to change nutrient ratios in the Mississippi River (Battelle 2005).

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with the impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** The additive effect of multiple diversion projects would reduce the overall loads carried by the Lower Mississippi River that enter the Gulf of Mexico and could have the potential to reduce the area of offshore hypoxia. The scale of reduction in load depends on the overall number of diversion projects conducted in the future.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be construction and installation of two intake structures for the two diversions that would result in more temporary impacts to water quality as described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.3.2 Blind River

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on water quality in Maurepas Swamp and the Blind River.

Indirect

Indirect impacts of not implementing restoration features would result in the persistence of existing conditions. Under the No Action Alternative, the current water quality conditions would persist; wetlands would still be affected by natural and man-made factors that would have both beneficial and detrimental effects on water quality conditions. Existing wetland communities would continue to diminish. Increased impoundment and limited circulation due to limited freshwater inputs and RSLR would continue to result in anoxic conditions, detrimental to fish and other aquatic organisms.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on water quality combined with similar water quality impacts throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. These other diversion projects would work to offset some of the changes in water quality such as decreases in DO and nutrients. Because of the spatial separation between these diversion projects and the Blind River/Maurepas Swamp, the effects of these diversion projects on the study area would be minimal.

Alternative 2

Direct

Direct impacts to water quality would result from impacts associated with construction activities in the Maurepas Swamp including the installation of control

structures, culverts under Highway 61, improvement of the berm cuts, and the addition of new 500-foot wide berm cuts. These impacts would result in temporary increases in turbidity and BOD with concomitant decreases in DO. These impacts would be localized to the construction area and would be temporary. Water quality would return to ambient conditions quickly after the termination of construction. Additional direct impacts to water quality would be potential changes in concentration of certain water quality parameters in the Blind River and Maurepas Swamp. In general, concentrations of DO, hardness, pH, sulfate, TSS, turbidity, atrazine, and nitrate are higher in the Mississippi River compared to the Blind River. The concentration of these parameters could increase in the Blind River due to the diversion. However, studies have found that based on outfall management, nutrient concentrations would not change significantly from ambient conditions (Day et al. 2004). In Maurepas Swamp, concentrations of DO are expected to increase (Battelle 2005). Although concentrations of atrazine are elevated in the Mississippi River, this pesticide is not expected to have negative impacts on wildlife in the Maurepas Swamp (Battelle 2005). Concentrations of TOC, copper, and lead are lower in the Mississippi River compared to the Blind River. Therefore, the diversion would likely reduce concentrations of these constituents in the Blind River. The diversion is not expected to significantly change the risk of chemical exposure to wildlife (Battelle 2005). Increases in contaminants should remain similar to region trends in an industrialized area.

Indirect

The indirect impacts of Alternative 2 would be the persistence of changes to water quality due to the diversion over time. There have been many studies of the relationship between the nutrient loading rate into wetlands and associated removal efficiency. The most comprehensive studies of wetland nutrient removal efficiency have been of wastewater wetland treatment systems. In these systems the predominant form of nitrogen is ammonium. Mississippi River water contains predominantly nitrate, which will be denitrified in the swamp. When the nitrate: ammonium ration is less than 1 the average nitrogen removal efficiency ranges from 95 to 100%. The Mississippi River has an average molar nitrate: ammonium ratio of 18 (Lane et al., 1999). Therefore the removal efficiency of nitrogen in the swamp is expected to be higher than documented for wetland wastewater studies.

Lane et al., (1999) indicate that the Mississippi River has an approximate average nitrate concentration of 1.5 mg-N/L (that generally ranges between 0.75 and 2.0 mg-N/L (Lane et al., 1999)) and the average ammonium concentration for the Mississippi River is less than 0.1 mg-N/L. TN in the Mississippi River was generally between 1.0 and 2.0 mg-N/L. Lane et al. (1999) indicate that the average TP concentrations in the Mississippi River were similar to TP concentrations in the swamps evaluated. The average value was 0.055 mg-P/L, and the range was (0.022-0.424 mg-P/L). The following values for the Mississippi River at Belle Chasse, compared well with the data presented above.

TN	average 2.26 mg-N/L (0.57 – 4.50 mg-N/L) n=190
Nitrate	average 1.73 mg-N/L (1.15 – 2.73 mg-N/L) n=19
Ammonium	average 0.08 mg-N/L (0.01 – 0.31 mg-N/L) n=95
TP	average 0.22 mg-P/L (0.06 – 0.51 mg-P/L) n=198

Nutrient load reduction provided by the swamp for nitrate, total nitrogen (TN), and total phosphorus (TP) was estimated using the following equation.

Load Reduction = Input Load x Concentration Reduction

Where:

Input Load = Diversion Flow to Swamp x Average Diversion Flow Concentration

The concentration reduction was estimated based on the first order k-C* model equation (Kadlec and Knight, 1996).

$Co = C^* + (Ci - C^*) \exp(-kA/0.0365 \times Q)$

Where:

Co = swamp outflow concentration in mg/L
A = swamp area in hectares
Q = inflow rate in m3/d
k = first order areal rate constant in m/yr
Ci = swamp inflow concentration in mg/L
C* = swamp background concentration in mg/L

And: *Concentration Reduction = (Ci – Co) / Ci*

Table 5-5 provides a summary of the values used for the first-order areal rate constant (k) for nitrate, TN, and TP, as well as the wetland background concentrations (Co) and average concentrations (Ci) in the Mississippi River. The average concentration values are based on water quality data collected at the USGS station at Belle Chasse (USGS 07374525 Mississippi River at Belle Chasse, LA).

Table 5-5: Nutrient Concentrations and Areal Rate Constants

	Background Concentration, C* (mg/L)	Average Concentration, Ci (mg/L)	k (m/yr)
Nitrate	0.008	1.73	35
TN	0.58	2.26	22
TP	0.034	0.22	5

The nutrient load reduction for Alternative 2: Romeville Diversion-3,000 cfs was estimated as follows:

The total average diversion flows to the swamp, as computed by the engineering calculations (**Appendix L, Section 2.2.4**), were used to estimate the inflow nutrient loading for Alternative 2 under existing, 20-year, 30-year, and 50-year sea level rise conditions. A summary of the diversion flows for Alternative 2 is provided in **Table 5-6**.

Table 5-6: Average Diversion Flows to Blind River Project swamp Area for Alternative 2

	No Sea Level Rise	20-year Sea Level Rise	30-year Sea Level Rise	50-year Sea Level Rise
Cfs	1080	1628	1802	2011

The percent load reduction for the four sea level rise scenarios for nitrate and TN ranged from 82-96% and 50-65%, respectively. The percent load reduction for the four sea level rise scenarios for TP ranged from 19-32%. These values are a little less than removal efficiency estimates provided by Day et al. (2006), that were based on Lane et al. (2003), which were73% for TN and 43% for TP for removal efficiency as a function of loading rates for data from both Mississippi River diversions and wetland wastewater treatment systems. The loading rates evaluated here for nitrate, TN, and TP were 18-34 g-N/m2/yr, 24-45 g-N/m2/yr, and 2-4 g-P/m2/yr, respectively, and were greater than the loading rates presented by Day et al. (2006). The lower removal efficiency estimates presented here reflect the fact that maximum removal efficiency occurs at low loading rates and decreases at higher loading rates. Wetlands also provide assimilation of metals. Increased delivery of freshwater to the swamp will also increase circulation and dissolved oxygen levels in the swamp and in Blind River.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres improved and protected by other Federal, state, local, and private restoration efforts such as Hope Canal and others as summarized in Section **5.1.2**. While the best available data were used to simulate the combined effects of a diversion and other restoration projects in the study area on water quality changes (**Appendix L, Section L2.10.1.2**), the installation of piezometers throughout the interior swamp south of US Highway 61 has been completed as part of this study and data is being collected to supplement existing swamp water quality data. A multi-directional flow gauge with water quality sensors that collects hourly data has also been installed on the Blind River near US Highway 61 and data is being collected from this gauge. Long-term data over variable conditions will provide a better understanding of flow and water quality fluctuations within the Study Area. The additional data from these

monitoring stations will be used to refine predictive water quality modeling during the PED phase.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2. Nutrient load reduction provided by the swamp for nitrate, total nitrogen (TN), and total phosphorus (TP) was estimated as described for Alternative 2. The nutrient load reduction for Alternative 4: Southbridge Diversion-3,000 cfs was estimated as follows:

The total average diversion flows to the swamp, as computed by the engineering calculations (**Appendix L, Section 2.2.4**), was used to estimate the inflow nutrient loading for Alternative 4 under existing, 20-year, 30-year, and 50-year sea level rise conditions. A summary of the diversion flows is provided for Alternative 4 in **Table 5-7.**

Table 5-7: Average Diversion Flows to Blind River Project swamp Area for Alternative 4

	No Sea Level Rise	20-year Sea Level Rise	30-year Sea Level Rise	50-year Sea Level Rise
Cfs	801	1175	1323	1575

The percent load reduction for the four sea level rise scenarios for nitrate and TN ranged from 89-98% and 56-70%, respectively. The percent load reduction for the four seal level rise scenarios for TP ranged from 23-40%. These values are a little less than estimates provided by Day et al. (2006) that were based on Lane et al. (2003), which were73% for TN and 43% for TP for removal efficiency as a function of loading rates for data from both Mississippi River diversions and wetland wastewater treatment systems. The loading rates evaluated here for nitrate, TN, and TP ranged from 14-27 g-N/m^2/yr, 18-35 g-N/m^2/yr, and 2-3 g-P/m^2/yr, respectively, and were greater than the loading rates presented by Day et al. (2006). The lower removal efficiency estimates presented here reflect the fact that maximum removal efficiency occurs and low loading rates and decreases at higher loading rates. Wetlands also provide assimilation of metals.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2. Nutrient load reduction provided by the swamp for nitrate, total nitrogen (TN), and total phosphorus (TP) was estimated as described for Alternative 2. The nutrient load reduction for Alternative 6: Romeville Diversion-1,500 cfs, Southbridge Diversion-1,500 cfs was estimated as follows:

The total average diversion flows to the swamp, as computed by the engineering calculations (**Appendix L, Section 2.2.4**), was used to estimate the inflow nutrient loading for Alternative 6 under existing, 20-year, 30-year, and 50-year sea level rise conditions. A summary of the diversion flows for Alternative 6 is provided in **Table 5-8.**

Table 5-8: Average Diversion Flows to Blind River Project swamp Area for Alternative 6

	No Sea Level Rise	20-year Sea Level Rise	30-year Sea Level Rise	50-year Sea Level Rise
Cfs	999	1473	1630	1857

The percent load reduction for the four sea level rise scenarios for nitrate and TN ranged from 85-97% and 52-66%, respectively. The percent load reduction for the four seal level rise scenarios for TP ranged from 20-34%. These values are a little less than estimates provided by Day et al. (2006) that were based on Lane et al. (2003), which were73% for TN and 43% for TP for removal efficiency as a function of loading rates for data from both Mississippi River diversions and wetland wastewater treatment systems. The loading rates evaluated here for nitrate, TN, and TP ranged from 17-32 g-N/m^2/yr, 22-41 g-N/m^2/yr, and 2-4 g-P/m^2/yr, respectively, and were greater than the loading rates presented by Day et al. (2006). The lower removal efficiency estimates presented here reflect the fact that maximum removal efficiency occurs and low loading rates and decreases at higher loading rates. Wetlands also provide assimilation of metals.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2. Nutrient load reduction provided by the swamp for nitrate, total nitrogen (TN), and total phosphorus (TP) was estimated as described for Alternative 2. The nutrient load reduction for Alternative 4B: Southbridge Diversion-3,000 cfs (with split flows) was estimated as follows:

The total average diversion flows to the swamp, as computed by the engineering calculations **(Appendix L, Section 2.2.4)**, was used to estimate the inflow nutrient loading for Alternative 6 under existing, 20-year, 30-year, and 50-year sea level rise conditions. A summary of the diversion flows for Alternative 4B is provided in **Table 5-9.**

Table 5-9: Average Diversion Flows to Blind River Project swamp Area for Alternative 4B

	No Sea Level Rise	20-year Sea Level Rise	30-year Sea Level Rise	50-year Sea Level Rise
Cfs	975	1428	1580	1801

The percent load reduction for the four seal level rise scenarios for nitrate and TN ranged from 86-97% and 53-67%, respectively. The percent load reduction for the four seal level rise scenarios for TP ranged from 21-34%. These values are a little less than estimates provided by Day et al. (2006) that were based on Lane et al. (2003), which were73% for TN and 43% for TP for removal efficiency as a function of loading rates for data from both Mississippi River diversions and wetland wastewater treatment systems. The loading rates evaluated here for nitrate, TN, and TP ranged from 17-31 g-N/m^2/yr, 22-40 g-N/m^2/yr, and 2-4 g-P/m^2/yr, respectively, and were greater than the loading rates presented by Day et al. (2006). The lower removal efficiency estimates presented here reflect the fact that maximum removal efficiency occurs and low loading rates and decreases at higher loading rates. Wetlands also provide assimilation of metals.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2. 5.3.3Lake Maurepas

Section 5.3.3 Maurepas Swamp
No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on water quality in Lake Maurepas.

Indirect

Indirect impacts of No Action Alternative (not implementing a freshwater diversion into the study area in southeast Maurepas Swamp) would result in the persistence of existing conditions. Under the No Action Alternative, the current water quality conditions would persist; wetlands would still be affected by natural and man-made factors that would have both beneficial and detrimental effects on water quality conditions in Lake Maurepas. Existing wetland communities would continue to deteriorate. Increased impoundment and limited circulation due to limited freshwater inputs would continue to result in anoxic conditions, detrimental to fish and other aquatic organisms.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative combined with the impacts and benefits for overall net acres improved and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. Nutrient concentrations would remain the same in the future based on assimilation rates in the swamp. The cumulative impacts of these restoration efforts could increase DO in the lake.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on water quality in Lake Maurepas.

Indirect

There would be few indirect impacts of Alternative 2 on water quality in Lake Maurepas because of the assimilation capacity of the wetlands around the lake. Nutrient levels in the lake would most likely remain near ambient levels (Day et al 2005). Concentrations of DO would likely increase in the lake. Although concentrations of atrazine are elevated in the Mississippi River, this pesticide is not expected to have negative impacts on wildlife in Lake Maurepas (Battelle 2005).

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 in combination with the impacts and benefits for overall net acres improved and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. Because most of the nutrients from the diversion would be retained in the swamp (Day et al 2005), adverse impacts on nutrient levels in Lake Maurepas resulting from diversions is unlikely. Based on the cumulative

effects of other restoration projects adjacent to Lake Maurepas, DO concentrations would increase in the future. The potential cumulative impacts on water quality in Lake Maurepas from combined diversions and other restoration projects will be further addressed in the PED phase. Water monitoring data from recently installed piezometers and gauges, along with additional data from other projects (as they are further developed) will be used to develop a more refined water quality model to simulate the water quality effects in the project area, downstream, and in Lake Maurepas.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.3.4 Salinity

5.3.4.1 Lower Mississippi River

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no freshwater diversion into the study area in southeast Maurepas Swamp), no direct impacts to salinity in the Lower Mississippi River would occur.

Indirect

Under the No Action Alternative (no freshwater diversion into the study area in southeast Maurepas Swamp), no indirect impacts to salinity in the Lower Mississippi River would occur.

Cumulative

Cumulative impacts would be the synergistic effect of taking the No Action Alternative on salinity combined with the wetland loss and increased runoff due to increased urbanization, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2**. Salinity trends would continue along the current trajectory with minimal effects on water quality in the Lower Mississippi River from other wetland restoration project in the region.

Alternative 2

Direct

There would be no direct impacts of this alternative on salinity in the Lower Mississippi River.

Indirect

The indirect impacts of Alternative 2 include a reduction in discharge which could contribute to the upstream movement of the saltwater wedge. The dominant factor in the movement of the saltwater wedge is discharge with flow duration. Channel slope, wind velocity and direction, tides, and water temperature also affect movement of the wedge. If the saltwater wedge migrated up to Belle Chase, Louisiana which is 100 miles south of the study area, then the USACE would likely build a sill to prevent upstream migration. The sill was previously constructed under an existing authority and is part of the USACE efforts to protect public water supply from excessive chloride concentrations. Additionally, the diversion of water from the Mississippi River would not occur during low flow or low stage conditions when saltwater wedge movement occurs. Therefore, it is unlikely that the diversion would contribute to the movement of the wedge.

Cumulative

The cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** The additive effects of other diversion projects could decrease flow in the Mississippi River and increase the rate of movement of the saltwater wedge. However, it is unlikely that these diversions would occur during low flow periods.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.3.4.2Blind River and Maurepas Swamp

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the Maurepas Swamp would have no direct impacts on salinity regimes within Maurepas Swamp and the Blind River.

Indirect

Indirect impacts of the No Action Alternative (not implementing a freshwater diversion into the study area in southwest Maurepas Swamp) would result in the persistence of existing conditions including increases in salinity within the study area.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on salinity regimes in combination with similar water quality impacts throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. Dependent on the flow rate and timing of discharge, the Hope Canal project would likely result in extensive freshening of Lake Maurepas, especially when operating during late-summer and early fall—low flow periods during which high salinity and saltwater intrusion present the greatest threat. Modeling efforts indicate that about 40 percent of water diverted through Hope Canal would flow westward across Maurepas swamp into Blind River and then into Lake Maurepas (Lee Wilson & Assoc. et al. 2001). Therefore, inflow from Lake Maurepas into southeastern Maurepas Swamp would likely exhibit decreased risk of salinity-related ecosystem damage.

Alternative 2

Direct

Direct impacts of Alternative 2 include decreases in salinity in the study area due to the contribution of freshwater from the diversion (Battelle 2005).

Indirect

Indirect impacts of Alternative 2 include present and future decreases in salinity due to the contribution of freshwater from the diversion (Battelle 2005).

Cumulative

Cumulative impacts would be the synergistic effect of Alternative 2 on salinity regimes combined with similar water quality impacts throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** The cumulative impacts would be similar to those described in the No Action Alternative with the added decreases in salinity associated with Alternative 2.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.3.4.3 Lake Maurepas

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp), no direct impacts to salinity in the Lake Maurepas would occur.

Indirect

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp), the indirect impacts to salinity in the Lake Maurepas include potential increases in concentrations in the future.

Cumulative

Cumulative impacts would be the synergistic effect of Alternative 2 on salinity regimes combined with similar water quality impacts throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. The cumulative impacts would be similar to those described in the No Action Alternative for Blind River and Maurepas Swamp.

Alternative 2

Direct

There would be no direct impacts of this alternative on salinity in Lake Maurepas.

Indirect

The indirect impacts of this alternative include future decreases in salinity in Lake Maurepas due to the contribution of freshwater from the diversion (Battelle 2005). Based on a diversion of 1,500 cfs, the freshwater replacement time of Lake Maurepas would decrease from 2.65 months to 1.83 months (Battelle 2005). Kelso et al. (2005) estimated that a 2,500 cfs diversion could decrease salinity by 30% in Lake Maurepas. Therefore, a diversion of 3,000 cfs would likely result in a further decrease s in salinity.

Cumulative

Cumulative impacts would be the synergistic effect of Alternative 2 on salinity regimes in combination with similar water quality impacts throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. The cumulative impacts would be similar to those described in the No Action Alternative for Blind River and Maurepas Swamp with the added decreases in salinity associated with Alternative 2. The

mean annual salinities for Pass Manchac (1951-2000) shown in Figure 4-12, show average salinities ranging from slightly above 0 to 3,5; the likelihood exists for the Alternative 2 diversion in combination with other local area projects such as Hope Canal to reduce salinities in this location by as much as 30 %. However, additional water quality monitoring and refined water quality modeling during PED will be done to establish quantitative change in salinity levels at various locations.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.4 Air Quality

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative, no freshwater diversion in the Maurepas Swamp would have no direct impacts on air quality.

Indirect

Indirect impacts of not implementing a diversion would result in the persistence of existing conditions. Air quality would continue to be subject to institutional recognition and further regulations. However, air quality in the study area would likely decline for the following reasons: continued population growth, further commercialization and industrialization, increased numbers of motor vehicles, and increased emissions from various engines. These impacts would be coupled with the continued loss of Louisiana coastal wetland vegetation that would no longer be available to remove gaseous pollutants. Nevertheless, air quality degradation is not anticipated to be a significant problem in the study area under the No Action Alternative.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on air quality combined with similar air quality impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity as summarized in **Section 5.1.2.**

Alternative 2

Direct

Direct impacts to ambient air quality would include temporary localized construction impacts as well impacts that would last the lifetime of the project. An air applicability determination analysis was extrapolated from previously completed similar projects based upon direct emission fro estimated construction hours. It has been shown that total emissions for the project (regardless if individual work items determined separately or even when all work items calculated cumulatively) generally do not exceed the threshold limit applicable to volatile organic compounds (VOC) for parishes where the most stringent requirement (approximately 50 tons per year or 49.38 metric tons per year in serious non-attainment parishes is in effect). The VOC emissions for the proposed construction would total approximately 42 tons for all construction features. The construction would take from 18 to 24 months to complete, so the VOC emissions would be approximately 24 to 29 tons per year. These emissions would be classified as de minimus, and no further action

would be necessary. It is likely that indirect emissions, if they occur, would be negligible.

The construction impacts would result from the emissions of construction equipment within the study area and construction and fugitive dust. These effects to air quality would be temporary. Air quality would return to pre-construction conditions soon after the completion of construction activities. For the life of the project, the control structure(s) would be operated by a diesel or gasoline generator.

Indirect

Bringing freshwater, sediment, and nutrients to the swamp at strategic times of the year may improve air quality by protecting, creating and nourishing the Maurepas Swamp. Common wetland plants can naturally produce oxygen and filter out air pollutants such as ozone, sulfur dioxide and carbon monoxide. Although unlikely to greatly impact air quality alone, the study area would provide some air quality improvement from the effects of creating, nourishing and protecting the swamp in conjunction with other restoration efforts in the area.

Cumulative

Cumulative impacts would be the synergistic effect of implementing this alternative with the additive combination of impacts and benefits for overall nets acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in Section 5.1.2.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.5 Noise

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) would result in the persistence of existing conditions. The study area is predominantly remote forested swampland. The noise from nearby urban areas has little, if any, impact on the study area. Limited noise impacts from boat navigation in Blind River and connecting channels, automobile traffic on I-10 and U.S. Highway 61, and railroad transport would be expected to continue in the foreseeable future.

Indirect

There would be no indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) on noise.

Cumulative

There would be no cumulative impact of the No Action Alternative on noise.

Alternative 2

Direct

The direct impacts of Alternative 2 would be a temporary increase in the noise level in the study area. However, the study area is remote and unpopulated so the noise level would not affect any nearby human communities. Once construction activities are completed noise levels would be slightly above the pre-construction levels due to the operation of control structures.

Potential noise impacts concerns may be expected from construction activities, although construction equipment is limited in the level of noise that can be emitted per regulations for Occupational Noise Exposure (29 CFR Part 1910.95) under the Occupational Safety and Health Act of 1970, as amended.

Indirect

Indirect impacts of Alternative 2 include increases in productivity and growth of the forest canopy which would buffer noise levels in the study area.

Cumulative

The cumulative impacts would principally be related to the potential short-term disruption of fish and wildlife species and similar impacts by other similar Federal, state, local and private restoration activities as well as other human-induced noise disruptions to these organisms. Cumulative impacts would be a synergistic effect of implementing this alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2**.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts would be similar to Alternative 2 with the following exception. Post construction noise levels would increase due to the use of a portable vacuum

pump used to operate the siphon. The noise levels would increase anytime the pump would lose prime. This would typically happen at low water level situations.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.6 Vegetative Resources

No Action Alternative (Future without Project Conditions)

Direct

The no Action Alternative would have no direct impacts on coastal vegetation resources.

Indirect

Indirect impacts of not implementing a freshwater diversion would result in the persistence of existing conditions. Both man-made and natural processes would contribute to the continued loss of vegetated wetland habitats, including loss of bald cypress-tupelo and bottomland hardwood resources, increased saltwater intrusion, increased flood duration and impoundment, and increased herbivory.

Exceedance of stress thresholds due to permanent inundation for species in existing plant communities would result in extensive mortality and a change in habitat from vegetated wetlands to open water under the No Action Alternative. Modeling efforts run over a 100-year time span for southern Maurepas Swamp support marsh persistence and swamp-to-marsh conversion (Hoeppner 2008). A chronosequence of swamp degradation processes nearer Lake Maurepas, however, suggests that bald cypress-tupelo swamp would change to open water. Based on field observations, Lee Wilson & Assoc. et al. (2001) support the following trajectory: mortality of

herbaceous vegetation with limited conversion to more salt-tolerant species, reduced tree basal area and stem density, followed by mortality and transition to open water.

Across the Upper Pontchartrain Sub-Basin, the Coast 2050 Report (LCWCRTF & WCRA 1999) projects a loss of approximately half of swamp habitat, which includes both bald cypress-tupelo and bottomland hardwood habitats, by 2050 without restoration efforts (Table 5-10).

Projections were based on observed rates of wetland loss from 1974-1990 by habitat type in each mapping unit. Land cover of the Amite/Blind River Mapping Unit in 1990 included 138,900 acres (56,211 ha) of swamp (bottomland hardwood and bald cypress-tupelo) and 3,440 acres (1,392 ha) of fresh marsh. Based on observed annual rates of loss for swamp (0.83 percent per year) and fresh marsh (0.02 percent per year) in this unit, approximately 42 percent (or 58,338 acres [23,609 ha]) of swamp and one percent (or 40 acres [16 ha]) of fresh marsh would be lost over 50 years. Within the Study Area, these rates of wetland loss would result in the conversion of 9,139 acres (3,698 ha) of bald cypress-tupelo forest and 697 acres (282 ha) of bottomland hardwood, or a total loss of 9,836 acres (3,980 ha) of swamp to fresh marsh and open water for the interval from 2012 to 2062.

These conservative estimates are based upon the assumptions that wetland loss rates are static in time and loss occurs continuously. Empirical evidence suggests that the rate of relative sea level rise may likely increase in the future, as may the frequency of extreme weather events (ie., tropical storms, hurricanes, and droughts) (IPCC, 2004), Consequently, flood duration, saltwater influx, and wind damage may also increase in the future, forcing elevated rates of swamp to marsh/open water conversion.

Table 5-10. Projected Land Loss from 1990 to 2050 for the Upper Pontchartrain Sub-Basin by General Habitat Type (LCWCRTF & WCRA, 1999)

Mapping Unit	Habitat Type	1990	2050	% Land Loss
Amite/Blind	swamp	138,930	69,430	50%
	Marsh	3,440	3,400	1%
	TOTAL	142,370	72,830	49%
Tickfaw River Mouth	swamp	22,840	11,340	50%
	Marsh	2,350	0	0%
	TOTAL	25,190	11,340	55%

West Manchac	swamp	8,550	4,280	50%
	Marsh	2,950	2,890	2%
	TOTAL	11,500	7,170	38%

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wetland loss and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Dependant on the flow rate and timing of discharge, the LCA Small Diversion at Hope Canal would likely result in extensive freshening of Lake Maurepas, especially when operating during late-summer and early fall—low flow periods at which high salinity and saltwater intrusion present the greatest threat (Lee Wilson & Assoc. et al. 2001; Day et al. 2006). Modeling efforts for that project indicate that 40 percent of water diverted through Hope Canal will flow westward across Maurepas Swamp into Blind River and then into Lake Maurepas (Lee Wilson & Assoc. et al. 2001). Therefore, inflow from Lake Maurepas into southeastern Maurepas Swamp would likely exhibit decreased risk of salinity-related vegetation damage. Nonetheless, this project would not adequately increase sediment and nutrient delivery to the Study Area necessary to offset relative sea level rise and the indirect negative impacts of increased flood duration and stage on wetland vegetation resources.

Alternative 2

Direct

The direct impacts of Alternative 2 include construction impacts to approximately 53 acres (21 ha) of forested wetland along the transmission canal. These negative direct impacts would be more than offset by positive impacts to forested wetlands in the distribution area. An increase in forest health and primary productivity would occur due to increased nutrient availability. The introduction of nutrients with diverted freshwater has been shown to potentially increase tree (Mitsch and Ewel, 1979; Browns and van Peer, 1989; Myers et al. 1995; Hesse et al. 1998; Effler et al. 2007; Brantley et al. 2008) and herbaceous (Shaffer et al. 2001; Effler et al 2007) growth and overall primary productivity (Brown, 1981; Rybczyk et al. 1996) in nutrient limited baldcypress-tupelo and other forested swamp systems. Increased nutrient availability would also promote baldcypress seedling growth, and consequently survival, by reducing the risk of mortality caused by complete submergence (Meyers et al. 1995). Lowered stage and reduced impoundment would further promote tree productivity and seedling survival. Hydrologic benefits are largely related to in-swamp management measures. Therefore, these benefits are relatively equivalent between alternatives.

Indirect

Indirect impacts of Alternative 2 include diverse benefits that synergistically would promote the health of the swamp over time. Swamp building (accretion) would approximately offset subsidence and eustatic sea level rise. Indirectly, this process would minimize the further degradation of wetland vegetation resources in the distribution area due to impoundment and support increased productivity. By maintaining relatively lower water levels in the study area, an increase would be realized in the probability of baldcypress and water tupelo seedling survival, recruitment, and thus forest stability. Forest productivity would also increase substantially due to the greater frequency of periodic drawdown and flow through the system. Drawdown would create opportunities for baldcypress and water tupelo germination and growth. Flow through of diverted water would facilitate seed dispersal. An increase in nutrient availability and productivity would indirectly increase wetland plant resistance to and recovery from herbivore, parasite, disease, and other damage. An increase in forest health would sustain and increase the relatively high basal areas observed throughout most of the study area, which indirectly would reduce the risk of windthrow damage to midstory and understory wetland plants in storms events (Shaffer et al. 2007; personal communication, Dr. Gary Shaffer, 2009).

The Wetland Value Assessment Methodology swamp Model (WVA) was used to contrast the effects of each alternative on wetland vegetation resources within the distribution area over the 50-year project life. Model runs were based on assumptions derived from trends discussed above, field sampling efforts in the study area and Maurepas Swamp, hydrologic modeling, and mapping of habitat conditions in the distribution area. A general description of the WVA is provided in Section 3.5, with more detailed description in **Appendix K**. Field sampling data and hydrologic modeling are described in **Appendices L.** Alternative 2 would provide benefits to approximately 21,369 acres (8,648 ha) of forested wetland. Under the WVA methodology, this alternative would yield a net gain of 6,421 average annual habitat units (AAHUs) over the No Action Alternative. Net benefits are the difference of total benefits (6,462 AAHUs) less total impacts (41 AAHUs) for Alternative 2.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with coastwide wetland loss and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. Restoration activities in the vicinity of the study area would offset to some degree losses of wetland vegetation resources in the Upper Pontchartrain Sub-Basin. However, the interrelatedness between these systems is poorly understood (i.e. feedback mechanisms, thresholds, patch dynamics, etc.).

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exception. Construction impacts would affect approximately 271 acres (110 ha) of forested wetlands—108 acres (44 ha) along the transmission canal and 163 acres (66 ha) within the distribution area.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Alternative 4 would provide benefits to approximately 21,206 acres (8,582 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 6,124 AAHUs over the No Action Alternative. Net benefits are the difference of total benefits (6,302 AAHUs) less total impacts (178 AAHUs) for Alternative 4.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4 with the addition of the direct impacts associated with the construction of the Romeville transmission canal. In total, 287 acres (116 ha) of forested wetland would be directly impacted—126 acres (51 ha) in the distribution area and 161 acres (65 ha) along the two transmission canals.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Alternative 6 would provide benefits to approximately 21,243 acres (8,597 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 7,114 AAHUs over the No Action Alternative. Net benefits are the difference of total benefits (7,313 AAHUs) less total impacts (199 AAHUs) for Alternative 6.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4 with the following exception. Increased conveyance of flow from the outfall point to the southeast would require the expansion of the St. James Parish

canal. Therefore, construction impacts would increase to an affected area of approximately 306 acres (124 ha) of forested wetlands: 126 acres (51 ha) in the northern section of the distribution area, 77 acres (31 ha) adjacent to the St. James Parish canal, and 108 acres (44 ha) along the South Bridge transmission canal.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Alternative 4B would provide benefits to approximately 21,243 acres (8,597 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 7,103 AAHUs over the No Action Alternative. Net benefits are the difference of total benefits (7,313 AAHUs) less total impacts (210 AAHUs) for Alternative 4B.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.6.1 Upland Vegetation Resources

No Action Alternative (Future without Project Conditions)
Direct, Indirect

The No Action Alternative would have no direct or indirect impacts on upland vegetation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on upland vegetation combined with coastwide upland vegetation losses and degradation, as well as the benefits and impacts of other state and federal projects in the vicinity.

Alternative 2

Direct

The direct impacts of Alternative 2 on upland vegetation resources would include construction impacts to approximately 94 acres (38 ha) of upland habitat, of which approximately 86 acres (35 ha) are in cultivated crops and the remainder developed. Direct impacts to this resource would exclusively occur along the transmission canal.

Indirect

There would be no indirect impacts of Alternative 2 on upland vegetation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on upland vegetation combined with coastwide upland vegetation losses and

degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of Alternative 4 on upland vegetation resources would include construction impacts to approximately 101 acres (41 ha) of upland habitat, of which approximately 68 acres (28 ha) are in cultivated crops, 3 acres (1.2 ha) in scrub/shrub, and the remainder (30 ac [12 ha]) low intensity development. Direct impacts to this resource would exclusively occur along the transmission canal.

Indirect

There would be no indirect impacts of Alternative 4 on upland vegetation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on upland vegetation combined with coastwide upland vegetation losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in Section 5.1.2.

Alternative 6

Direct

The direct impacts of Alternative 6 on upland vegetation resources would include construction impacts to approximately 195 acres (79 ha) of upland habitat, of which approximately 154 acres (62 ha) are in cultivated crops, 4 acres (1.6 ha) in scrub/shrub, and the remainder (36 ac [15 ha]) low intensity development. Direct impacts to this resource would exclusively occur along the two transmission canals.

Indirect

There would be no indirect impacts of Alternative 6 on upland vegetation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on upland vegetation combined with coastwide upland vegetation losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in Section 5.1.2.

Alternative 4B

Direct

The direct impacts of this alternative would be the same as for Alternative 4.

Indirect

There would be no indirect impacts of Alternative 4B on upland vegetation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on upland vegetation combined with coastwide upland vegetation losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in Section 5.1.2.

5.6.2 Invasive Species - Vegetation

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative would have no direct impacts on invasive vegetation resources.

Indirect

The No Action Alternative, not implementing a diversion into the Study Area in southeastern Maurepas Swamp, would have minimal to no indirect impacts on invasive vegetation resources. Several invasive non-indigenous plant species (NIPS) are established in the Study Area. Based on field observations, however, these species do not appear to be displacing native species and dominating communities that are converting to marsh. Under the No Action Alternative, reduced species diversity and removal of native vegetation is likely. Such disturbance (i.e., increased water levels or stochastic event such as storm-related influx of saltwater) may facilitate the spread of invasive plant species in the Study Area (e.g., Theoharides and Dukes, 2007).

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on invasive vegetation with the additive combination of impacts from coastwide native vegetation losses and degradation on the transport, colonization, establishment, and spread of invasive plant species, as well as the benefits and impacts of other state and Federal projects in the vicinity.

Alternative 2

Direct

There would be minimal and localized direct impacts of Alternative 2 on invasive vegetation. Because of similar invasive aquatic plant species currently inhabit the Lower Mississippi River and the Maurepas Swamp, introduction of freshwater from the River to the swamp would likely not result in the transport of new invasive aquatic plant species into the study area. Habitat fragmentation and propagule transport due to construction activities may result in localized colonization of invasive plant species in these areas. Best management practices implemented in construction activities would limit the occurrence of such events.

Indirect

Indirect impacts of this alternative on invasive vegetation would be minimal. Increased resource availability due to the introduction of nutrients would increase

productivity, maintain diversity, and consequently promote the resistance of existing swamp communities to invasion, which is unlikely under the No Action Alternative (e.g., Theoharides and Dukes, 2007). Outbreaks of common salvinia within parish canals and the Blind River would continue and may be exacerbated; however, such events would continue to be restricted to these areas.

Cumulative

Cumulative impacts would be the synergistic effect of Alternative 2 on invasive vegetation combined with impacts from coastwide native vegetation losses and degradation on the transport, colonization, establishment, and spread of invasive plant species, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would e similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.7 Wildlife and Habitat

5.7.1 Birds

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion to the study area in southeastern Maurepas Swamp, would have no direct impacts on bird resources.

Indirect

Indirect impacts of not implementing a freshwater diversion would result in the persistence of existing conditions which includes the gradual conversion of existing forested wetlands used by birds for foraging, nesting, and over-wintering habitat to severely degraded and fragmented swamp forest habitats. Based on the habitat condition classes for the study area (20-3- years to marsh and 30-50 years to marsh), this includes the conversion of 11,228 acres of forested swamp to marsh. As interior forested wetlands convert to marsh and open water, there would be an expected loss of habitat for species dependent on swamp forest habitat.

The LCWCRTF & WCRA (1999) projects increases in bald eagles, while all other wildlife species are projected to remain stable under the No Action Alternative. However, more recent data indicates that degraded baldcypress-tupelo habitat in southeastern Maurepas supports significantly lower overall mean forest songbird species richness and abundance and lower mean abundance of prothonotary, northern parula, and yellow-throated warblers (Stouffer et al. 2005). This finding is consisting with more recent trends documented by Partners In Flight (PIF) (PIF) 2009. As such, continued degradation of swamp habitat in the study area would eventually result in decreased forest songbird abundance under the No Action Alternative. Significant loss of forest songbirds would have effects on the entire Maurepas Swamp ecosystem. Emerging insect pests of baldcypress and water tupelo have moderately to severely defoliated the Maurepas Swamp since about 1993 (Goyer and Chambers 1997). Declines in forest bird species richness and abundance may result in decreased functionality of insectivorous birds, increased caterpillar herbivory, and an accelerated rate at which swamp transitions into open marsh. Bird assemblages present would likely transition to species more typical of open water habitats.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative combined with coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse cumulative impacts on bird species would be offset, to some degree, by the positive impacts of implementing other state and Federal projects as detailed in **Section 5.1.2.** Without the restoration and protection of the Maurepas Swamp, the dense populations of wading birds, waterfowl, raptors, and songbirds that breed, rest, and forage there would decline over an increasing area as trees die due to flooding, salinity, and defoliation stressors. If this trend continues, many of the populations of bird species observed will be detrimentally impacted.

Alternative 2

Direct

Direct impacts include temporary and localized alteration and disturbance of foraging habitat (i.e., forest and canal edge habitat) associated with construction activities. This activity would have negative impact to species such as egrets, herons, common yellowthroat, killdeer, and mockingbird. There would be construction impacts to approximately 53 acres (21 ha) of forested wetland along the transmission canal. Construction activities would also represent temporary disturbances to a small area of available waterfowl habitat. These impacts would be temporary as waterfowl and foraging wading birds would most likely abandon the area during construction activity, and return after construction ends and water clarity improves.

Depending on the time period of construction, installation of a control structure may impact some breeding bird species of the area. Temporary increases in noise and turbidity could impact birds sensitive to noise or dependent on clear water for foraging. These temporary impacts would be localized to the control structure area.

Indirect

Indirect impacts include increases in primary productivity of the Maurepas Swamp ecosystem (Stouffer et al. 2005) which would benefit wading bird populations by restoring diminishing suitable swamp forest habitat and increasing abundance of forage fish and crayfish in the study area. Under Alternative 2, bird population in the distribution area would benefit from the restoration of 21,369 acres of swamp. Indirect impacts to bird species from chemical contaminants in diverted water are unlikely (Battelle 2005; Stouffer et al. 2005). Overall, birds would benefit in the longer term from the healthier swamp forest ecosystem that would provide better food sources and nesting sites than currently exist.

An additional indirect impact of diversion canal construction and maintenance may be increased brown-headed cowbird nest-parasitism of breeding songbirds. Brown-headed cowbirds could utilize maintained levees (i.e., forest openings) to probe deeper into forested habitat (Rich et al. 1994). However, populations of songbirds

appear to be reproducing with relatively high success rates, and it is unlikely that increased nest parasitism in a portion of the swamp will cause major population declines of host species (Stouffer et al. 2005). In the long-term, indirect impacts of Alternative 2 could result in a decrease access points for cowbirds due to enhanced swamp growth and regeneration.

The diversion is expected to decrease salinity in the Maurepas Swamp, which should have positive effects on bald eagles. Watts et al. (2006) found population growth, nesting density and productivity of Bald Eagles was negatively correlated with salinity due to long term effects of saltwater intrusion on forest health and nest tree survival.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. Reducing salinity and improving forest health will benefit cypress-tupelo swamp forts nesting species such as vireous (e.g., red-eyed, white-eyed, and yellow-throated) and woodpeckers (e.g. downy, hairy, northern flicker, pileated, and red-bellied), Salinity reduction from several projects in the area would maintain and benefit local populations of fish eating birds such as bald eagle, belted kingfisher, great-blue heron, and osprey by improving habitat and increasing the populations of preferred, freshwater forage fish (Stoufferet al. 2005).

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The construction of the South Bridge diversion could negatively impact birds dependent on those forest habitats temporarily.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The indirect impacts of clearing forested swamp for the South Bridge diversion would negatively impact birds dependent on those forest habitats and would persist into the future. Under Alternative 4 bird populations in the distribution area would benefit from the restoration of 21,206 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The loss of forested swamp due to the South Bridge diversion would be added to the overall loss of forested swamp habitat in the region. Increases in swamp productivity would benefit bird populations in the future.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4 with the following exception. There would be construction impacts to approximately 287 acres (116 ha) of forested wetland along the transmission canals.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 4 with the following exceptions. Under Alternative 6, bird populations in the distribution area would benefit from the restoration of 21,243 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4 with the following exceptions. There would be construction impacts to approximately 306 acres (124 ha) of forested wetland along the transmission canal.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 4 with the following exception Under Alternative 4B, bird populations in the distribution area would benefit from the restoration of 21,243 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

5.7.2 Mammals

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on mammal species.

Indirect

Indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) would result in the continued degradation, conversion, and eventual loss of important wetland habitats used by many different mammalian species. Based on the habitat condition classes for the study area (20-3-

years to marsh and 30-50 years to marsh), this includes the conversion of 11,228 acres of forested swamp to marsh.

The Coast 2050 Plan shows the status, functions of interest, trends, and projections through 2050 for furbearers and game mammals across the state by mapping units (LCWCRTF & WCRA 1999). The Amite/Blind mapping unit encompasses the interior southeastern Maurepas Swamp (study area). Under the No Action Alternative, declines in rabbit, deer, and squirrel populations are predicted by 2050, with all other wildlife species remaining stable.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative combined with coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse cumulative impacts on mammal species would be offset, to some degree, by the positive impacts of implementing other state and Federal projects as detailed in **Section 5.1.2**. This would include possible migration of mammal species out of the study area to areas of higher habitat quality.

Alternative 2

Direct

Direct impacts from construction would have minimal to no affect on deer and other mammals due to the high mobility of these species. Some resident mammals would be temporarily displaced by construction and would utilize large tracts of similar habitat nearby. Along the diversion corridor, several mammals that live in den sites within agricultural areas (e.g. coyote) or along existing ditches or canals (e.g. mink, otter) may be temporarily displaced. There would be construction impacts to approximately 53 acres (21 ha) of forested wetland along the transmission canal.

Indirect

Indirect impacts of Alternative 2 include improvement and creation of habitat for a variety of mammalian species associated with the freshwater and sediment inputs. Additionally, increased vegetative productivity and forest health will provide additional browse and shelter for mammals. Under Alternative 2, mammal populations in the distribution area would benefit from the restoration of 21, 369 acres of swamp.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. The restoration of significant areas of coastal wetlands throughout coastal Louisiana would improve connectivity of mammal populations once fragmented by areas of deep water and habitat degradation.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The construction of the South Bridge diversion would impact approximately 271 acres (110 ha) of forested wetlands. The direct impacts associated with construction would be more extensive due to the longer South Bridge diversion route including a small loss of forested swamp habitat.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Under Alternative 4 mammal populations in the distribution area would benefit from the restoration of 21,206 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4 the following exceptions. There would be construction impacts to approximately 287 acres (116 ha) of forested wetland along the transmission canals.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Under Alternative 6 mammal populations in the distribution area would benefit from the restoration of 21,243 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 4 with the following exceptions. There would be construction impacts to approximately 306 acres (124 ha) of forested wetland along the transmission canal.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

5.7.3 Reptiles

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) no direct impacts to reptile species in the study area would occur.

Indirect

Indirect impacts of the No Action Alternative include potential decreases in population sizes that result from decreased forest health and degradation. Based on the habitat condition classes for the study area (20-30 years to marsh and 30-50 years to marsh), this includes the conversion of 11,228 acres of forested swamp to marsh. Hibernation and nest habitat will become increasingly scarce as ridges are flooded and swamp vegetation is replaced with dense herbaceous vegetation typical of open marsh. Food sources will continue to decrease due to poor water quality, low nutrient availability, and low levels of productivity.

The Coast 2050 Plan shows the status, functions of interest, trends, and projections through 2050 for reptiles across the state by mapping units (LCWCRTF & WCRA 1999). The Amite/Blind mapping unit encompasses the interior southeastern Maurepas Swamp (study area). While increases in alligators are projected to 2050, all other reptile species are to remain stable under the No Action Alternative. However, if habitat degradation continues, wildlife assemblages present would likely transition to species more typical of open water habitats, provided such species are able to immigrate into the study area. Observations provide evidence that the ridges and hummocks that are becoming exceedingly rare in the Blind River ecosystem are critical reptile habitat (Gosselink 1984; Stouffer 2005; Tinkle 1955).

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative combined with coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse cumulative impacts on reptile species would be offset, to some degree, by the positive impacts of implementing other state and Federal projects as detailed in **Section 5.1.2.**

Alternative 2

Direct

The direct impacts of Alternative 2 include temporary effects on alligator abundance and displacement of some reptile species during construction of a diversion canal and control structures (Stouffer et al. 2005). Alligators and other reptiles would most likely leave the construction area and return after the disturbance has ended. There would be construction impacts to approximately 53 acres (21 ha) of forested wetland along the transmission canal.

Indirect

The indirect impacts of Alternative 2 include Benefits to reptile populations in the distribution area from the restoration of 21,369 acres of swamp, The indirect impacts also include increases reptile prey abundance and positive impacts on reptile densities due to increased nutrient availability, swamp productivity, and dissolved oxygen associated with the diversion.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 combined with impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. The additive combination of all the restoration projects in the vicinity of the study area will be an increase in reptile populations due to improved habitat conditions, prey availability, and connectivity across the region.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The construction of the South Bridge diversion would impact approximately 271 acres (110 ha) of forested wetlands.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions, Under Alternative 4, reptile populations in the distributions area would benefit from the restoration of 21,206 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 the following exceptions. There would be construction impacts to approximately 287 acres (116 ha) of forested wetland along the transmission canals

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.7.4Amphibians

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a diversion in southeastern Maurepas Swamp, would have no direct impact amphibian species.

Indirect

The indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) includes the continued degradation of swamp habitat and increased conversion of swamp into open freshwater marsh which will alter amphibian species composition presently observed in the area. Open freshwater marsh habitats are favored by larger anuran species like the bullfrog, pig frog, and southern leopard frog (Dundee and Rossman 1989). However the large numbers of small, vocal frogs that prefer the dense swamplands will be unable to transition and thus populations would decline. Populations of some salamanders like the lesser siren and three-toed amphiuma would increase due to increases in

open marshland habitat; however, other species such as the southern dusky salamander that utilize the swamp habitat would have population declines.

Decreases in amphibian populations would also be associated with increases in salinity in the future. Amphibians cannot tolerate the increasing salinity that has been reported in baldcypress-tupelo swamps throughout southern Louisiana (Dundee and Rossman 1989). With continued habitat degradation, assemblages present would likely transition to species more typical of open water habitats, provided such species are able to immigrate into the study area.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse cumulative impacts on amphibians would be offset, to some degree, by the positive impacts of implementing other state and Federal projects as detailed in **Section 5.1.2.**

Alternative 2

Direct

The direct impacts of Alternative 2 include temporary effects on amphibian abundance and displacement of some amphibian species during construction of a diversion canal and control structures.

Indirect

The indirect impacts of Alternative 2 include increases in current amphibian populations due to the increases in productivity, decreases in salinity, and increases in habitat from the diversion.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impact of the restoration projects in coastal Louisiana will be the conservation of local amphibian species dependent on areas of swamp forest for shelter, forage, and reproductive needs.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The construction of the south Bridge diversion would impact approximately 271 acres (110 ha) of forested wetlands.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions, Under Alternative 4, reptilepopulations in the distribution area would benefit from the restoration of 21,206 acres of swamp.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 the following exceptions. There would be construction impacts to approximately 287 acres (116 ha) of forested with the following exceptions. There would be the added direct impacts of two diversions including the temporary impacts to amphibians associated with construction activities.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 4.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

5.7.5 Invasive Wildlife Species

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a diversion in southeastern Maurepas Swamp, would have no direct impacts on invasive species.

Indirect

The indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) include increases in the populations and distribution of nutria due to the conversion of swamp into open water and freshwater marsh. There is evidence that nutria prefer fresh marsh and open areas within swamp forests (LDWF 2009), and the No Action Alternative would create optimal nutria habitat.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity as detailed in **Section 5.1.2.**

Alternative 2

Direct

Under Alternative 2, there would be no direct impacts on invasive wildlife species.

Indirect

Indirect impacts of Alternative 2 could include a decrease of current nutria populations due to increases in swamp productivity and maintenance of forested swamp habitat which could prevent the development of optimal nutria habitat.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity as detailed in **Section 5.1.2**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.8 Fisheries

5.8.1 Lower Mississippi River

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on fishery resources in the Lower Mississippi River.

Indirect

The No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no indirect impacts on fishery resources in the Lower Mississippi River.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** Although these projects will

benefit fishery resources in the Lake Pontchartrain Basin, they will be spatially limited to this basin and are unlikely to impact fishery resources in the Lower Mississippi River.

Alternative 2

Direct

The direct impacts of Alternative 2 include a small loss of fish habitat and potential direct fish mortality due to the placement of an intake structure and associated construction in the Mississippi River. These direct impacts would be temporary and localized. Structures associated with Alternative 2 will have openings to allow fish to migrate in the drainage canals as they have historically, and the low salinity that results from local rain runoff will not change species selectivity.

Indirect

The indirect impacts of Alternative 2 include fish mortality due to the long-term presence of an intake location. Another indirect impact is the potential loss of habitat due to reduction in discharge and sediment and nutrient load associated with the withdrawal of 3,000 cfs from the river during various times of the year. These reductions in discharge and nutrient and sediment load are minor compared to the overall load carried by the Mississippi River. Therefore, these indirect impacts will have little to no effect on the fishery resources in the Mississippi River.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. The cumulative impacts of this alternative also include impacts to fishery resources from other water withdrawals and discharges in the Mississippi River. The additional effects of decreases in river discharge and reductions in nutrient and sediment load from this alternative are comparatively small. The cumulative impacts of this alternative are unlikely to significantly affect fishery resources in the Lower Mississippi River.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be two intake locations placed in the Mississippi River that could potentially result in direct fish mortality and small losses in fish habitat.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be two intake locations that could result in fish mortality in the future.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.8.2 Blind River and Maurepas Swamp

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on fishery resources in the Blind River and Maurepas Swamp.

Indirect

Indirect impacts of not implementing a freshwater diversion would result in the persistence of existing conditions. The persistence of low oxygen conditions could contribute to fish kills and low species diversity in the Blind River. Persistence of existing conditions would also include continued loss of fragmented and deteriorating transitional wetland habitats used by fish for shelter, nesting, feeding, cover, nursery, and other life requirements; and increased inter- and intra-specific competition between resident and migratory fish species.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of coastwide fishery habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. The Small Diversion at Hope Canal would freshen the surrounding waters, albeit to an unknown extent, and slightly alter the flow patterns in Blind River, which might enhance aquatic habitat for fishery resources in its lower extent. Predictions from the Coast 2050, Habitat Switching and Land-Building models were used to assess changes in fisheries habitat. The models predict changes in marsh-type and marsh loss and gain, which, combined with other factors, were used to predict habitat suitability and fisheries productivity for Louisiana coastal areas. Sharp declines are predicted in fisheries productivity under the No Action Alternative (Minello et al. 1994; Rozas and Reed et al 1993; in LCA 2004). The LCA Study (USACE, 2004) estimated a net loss of 328,000 acres (132,734 ha) of coastal wetland habitats may occur by 2050. This is almost 10 percent of Louisiana's remaining coastal wetlands, which is utilized by various fish species for shelter, foraging, cover, nursery, and other life requirements.

Other cumulative impacts to fishery resources would include impacts to aquatic habitat suitability. Aquatic habitat suitability for fishery resources varies by species and depends primarily on different water quality and substrate parameters. Hence, impacts to water quality (such as salinity, dissolved oxygen and temperature) as well as wetland development activities (dredge/fill); habitat conversion (e.g., wetland to upland); and blockage of ingress and egress access would adversely impact fishery resources in the study area. These factors would likely affect aquatic habitat and fishery species diversity, population size, and harvest rates of fisheries.

Alternative 2

Direct

The direct impacts of Alternative 2 include negative effects on fishery resources from temporary increases in turbidity and BOD and decreases in DO associated with construction activities in the Maurepas Swamp. These impacts would be localized to the construction area and would be temporary. The presence of control structures in the interior canals of Maurepas Swamp could limit migration of fish species. These control structure would only be operated during certain stages and thus would restrict migration for short time periods.

Indirect

The indirect impacts of Alternative 2 include the possible displacement of some fish species due to changes in salinity (Caffey and Schexnayder 2002). Consequentially, fish populations in some areas may decline as certain species migrate to other areas. Another indirect impact would be benefits to fishery resources in the long term due to augmentation of food webs and increases larval fish habitat associated

with the diversion (Caffey and Schexnayder 2002). The presence of control structures would restrict fish migration during certain time periods in the future.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. The benefits of other diversion projects in the area will also increase productivity, which would increase fish populations. This may increase fish populations in the Blind River and Maurepas Swamp due to migration. Additionally, decreases in salinity in Lake Maurepas from other diversion projects could increase freshwater fish species in the area which may increase populations in the Blind River and Maurepas Swamp. These projects will result in positive cumulative impacts in fishery resources in the Lake Pontchartrain Basin. Overall increases in fish populations will not be spatially localized to individual project areas due to migration of fish within the basin.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with more extensive direct impacts due to the additional construction associated with the widening of the St. James Parish canal by 100 feet. This would have temporary negative effects on local fish populations due to decreases in DO and increases in turbidity and BOD.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The widening of the St. James Parish canal would increase habitat for freshwater fish species.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.8.3 Lake Maurepas

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion in the southeastern Maurepas Swamp, would have no direct impacts on fishery resources in Lake Maurepas.

Indirect

The indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) would be similar to those described for the No Action Alternative for the Blind River and Maurepas Swamp with the following exceptions. There would be population increases of saline-tolerant fish species due to increases in salinity levels in Lake Maurepas. Consequentially, populations of freshwater fish species in the lake would decline.

Cumulative

The cumulative impacts of the No Action Alternative would be similar to those described for the No Action Alternative for the Blind River and Maurepas Swamp. Wetland conversion to open water would continue which would result in decreases in habitat for larval fish and increases in habitat for some fish species. These processes would be slowed by other diversion projects in and around Lake Maurepas. Statewide changes in fisheries would be related to trends within the region as well as the beneficial impacts of other Federal, state, local, and private restoration efforts, as summarized in **Section 5.1.2.**

Alternative 2

Direct

There would be no direct impacts of this alternative on fishery resources in Lake Maurepas.

Indirect

Indirect impacts of this alternative would be similar to those described for Alternative 2 for the Blind River and Maurepas Swamp. Changes in salinity would result in population decreases in saline-tolerant fish species and increases in populations of freshwater fish species. Increases in productivity in the Blind River and Maurepas Swamp would benefit overall fish populations in the future.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2 for Blind River and Maurepas Swamp.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.9 Aquatic Resources

5.9.1 Plankton

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative (no freshwater diversion in the southeastern Maurepas Swamp) would have no direct impacts on plankton resources.

Indirect

Indirect impacts of not implementing the diversion into the southeastern Maurepas Swamp would result in the persistence of existing conditions in the distribution area including the continued degradation and eventual loss of forested wetlands. This loss of wetlands would lead to a shift in plankton populations to species assemblages that prefer open water habitats. There would be no indirect impacts to plankton populations in the Lower Mississippi River.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on plankton resources with the additive combination of similar wetland degradation and wetland loss impacts to plankton resources throughout southern Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**.

Alternative 2

Direct

The direct impacts of Alternative 2 include the negative effects of some plankton populations due to construction activities associated with dredging and installation of structures in the study area. During construction, there would be a localized and short-term decrease in DO concentrations and an increase in turbidity,

temperature, and BOD. Following construction activities, the area would return to ambient conditions and be decolonized by plankton populations.

Indirect

The indirect impacts of Alternative 2 would benefit plankton populations due to increases in the planktonic food web in Maurepas Swamp and the Blind River associated with increases in DO, nutrients and detritus from the diversion. Indirect impacts to plankton also include localized changes in population's assemblages due to the diversion.

Cumulative

Cumulative impacts to plankton resources would primarily be associated with the incremental impacts due to increased nutrients, oxygen and sediment being provided into the river and swamp. Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.** Alternative 2 would synergistically interact with other restoration projects to provide more a complete addition of freshwater, nutrients, oxygen and sediments necessary to improve and help restore the Blind River and Maurepas Swamp. As a result, this would enhance and provide important energy inputs to the planktonic food web.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

Direct impacts will be similar to Alternative 2 with the following exceptions. Construction activities would occur at two intake locations in the Lower Mississippi River.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.9.2 Benthic Resources

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on benthic resources.

Indirect

The indirect impacts of the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp) include conversion of existing forested wetlands to emergent or open water bottoms that would decreases populations of benthic species assemblages that typically utilize or require wetland habitats. Other indirect impacts include a decrease in benthic populations due to decreases of available nutrients and detritus. The conversion of primarily wetland dependent benthic species assemblages to more emergent and open water benthic species assemblages would also occur.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of similar forested wetland degradation and conversion to emergent and open water habitats and resultant impacts to benthic resources throughout southern Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

The direct impacts of Alternative 2 include direct mortality of slow-moving, sessile or benthic organisms during construction activities in the Lower Mississippi River and Maurepas Swamp. Other benthic species using these areas would likely be displaced to more suitable habitats. Any such impacts would initially cause increased inter- and intra-specific competition between various benthic species for nearby available habitat resources. There would also be a shift in species composition to those benthic species more tolerant of disturbance. The settlement of sediment out of the water column during the introduction of freshwater into the river and swamp would also cause temporarily and localized impacts to some sessile and benthic species. However, the prolific nature of the benthic community is expected to result in rapid re-colonization of substrates once construction is completed. Short-term disturbance to benthic species would likely occur from increased turbidity, temperature and BOD and decreased DO due to installation of control structures. These direct impacts would generally be localized and temporary as benthos would quickly re-colonize areas disturbed by construction activities. The diversion of water from the Mississippi could result in the introduction of the zebra mussel to the Lake Pontchartrain Basin.

Indirect

The indirect impacts of Alternative 2 would benefit benthic resources by providing increased dissolved oxygen and nutrients that would provide food and energy resources for benthic organisms due to the diversion. This would eventually increase local epifauna which, in turn, would serve as important sources of food for birds, nekton, and people (Day et al., 1989).

Cumulative

Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2** Alternative 2 would work synergistically with those projects to provide freshwater, nutrients and sediments which provide energy inputs to the benthic food web.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Construction activities would occur in two separate areas in the Lower Mississippi River and Maurepas Swamp which would cause some additional temporary impacts to benthic populations.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.10 Essential Fish Habitat (EFH)

No Action Alternative (Future without Project Conditions)

Direct

There is no EFH located within the study area. Lake Maurepas is EFH for red drum and white shrimp. Therefore, potential impacts to EFH in the lake are considered. The No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on EFH in Lake Maurepas.

Indirect

The indirect impacts of the No Action Alternative no freshwater diversion into the southeastern Maurepas Swamp would result in the persistence of existing

conditions resulting in the continued conversion of marsh to open water and increases in salinity in and around Lake Maurepas. Continued increases in salinity levels in Lake Maurepas could shift or increase the optimal habitat for red drum and white shrimp closer to the outlet of the Blind River. Conversion of emergent marsh to open water would represent a loss of EFH for juvenile life cycle requirements of both white shrimp and red drum.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of coastwide fishery habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** The Small Diversion at Hope Canal along with other diversion projects would freshen the surrounding waters, albeit to an unknown extent, and slightly alter the flow patterns, which might shift or decrease EFH in Lake Maurepas. Predictions from the Coast 2050, Habitat Switching and Land-Building models were used to assess changes in fisheries habitat. The models predict changes in marsh-type and marsh loss and gain, which, combined with other factors, were used to predict habitat suitability and fisheries productivity for Louisiana coastal areas (LCWRTE WCA 1999). Sharp declines are predicted in fisheries productivity under the No Action Alternative (Minello et al. 1994; Rozas and Reed et al 1993; in LCA 2004). The LCA Study (USACE, 2004) estimated a net loss of 328,000 acres (132,737 ha) of coastal wetland habitats may occur by 2050. This is almost 10 percent of Louisiana's remaining coastal wetlands, which is utilized by various fish species for shelter, foraging, cover, nursery, and other life requirements. These losses would represent a reduction in EFH for juvenile life cycle requirements of both white shrimp and red drum.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on EFH in Lake Maurepas.

Indirect

The indirect impacts of Alternative 2 include a potential shift or decrease in the optimal habitat for red drum and white shrimp towards the east in Lake Maurepas due to decreases in salinity. Other indirect impacts include an increase in EFH for juvenile life cycle requirements of both white shrimp and red drum due to the increase and maintenance of swamp habitat from the diversion. Increases in productivity resulting from Alternative 2 would benefit populations of red drum and white shrimp in Lake Maurepas.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of coastwide fishery habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** The cumulative impacts of Alternative 2 with

other diversion projects include decreases in salinity in Lake Maurepas which would shift or decrease optimal habitat for red drum and white shrimp in the lake. Wetland building processes resulting from other diversions in addition to Alternative 2 could result in an increase in EFH for juvenile life cycle requirements of both white shrimp and red drum. Increases in productivity resulting from other diversion projects and Alternative 2 would benefit populations of red drum and white shrimp in Lake Maurepas.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.11 Threatened and Endangered Species

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative would have no direct impacts on listed (endangered or threatened) species or their critical habitat in the Study Area.

Indirect

Indirect impacts of not implementing the diversion into the Study Area in southeastern Maurepas Swamp would result in the continued degradation, conversion, and eventual loss of important wetland habitats used by threatened and endangered species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements.

Cumulative

Cumulative impact would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide wildlife habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity. Adverse impacts on listed species from not implementing this project would be offset, to some degree, by the positive cumulative impacts of implementing other state and Federal projects.

Alternative 2

Direct

The direct impacts of Alternative 2 include potential entrainment of pallid sturgeon at the intake location. The entrainment risk is low for juveniles due to low likelihood of occurrence in the study area, and moderate for sub-adults and adults due to presumed lower limits on swimming capabilities of some individual fish.

Additional direct impacts include temporary displacement of manatees (although they are exceptionally rare) during construction activities in the study area. The manatees, if present, would likely move to other areas for foraging or resting purposes.

Indirect

The indirect impacts of Alternative 2 include creation of structures beneficial to pallid sturgeon. Pallid sturgeon in the Mississippi River is frequently found in the vicinity of man-made structures that provide shelter from main channel water

velocities. They also provide hard, permanent substrates for benthic invertebrates and fish eaten by pallid sturgeon (Hoover et al. 2007).

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be two intake locations which could result in entrainment of pallid sturgeon.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. There would be two intake locations which could provide habitat for the pallid sturgeon.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect
The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative
The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.12 Cultural and Historic Resources
No Action Alternative (Future without Project Conditions)
Direct, Indirect
Under the No Action Alternative (Future Without Project conditions), no direct or indirect impacts to cultural and historic resources in Study Area would occur.

Cumulative

Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other federal, state, local, and private restoration efforts as summarized for coastal Louisiana, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2
Direct
Direct impacts could result from construction activities if there were cultural resources present. A preliminary Cultural Resources Survey has been conducted to identify sites of significance that may or may not be directly impacted by the implementation of the freshwater diversion and its associated structures. No archaeological or historical resources in the study area were identified in the Cultural Resources Survey, and therefore no affect to any cultural resource is expected to occur. Forthcoming Phase I survey results will be considered, to avoid any direct impacts with existing cultural resources that could be identified.

Indirect
Indirect impacts on cultural resources include depositing sediments and restoring the health of the swamp in the distribution area. Deposition of sediment can change the environment of an existing site by providing additional protection to the site. This alternative could benefit cultural resources by protecting them against impacts such as flooding, land subsidence and/or erosion from annual storms.

Cumulative
Cumulative impacts would be the synergistic effect with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized for coastal

Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. This alternative would provide additional restorative and regenerative ecological potential for the Blind River and the Maurepas Swamp, which would continue to provide protection to the cultural resources in the study area.

Alternative 4

Direct

Direct impacts from this alternative would potentially impact some archaeological and historical resources. Records indicate the probable presence of some archaeological sites, as well as the location of the Tippecanoe Plantation within the proposed corridor for this alternative.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2, but with the exception that potential direct impacts to archaeological and historical resources along the South Bridge transmission canal could occur.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

5-13 Aesthetics

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, no directs impacts to aesthetics in the study area would occur.

Indirect

The indirect impacts of the No Action Alternative no freshwater diversion into the southeastern Maurepas Swamp include continued swamp degradation and conversion of existing wetlands to fresh marsh and open water habitats. This would result in decreased structural complexity and habitat diversity, limiting the aesthetic appeal of the study area.

Along the Blind River, the continued conversion to marsh and open water habitats would directly and dramatically affect the viewscape. Viewers on the Blind River would be able to see through the vegetation and preview the adjacent areas before arriving at them. Large baldcypress trees would be lost and not replaced, negatively impacting the aesthetic quality of the river. The surrounding environment would change from shaded with partial canopy cover to a brighter and more open river. Changes in vegetation may also result in a change in wildlife viewable by the user which adds to the loss or reduction of many of the qualities that qualified the Blind River as a Scenic River. This loss would also be evident along the canals, although to a somewhat lesser extent due to man-made effects already seen (e.g. straightness, side cast berms, and petroleum pipeline easements).

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on aesthetic resources with the additive combination of similar impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** Other restoration projects near Lake Maurepas would maintain and enhance the aesthetic quality of the swamps around the lake. These benefits would primarily be localized to those project areas and would not directly improve aesthetics in the study area.

Alternative 2

Direct

The direct impacts of Alternative 2 include the installation of the diversion structures adjacent to the Mississippi River that would add industrial-looking

elements at the levee. Visual impacts from the diversion structure would be minimal because they would be similar to the industrial aesthetics of the nearby oil refineries on River Road (Highway 44). The nearest residences are a minimum of approximately 0.2 miles from the diversion culvert location; the shape of the neighborhoods and a bend in River Road would hide the diversion structure from most of the nearby residences. The berm and canal construction of the diversion route would be aesthetically similar to canal and railroad features that currently existing along the diversion corridor.

Visual impacts within the distribution area are expected to be minimal. The control structures are likely to be gates or weirs that would only be visible in their immediate vicinity. Furthermore, these structures would only be operated in the closed position periodically and would be below the water surface in the open position. Improvements in the berm cuts and the addition of new berm cuts would either have negligible impacts or could even improve the nearby viewshed by improving views into the swamp from the canals and removing some of the visually unappealing berms.

Indirect

The indirect impacts of Alternative 2 include the improvement of the visual aesthetics of the study area through restoration of the forested swamp where it has been deteriorating within the study area.

Cumulative

Cumulative impacts would be the synergistic effect of the Alternative 2 on aesthetic resources with the additive combination of similar impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** Restoration and preservation of the study area around Lake Maurepas from other diversion projects would maintain and enhance the aesthetic quality of the region.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. Within Maurepas Swamp, the visual impacts of the diversion canal would be slightly greater than Alternative 2 because the canal would cut through a section of swamp that is relatively undisturbed. The viewshed in this area would not be considerably affected because the canal would be hidden by trees and access is limited.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The direct impacts associated with the South Bridge diversion described in Alternative 4 would also be present.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.14 Recreation

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the Study Area in southeastern Maurepas Swamp, would have direct impacts on recreational resources. The recreational experience of the site is related to the condition of the area's natural resources. The continued water quality degradation of existing marsh and wetlands would diminish the wildlife habitat of the area, which in turn would adversely impact the recreational opportunities of the Study Area.

The existing recreation benefit of the Study Area is estimated by way of the Unit Day Value (UDV) method, employed in compliance with the USACE Economics

Guidance Memorandum, 09-03. The natural and built resources of the study site are analyzed and assigned points based on five criteria:

- Recreation Experience: Based on the number of activities available at the site and whether they are unique to the site;
- Availability of Opportunity: Based on how many other areas for fishing and hunting are within 30 minutes, 45 minutes, 1 hour and 2 hours travel time of the study site;
- Carrying Capacity: Based on a rating of the facilities on site: minimum, basic, adequate, optimum and ultimate;
- Accessibility: Based on a rating of the accessibility to the site and within the site: limited; fair and good; and
- Environmental: Based on aesthetic factors such as geology, topography, water and vegetation, air pollution, water pollution, poor climate, and adjacent views.

The following table (Table 5-11) demonstrates the guidelines for assigning points within the UDV method.

Table 5-11. Guidelines for assigning points within the Unit Day Value Method

Criteria	Judgement Factors				
Recreation experience Total Points: 30	Two general activities	Several general activities	Several general activities; one high quality value activity	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Point Value: 13	0-4	5-10	11-16	17-23	24-30
Availability of opportunity Total Points 18	Several within one hour travel time; a few within 30 minutes travel time	Several within one hour travel time; none within 30 minutes travel time	One or two within one hour travel time; none within 45 minutes travel time	None within one hour travel time	None within 2 hour travel time
Point Value: 6	0-3	4-6	7-10	11-14	15-18
Carrying capacity Total Points 14	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource of activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative

Point Value: 8	0-2	3-5	6-8	9-11	12-14
Accessibility Total Points: 18	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access to good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value: 11	0-3	4-6	7-10	11-14	15-18
Environmental Total Points: 20	Low aesthetic factors that significantly lower quality	Average aesthetic quality; factors exist that lower quality to minor degree	Above average aesthetic quality; any limiting factors can be reasonably justified	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value: 8	0-2	3-6	7-10	11-15	16-20

Based on project team site visits in July and September 2009 and consultation with user groups, the values were scored as follows:

- Recreation Experience: There are several general activities on site, but none unique to the site. The Study Area is predominantly navigable by water; as a result many of the activities are water-based. As a result, the point value assigned to the study site is **6**.
- Availability of Opportunity: The Elm Hall WMA is within 20 miles of the Study Area. Eight additional WMAs and National Wildlife Refuges (NWRs) are within 40 miles of the study site. Therefore, the point value assigned is **2**.
- Carrying Capacity: Facilities within the Study Area include the St. James Boat Club in Paulina, a private non-profit club with the only bathroom facilities on site; private hunting camps; and the Grand Point Boat Ramp. Facilities are characterized as basic; the points assigned are **3**.
- Accessibility: The majority of the study site is navigable only by water; the Boat Club and Grand Point Ramp serve as access points. However on occasion the water level can be too low to employ an air boat. Thus, the points assigned are 10.
- Environmental: During project team site visits in July and September 2009, debris such as televisions, tires, and bottles were noted on site, as well as an odor of animal tissue decay. Although these factors diminish the aesthetic value of the site, they can be reasonably rectified and the

overall aesthetic quality of the site is deemed above average. Thus, the points assigned are 8.

The total points allocated to the site are 29. According to the USACE Memorandum, 29 points equates to a $6.89 UDA for general fishing and hunting.

The LDWF estimated annual use of the Maurepas Swamp WMA from July 2007 to June 2008 was 9,442, making it the second-most frequented WMA in the LDWF's Region 7. The Maurepas Swamp WMA experienced peak use in October through December, and low use in April through May. The average monthly visitation for the Maurepas WMA is 787 for the July 2007 to June 2008 timeframe. The proposed Study Area comprises of approximately half of the total WMA area. Thus, half of 787, or 394, provides an approximate average monthly use for the proposed Study Area. Three hundred and ninety-four times the $6.89 unit day value yields an estimated total monthly recreation benefit of $2,700 for the Study Area or approximately $32,400 on an annual basis.

However, if nothing is done in the future to stem the trend of degradation in the swamp (the No Action Alternative) this value will decline. Recreational resources in the Study Area that would most likely be affected by the No Action Alternative are those related to loss of wetlands/marshes and habitat diversity. Fish and wildlife abundance is related to the quantity and quality of wetlands present.

As the Maurepas Swamp continues to degrade, fragment and convert to marsh and open water habitat, the local abundance and diversity of fish and wildlife species that present utilize the existing Maurepas Swamp habitats would be expected to decline over time. More mobile fish and wildlife species would relocate to more suitable wetland habitats; migratory birds would be required to find more suitable stopover habitats on their trans-Gulf migrations. Hence, fishing and hunting opportunities would also like decline. Waterfowl populations, particularly mallards, are presently declining throughout North America. Consequently, waterfowl hunting opportunities in the Study Area would likely decline if these waterfowl population trends continue and if suitable waterfowl wintering habitat continues to degrade, fragment and decline in the Study Area. Recreational birdwatching opportunities would also likely diminish as migratory bird usage of the Maurepas Swamp declines in response to swamp habitat degradation, fragmentation and conversion to marsh and open water.

Indirect

Indirect impacts of the implementation of the No Action Alternative, not implementing a freshwater diversion intothe Study Area in southeastern Maurepas Swamp, would result from the continuing swamp degradation, fragmentation and conversion to marsh and open water. For these conditions would be expected to cause the abundance and diversity of fish and wildlife to decline over time. Lower-quality fishery spawning, nursery, and foraging habitat would translate to a decline in sport fishing opportunities in the future. Decreased use of the Study Area by

game species would likewise reduce hunting opportunities. Thus, implementation of the No Action Alternative would cause the recreational value of the Study Area to decline.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts.

In addition, more recent restoration efforts would also cumulatively interact to help offset losses of recreational resources in the Study Area by preserving and enhancing the natural habitats, thereby enabling the continuation and even expansion of existing recreational activities within the Study Area and the region as a whole.

Alternative 2

Direct

The primary direct impacts on recreational resources would result from the study area being temporarily unavailable during construction. In addition, there would be a temporary and localized decrease in the quality of recreational opportunities near construction areas.

Indirect

Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. Following construction, this freshwater swamp would provide important and essential fish and wildlife habitats that would contribute to restoring the base of organisms used for recreational activities such as fishing, bird watching and hunting.

Wildlife-dependent recreation activities would be maintained and possibly increased. Recreation activities dependent upon swamp habitats, such as hunting, fishing and bird watching, would be maintained and possibly increased. Fishing and hunting activities could continue in areas near the study site.

Taking into consideration both the direct and indirect impacts of the proposed Alternative 2, the UDV method was employed and values were scored as follows:

- **Recreation Experience**: There are several general activities, common to the region, which can be conducted on site. Many of these activities are dependent upon the freshwater the swamp provides. The addition of a diversion along the Romeville alignment would preserve and restore the freshwater habitat, enabling the quality of the recreation to increase. As a result, the implementation of Alternative 2 would result in a point value assigned to the study site as an 8.

- **Availability of Opportunity**: The Elm Hall WMA is within 20 miles of the study area. Eight additional WMAs and National Wildlife Refuges (NWRs) are within 40 miles of the study site. The implementation of Alternative 2 would not affect this guideline category. Thus, the point value assigned would be **2**.
- **Carrying Capacity**: Facilities within the study area are characterized as basic. Alternative 2 would not involve the addition of new facilities or the improvement of existing ones. The points assigned would therefore remain as **3**.
- **Accessibility**: The implementation of Alternative 2 is designed so as to not impede accessibility. Therefore, the points assigned would remain as **10**.
- **Environmental**: Alternative 2 is designed to restore the freshwater habitat within the study area. A freshwater diversion along the Romeville alignment would reduce the salinity within the study area as well as the frequency of flooding. Habitat restoration would significantly increase the aesthetic value of the study site. Thus, the points assigned would be **14**.

The total points allocated to the site would be 37. According to the USACE Memorandum, 37 points equates to a $7.43 UDV for general fishing and hunting. The approximate average monthly use for the proposed study area is 394. Three hundred and ninety-four times the $7.43 UDV yields an estimated total annual recreation benefit of approximately $35,000 for the study area, an annual increase of $2,600 over the value of existing conditions.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2**. The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area, thus unlike the No Action Alternative, this proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts for this Alternative would be similar to those described for Alternative 2 with the following exceptions.

Taking into consideration both the direct and indirect impacts of the proposed Alternative 4, the UDV method was employed and values were scored as follows:

- **Recreation Experience**: There are several general activities, common to the region, which can be conducted on site. Many of these activities are dependent upon the freshwater the swamp provides. The addition of a diversion along the South Bridge alignment would preserve and restore the freshwater habitat, enabling the quality of the recreation to increase. As a result, the implementation of Alternative 4 would result in a point value assigned to the study site as an **8**.
- **Availability of Opportunity**: The Elm Hall WMA is within 20 miles of the study area. Eight additional WMAs and National Wildlife Refuges (NWRs) are within 40 miles of the study site. The implementation of Alternative 4 would not affect this guideline category. Thus, the point value assigned would be **2**.
- **Carrying Capacity**: Facilities within the study area are characterized as basic. Alternative 4 would not involve the addition of new facilities or the improvement of existing ones. The points assigned would therefore remain as **3**.
- **Accessibility**: The implementation of Alternative 4 is designed so as to not impede accessibility. Therefore, the points assigned would remain as **10**.
- **Environmental**: Alternative 4 is designed to restore the freshwater habitat within the study area. A freshwater diversion along the South Bridge alignment would reduce the salinity within the study area as well as the frequency of flooding. Habitat restoration would significantly increase the aesthetic value of the study site. Thus, the points assigned would be **14**.

Upon implementation of Alternative 4, the total points allocated to the site would be 37. According to the USACE Memorandum, 37 points equates to a $7.43 UDV for general fishing and hunting. The approximate average monthly use for the proposed study area is 394. Three hundred and ninety-four times the $7.43 UDV yields an estimated total annual recreation benefit of approximately $35,000 for the study area, an annual increase of $2,600 over the value of existing conditions.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 4 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts. The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts for this Alternative would be similar to those described for Alternative 2 with the following exceptions.

Taking into consideration both the direct and indirect impacts of the proposed Alternative 6, the UDV method was employed and values were scored as follows:

- **Recreation Experience**: There are several general activities, common to the region, which can be conducted on site. Many of these activities are dependent upon the freshwater the swamp provides. The addition of two diversions along the Romeville and South Bridge alignments would preserve and restore the freshwater habitat, enabling the quality of the recreation to increase. Two diversions would prevent salinity concentrations within the study area and decrease the overall salinity in the swamp at a faster rate than the installation of just one diversion. As a result, the implementation of Alternative 6 would result in a point value assigned to the study site as a **10**.
- **Availability of Opportunity**: The Elm Hall WMA is within 20 miles of the study area. Eight additional WMAs and National Wildlife Refuges (NWRs) are within 40 miles of the study site. The implementation of Alternative 6 would not affect this guideline category. Thus, the point value assigned would be **2**.
- **Carrying Capacity**: Facilities within the study area are characterized as basic. Alternative 6 would not involve the addition of new facilities or the improvement of existing ones. The points assigned would therefore remain as **3**.
- **Accessibility**: The implementation of Alternative 6 is designed so as to not impede accessibility. Therefore, the points assigned would remain as **10**.
- **Environmental**: Alternative 6 is designed to restore the freshwater habitat within the study area. Two freshwater diversions would reduce the overall salinity within the study area, reduce salinity concentrations throughout the study area, and control for flooding. Two diversions would serve to significantly facilitate habitat restoration, which in turn would significantly increase the aesthetic value of the study site. Thus, the points assigned would be **16**.

Upon implementation of Alternative 6, the total points allocated to the site would be 41. According to the USACE Memorandum, 41 points equates to a $7.70 UDV for general fishing and hunting. The approximate average monthly use for the proposed study area is 394. Three hundred and ninety-four times the $7.70 UDV

yields an estimated total annual recreation benefit of $36,400 for the study area, an annual increase of $4,000 over the value of existing conditions.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 6 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts. The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts for this Alternative would be similar to those described for Alternative 2 with the following exceptions.

Taking into consideration both the direct and indirect impacts of the proposed Alternative 4B, the UDV method was employed and values were scored as follows:

- **Recreation Experience**: There are several general activities, common to the region, which can be conducted on site. Many of these activities are dependent upon the freshwater the swamp provides. The addition of a diversion along the South Bridge alignment and the modification to allow flow through the St. James Parish Canal would preserve and restore the freshwater habitat, enabling the quality of the recreation to increase. Two diversions would prevent salinity concentrations within the study area and decrease the overall salinity in the swamp at a faster rate than the installation of just one diversion. As a result, the implementation of Alternative 4B would result in a point value assigned to the study site as a **10**.
- **Availability of Opportunity**: The Elm Hall WMA is within 20 miles of the study area. Eight additional WMAs and National Wildlife Refuges (NWRs) are within 40 miles of the study site. The implementation of Alternative 4B would not affect this guideline category. Thus, the point value assigned would be **2**.
- **Carrying Capacity**: Facilities within the study area are characterized as basic. Alternative 4B would not involve the addition of new facilities or the improvement of existing ones. The points assigned would therefore remain as **3**.
- **Accessibility**: The implementation of Alternative 4B is designed so as to not impede accessibility. Therefore, the points assigned would remain as **10**.

- **Environmental**: Alternative 4B is designed to restore the freshwater habitat within the study area. A split freshwater diversion would reduce the overall salinity within the study area, reduce salinity concentrations throughout the study area, and control for flooding. Two diversions would serve to significantly facilitate habitat restoration, which in turn would significantly increase the aesthetic value of the study site. Thus, the points assigned would be **16**.

Upon implementation of Alternative 4B, the total points allocated to the site would be 41. According to the USACE Memorandum, 41 points equates to a $7.70 UDV for general fishing and hunting. The approximate average monthly use for the proposed study area is 394. Three hundred and ninety-four times the $7.70 UDV yields an estimated total annual recreation benefit of $36,400 for the study area, an annual increase of $4,000 over the value of existing conditions.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 4B with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration. The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15 Socioeconomics and Human Resources

5.15.1 Displacement of Population and Housing

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on the displacement of population and housing. According to the U.S. Census Bureau, Ascension Parish increased in population from 2000 to 2008 by nearly 33 percent. The Louisiana Parish Population Projections Series, 2010-2030, published by the State of Louisiana Office of Electronic Services, predicts that Ascension Parish will continue to grow exponentially, projecting an increase in population of 196,140 in 2030, or nearly 93 percent over 2008 figures. In contrast, St. James Parish's population increased by less than 1 percent from 2000 to 2008 and is projected by the State to slightly decrease in population in 2030 to 19,670, a decrease of more than 7 percent from 2008. Within the distribution area there are no permanent residents and no new residences are permitted within the WMA, which comprises much of the study area. Therefore, no displacement of population and housing is anticipated as a result of the implementation of the No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp.

Indirect

As there are no permanent residents within the distribution area, there would be no indirect impacts on the displacement of population and housing from the implementation of the No Action Alternative.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

Alternative 2

Direct

There are no permanent residences along the Romeville alignment involved in the proposed Alternative 2. Thus, there would be no direct impacts on the displacement of population and housing as a result of the implementation of Alternative 2.

Indirect

Since there are no permanent residences within the study area of Alternative 2, there would be no indirect impacts on the displacement of population and housing as a result of the implementation of Alternative 2.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative.

Alternative 4

Direct

The direct impacts of Alternative 4 include the potential displacement of at most three houses and their inhabitants along the South Bridge transmission canal.

Indirect

There would be no indirect impacts of Alternative 4 on displacement of populations or housing.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 4 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts.

Alternative 6

Direct

The direct impacts of Alternative 6 include the potential displacement of at most three houses and their inhabitants along the South Bridge transmission canal. There would be no direct impacts on populations or housing along the Romeville transmission canal.

Indirect

There would be no indirect impacts of Alternative 6 on displacement of populations or housing.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 6 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts.

Alternative 4B

Direct

Direct impacts of Alternative 4B include the potential displacement of at most three houses and their inhabitants along the South Bridge transmission canal.

Indirect

There would be no indirect impacts of Alternative 4B on displacement of populations or housing.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 4B with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts.

5.15.2 Employment, Business, and Industrial Activity

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on employment or income.

Indirect

Indirect impacts of the implementation of the No Action Alternative, not implementing a freshwater diversion into the southeastern Maurepas Swamp,

would result in the persistence of existing conditions including continued wetland degradation. This continued wetland loss would have localized impacts on employment and income including a decline in forested wetland habitats which in turn could lead to potential economic decline in wetland-related employment.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

Coastal Louisiana's continued wetland loss and the related depletion of wetland-dependent natural resources could likely result in a decline of job opportunities and personal income throughout rural coastal areas (USACE 2004). Other supporting economic activities such as marinas, bait and tackle shops could also be adversely impacted by the degradation and eventual loss of these wetlands and wetland-dependent resources.

The loss of wetlands could result in the need for greater expenditures for maintaining and repairing existing infrastructure. This could provide local employment and industrial activity benefits.

Alternative 2

Direct

The primary direct impacts of Alternative 2 on employment and industrial activity would result from the potential for temporary employment in the construction of the proposed action.

Indirect

Alternative 2 would serve to slow or reverse the trend of swamp degradation and habitat conversion in the study area. The proposed action would serve to protect and enhance essential fish and wildlife habitats. Economic activities dependent upon such habitats, and the fish and wildlife it supports, would be maintained and possibly increased, leading to a rise in fishery and wildlife-related employment and industrial activity.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area. Thus unlike the No Action Alternative, this proposed action would work in conjunction with the other

restoration efforts of the region to preserve and enhance natural habitats and thereby preserving and enhancing the economic activities tied to these habitats.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.3 Availability of Public Facilities and Services

No Action Alternative (Future without Project Conditions)

Direct

The implementation of the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would result in no direct impacts on the availability of public facilities and services.

Indirect

The implementation of the No Action Alternative, not implementing a freshwater diversion into the southeastern Maurepas Swamp, would not indirectly impact the availability of public facilities or services within the study area, which includes the utilities, emergency services and education.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

The loss of coastal land could lead to a population shift. In addition, Ascension Parish is projected to grow exponentially in population by 2030 (Louisiana Office of Electronic Services). This expected population growth, in conjunction with a potential population shift, would lead to greater demand on the existing public facilities and services. Thus, public facilities and services would be expected to expand.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on the availability of public facilities or services.

Indirect

The implementation of Alternative 2 would not indirectly impact the availability of public facilities or services within the study area.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area. Unlike the No Action

Alternative, this proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats and coastal lands. The potential population shift as a result of land loss could be lessened, leading to a proportionally lesser degree of strain on the area's public facilities and services.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.4 Transportation

No Action Alternative (Future without Project Conditions)

Direct

Implementation of the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would result in no direct impacts on transportation in the study area.

Indirect

Implementation of the No Action Alternative, no freshwater diversion into the study area in southeastern Maurepas Swamp, would have indirect impacts on the transportation resources within the study area. The No Action Alternative would allow the continued degradation within the study area, enabling invasive species such as salvinia to grow and spread and the persistence of flooding conditions. This in turn would adversely impact travel by foot or by boat within the study area.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

The loss of coastal land could lead to inland migration. In addition, Ascension Parish is projected to grow exponentially in population by 2030 (Louisiana Office of Electronic Services). This expected population growth, in conjunction with a potential population shift, would lead to greater demand on the existing transportation network. Thus, transportation infrastructure would be expected to expand.

Alternative 2

Direct

The direct impacts of Alternative 2 would include increased demands on transportation resources network during construction. The installation of culverts under US 61, LA 3125, and the Canadian National Railroad will not result in traffic delays or disruption of normal traffic flow. Detours during construction will be constructed to allow full traffic flow for both roadways and the railroad. Heavy truck traffic along US 61 could occur. However, all direct impacts would be temporary in nature.

Indirect

The indirect impacts of Alternative 2 include facilitating foot and boat travel within the study area through the restoration of the forested swamp.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would forestall further wetland and habitat deterioration in the study area by working in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats and coastal lands. Population shifts could be lessened leading to a proportionally lesser degree of strain on the area's transportation network.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The direct impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

5.15.5 Disruption of Desirable Community and Regional Growth (including Community Cohesion)

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp would have no direct impacts on desirable community and regional growth of the study area.

Indirect

Indirect impacts of the implementation of the No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would involve the persistence of existing conditions including continued wetland degradation. This continued wetland loss would have detrimental impacts on fishery and wildlife-related employment in the area, which could consequently impede positive community and regional growth.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

The loss of coastal land could lead to a population shift. In addition, Ascension Parish is projected to grow exponentially in population by 2030 (Louisiana Office of Electronic Services). This expected population growth, in conjunction with a potential population shift, may disrupt community cohesion and affect the attainment of desirable community and regional growth.

Alternative 2

Direct

The implementation of this proposed action would not directly impact community or regional growth of the study area.

Indirect

Implementation of Alternative 2 would serve to protect and enhance essential fish and wildlife habitats. Economic activities dependent upon such habitats, and the fish and wildlife they support would be maintained and possibly increased, thereby potentially spurring community and regional growth.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area. Thus, unlike the No Action Alternative, the proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats and coastal lands. The potential population shift as a result of land loss could be lessened, leading to a proportionally lesser degree of undesirable community and regional growth.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.6 Tax Revenues and Property Values

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion in the southeastern Maurepas Swamp would have no direct impacts on the tax revenues and property values within the study area.

Indirect

The implementation of the No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, could indirectly cause the property value of this area to decline due to the continued degradation of southeastern Maurepas Swamp. Tax revenues within the study area are tied to property value. Property values tend to reflect the quality and condition of nearby amenities. Thus, the recreational and aesthetic resources of a community will impact the assessed value of a property.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

Cumulative impacts of the potential diminishment of recreational and aesthetic resources in the study area would be in addition to the loss of recreational and aesthetic resources throughout Louisiana.

In addition, more recent restoration efforts would cumulatively interact to help offset losses of recreational and aesthetic resources in the study area by preserving and enhancing the natural habitats, thereby enabling the continuation and even expansion of existing recreational activities within the study area and the region as a whole.

Thus, the implementation of the No Action Alternative would serve to partially offset the recreation and aesthetic benefits incurred by the restoration projects in the region and thereby could negatively impact localized tax revenues and property values.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on tax revenues or property values in the study area.

Indirect

The indirect impacts of Alternative 2 could cause the property value of the privately owned parcels to increase, which could in turn increase the tax revenue received by the local governments. This would be due to the proposed action protecting and enhancing the visual aesthetic of the study area and thereby increasing property values.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area. Thus unlike the No Action Alternative, this proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance recreation and aesthetic resources and thereby maintain and perhaps increase property values and tax revenues.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

5.15.7 Infrastructure

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp would have no direct impacts on infrastructure.

Indirect

Indirect impacts of no freshwater diversion into the southeastern Maurepas Swamp would result in the persistence of existing conditions including impacts related to continue coastal land loss, which would adversely impact infrastructure along and leading to the coastline.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.**

Ascension Parish is projected to grow exponentially in population by 2030 (Louisiana Office of Electronic Services). This expected population growth, in conjunction with a potential population shift due to coastal land loss, would lead to greater demand on the existing infrastructure. In addition, the projected continued coast-wide decline of forested wetlands (USGS) would contribute to the deterioration of substrate upon which infrastructure features (e.g., oil, gas and water pipelines and telephone and electric transmission wires) are constructed. The effects of land loss and swamp degradation and conversion to marsh and open water could lead to increased costs for maintaining and repairing existing infrastructure. The loss of storm buffering provided by wetlands (USACE 2009) could result in the need for greater expenditures for maintaining and repairing existing infrastructure. However, these impacts would be somewhat offset by the other restoration projects within the vicinity of the study area.

Alternative 2

Direct

The direct impacts of the implementation of Alternative 2 on the infrastructure within the study area would be the re-establishment of the existing berm cuts, construction of new breaks, and the installation of a transmission canal along the Romeville alignment.

Construction of the infrastructure components associated with this proposed action would serve to bring freshwater into the study area, enabling the preservation and restoration of the existing swamp habitat. No impact to the drainage structures will occur as a result of the project; the diversion flows would be stopped during significant rain events.

Indirect

The proposed action would preserve and enhance the forested wetlands within the study area; thereby decreasing the potential for substrate deterioration, which in turn would reduce the need for the relocation, repair or replacement of existing infrastructure.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following

exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area, thus unlike the No Action Alternative, this proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance natural habitats and coastal lands. Thus, the potential population shift as a result of land loss could be lessened, leading to a proportionally lesser demand on the area's infrastructure as well as lessening the potential for substrate deterioration.

Alternative 4

Direct

The direct impacts of this alternative on the infrastructure within the study area would be the re-establishment of the existing berm cuts, construction of new breaks, and the installation of a transmission canal along the South Bridge alignment.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts on the infrastructure within the study area would be the re-establishment of the existing berm cuts, construction of new breaks, and the installation of a transmission canal along the two alignments.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative on the infrastructure within the study area would be the re-establishment of the existing berm cuts, construction of new breaks, and the installation of a transmission canal.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

U.S. Geological Survey, Marine and Coastal Geology Program. Louisiana Coastal Wetlands: A Resource at Risk. Accessed: http://marine.usgs.gov/fact-sheets/LAwetlands/lawetlands.html

5.15.8 Environmental Justice

No Action Alternative (Future without Project Conditions)

Direct

Minority and/or low-income communities have been identified in the study area of St. James Parish. In a future without project conditions, no anticipated disproportionately high or adverse human health or environmental effects on minority or low-income populations would occur, as no property would be acquired for construction of the proposed diversion within the study area and no construction activities would occur

Indirect

No disproportionately high or adverse human health or environmental indirect impacts on minority or low-income populations would occur.

Cumulative

There would be no cumulative impacts on minority and/or low-income communities within the study area per 2000 U.S. Census information and requirements of E.O. 12898. The No-Action Alternative would not contribute to any additional EJ issues when combined with other Federal, state, local, and private restoration efforts.

Alternative 2

Direct

Minority populations have been identified within the study area of St. James Parish, per 2000 U.S. Census information and requirements of E.O. 12898, this area should be considered for further public outreach efforts for Environmental Justice. Direct impacts from construction activities such air quality, noise, traffic, safety, etc. would occur. As there are no permanent residences along the Romeville alignment, no direct impacts on human health or environmental effects are expected for Alternative 2 (Recommended Plan)

Indirect

Under Alternative 2 (Recommended Plan) no indirect impacts on human health or environmental effects within the study area would occur.

Cumulative

While there are minority and/or low-income communities in the project vicinity, none have been identified within the proposed Romeville alignment per 2000 U.S. Census information and requirements of E.O. 12898. Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in Section 5.1.2. The cumulative impacts of Alternative 2 would be similar to those described for the No Action Alternative, however, further public outreach efforts should be made per requirements of E.O. 12898.

Alternative 4

Direct

Minority populations have been identified within the study area of St. James Parish, per 2000 U.S. Census information and requirements of E.O. 12898, this area should be considered for further public outreach efforts for Environmental Justice. Direct impacts from construction activities such as property acquisition, air quality, noise, traffic, safety, etc. would occur. With the exception of property acquisition, the concern for the aforementioned construction activities would be temporary in nature (no more than 12-24 months) and would have minimal, if any, disproportionately high or direct adverse human health or environmental impacts on minority and/or low income communities. Property acquisition may have a potential disproportionate impact on community cohesion should residents choose to relocate outside of the existing community. In order to minimize potential direct impacts to community cohesion, only 3 houses would be directly impacted from implementing the proposed action.

Indirect

No disproportionately high or adverse human health or environmental indirect impacts on minority and/or low-income populations would occur.

Cumulative

There may be synergistic cumulative impacts of implementing Alternative 4 on minority and/or low-income communities within the study area per 2000 U.S. Census information and requirements of E.O. 12898. These impacts would be the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in Section 5.1.2. The LCA Convent/Blind River project would contribute toward achieving and sustaining a coastal ecosystem that can support

and protect the environment, local economy and culture of the region. Further public outreach efforts should be made per requirements of E.O. 12898.

Alternative 4B
Direct

Direct impacts of Alternative 4B would be similar to Alternative 4.

Indirect

Indirect impacts of Alternative 4B would be similar to Alternative 4.

Cumulative

Cumulative impacts of Alternative 4B would be similar to Alternative 4.

Alternative #6

Direct

Direct impacts of Alternative 6 would be similar to Alternative 4.

Indirect

Indirect impacts would be similar to Alternative 4.

Cumulative

Cumulative impacts would be similar to Alternative 4.

5.15.9 Navigation

No Action Alternative (Future without Project Conditions)

Direct
Under the No Action Alternative, no freshwater diversion into the study area in southeastern Maurepas Swamp, there would be no direct impacts to navigation in the Mississippi River, Blind River or connecting waters and tributaries in the study area.

Indirect
Under the No Action Alternative, no freshwater diversion into the study area in southeastern Maurepas Swamp, there would be no indirect impacts to navigation in the Mississippi River, Blind River or connecting waters and tributaries in the study area.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of wetland loss and increased runoff due to increasedurbanization, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

The direct impacts of Alternative 2 include impediments to boat traffic on the parish canals. This impact would only occur when the control structures are in use. When the control structures are down, there would be no direct impacts to navigation. Direct impacts to navigation on the Lower Mississippi River are not anticipated per coordination with the USCG.

Indirect

There would be no indirect impacts of Alternative 2 on navigation.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of wetland loss and increased runoff due to increased urbanization, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.9.1 Land Use Socioeconomics

5.15.9.2 Agriculture

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (), no direct impacts to agriculture would occur.

Indirect

Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, no indirect impacts to agriculture would occur.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of wetland loss and increased runoff due to increased urbanization of the Pontchartrain Basin, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

Direct impacts to agriculture would include the loss of a small amount of land currently in agricultural production along the diversion route.

Indirect

There would be no indirect impacts of Alternative 2 on agriculture.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of wetland loss and increased runoff due to increased urbanization of the Pontchartrain Basin, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the following exceptions. The loss of agricultural land associated with the construction of the South Bridge diversion would be added.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 4.

5.15.9.3 Forestry

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp), no direct impacts to forestry resources would occur.

Indirect

Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp adverse indirect impacts would occur as a result of the continued degradation in the quality and quantity of the trees within the study area and vicinity, greatly reducing the potential for forestry activities. Conversion of forested swamp to marsh and open water would likely preclude the study area from future forestry activities.

Cumulative

Cumulative impacts would be the synergistic effect of implementing the No Action Alternative with the additive combination of coastwide forest loss and degradation, as well as the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2**. Other restoration efforts would change the acreage of merchantable timber through the CIAP Baldcypress/Tupleo Coastal Forest Protection; Pontchartrain Basin would remove 1,762 acres from potential forestry activities.

Alternative 2

Direct

The direct impacts of the Alternative 2 include the loss of a small amount forested wetland due to the construction of the Romeville diversion.

Indirect

The indirect impacts of alternative 2 include wetland preservation and increased productivity which would benefit forest resources in the study area.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of wetland restoration and preservation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. The cumulative impacts of Alternative 2 with other diversion projects include wetland building processes that would prevent forested

wetland degradation and increases in productivity that would increase canopy cover.

Alternative 4

Direct

The direct impacts of the Alternative 4 include the loss of a small amount forested wetland due to the construction of the South Bridge diversion which would be more extensive than Alternative 2 due to the longer length of the transmission canal.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2 with the additive direct impacts of Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 4.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.9.4 Public Lands

No Action Alternative (Future without Project Conditions)

Direct

Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swap, no direct impacts to public lands would occur.

Indirect

Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, adverse indirect impacts could occur as a result of swamp degradation and conversion to fresh marsh open water. Continued degradation would limit the capacity of Maurepas Swamp WMA to continue to provide existing services. Specifically, continued degradation and conversion to open water would drastically reduce fish and wildlife habitat, abundance and diversity. Recreational activities, such as hunting and fishing, would be negatively impacted by decreased abundance of game animals and fisheries, as would access to this public land.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2**.

Cumulative impacts of the potential diminishment of public land resources in the study area would be in addition to the loss of public land throughout Louisiana. The LCA Study (LCA 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year (2,671 ha/year) over the next 50 years. It is estimated that an additional net loss of 328,000 acres (132,737 ha) may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands. However, these wetland losses in the Louisiana study area would be offset to some extent by other Federal, state, local, and private restoration efforts as described in the 2004 LCA Report (Table 4-2).

In addition, more recent restoration efforts would also cumulatively interact to help offset losses of public land resources in the study area by preserving and enhancing the natural habitats, thereby enabling the continuation and even expansion of existing recreational activities and public land access within the study area and the region as a whole.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on public lands.

Indirect

The indirect impacts of Alternative 2 include the preservation of public lands due to the diversion slowing or reversing the trend of swamp degradation and habitat

conversion in the study area. Thus, the capacity of the Maurepas Swamp WMA to provide existing services would be enhanced.

Cumulative

Cumulative impacts would be the synergistic effect of Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local and private restoration efforts as summarized in **Section 5.1.2.** The cumulative impacts of this alternative would be similar to those described for the No Action Alternative with the following exception. The implementation of Alternative 2 would serve to forestall further wetland and habitat deterioration in the study area, thus unlike the No Action Alternative, this proposed action would work in conjunction with the other restoration efforts of the region to preserve and enhance the public lands within the area.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described in Alternative 2.

Indirect
The indirect impacts of this alternative would be similar to those described in Alternative 2.

Cumulative
The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.15.10 Water Use and Supply

No Action Alternative (Future without Project Conditions)

Direct
The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on water use and supply.

Indirect
Under the No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, indirect impacts would include continued increases in the salinity of Lake Maurepas and Lake Pontchartrain, which currently serve as a minor surface water supply source for Ascension Parish. Increased salinity levels may render this supply source unsuitable for water uptake.

Cumulative
Cumulative impacts would be the synergistic effect of the No Action Alternative on water supply and use with the additive combination of similar wetland degradation and wetland loss impacts to sediment throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. The increase in salinity in Lake Maurepas would be offset to some extent by the decreases in salinity caused by other diversion projects in the region.

Alternative 2

Direct
There would be no direct impacts of Alternative 2 on water use and supply.

Indirect
Indirect impacts of Alternative 2 on water use and supply include decreases in the salinity of Lake Maurepas which currently serves as a minor surface water supply source for Ascension Parish. Decreases in salinity would benefit this water supply.

Cumulative
Cumulative impacts would be the synergistic effect of implementing this alternative with the additive combination of impacts and benefits for overall nets acres created, nourished, and protected by other Federal, state, local, and private restoration

efforts as summarized in **Section 5.1.2.** Cumulative impacts include decreases in salinity in Lake Maurepas and Pontchartrain from this and other diversion and restoration projects.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2

5.15.11 Man-Made Resources

5.15.11.1 Oil, Gas, Utilities

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, not implementing a freshwater diversion into the Study Area in southeastern Maurepas Swamp, would have no direct impacts on oil, gas, and utilities pipelines.

Indirect

Indirect impacts of not implementing a diversion would result in the persistence of existing conditions including swamp degradation, increased flood duration, and elevated stage levels. The effects of land loss and degradation could lead to increased costs for maintaining and repairing existing infrastructure in the Study Area.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on oil, gas, and utilities pipelines with the additive combination of similar oil, gas, and utilities pipeline impacts from wetland loss and degradation throughout coastal Louisiana, as well as the benefits and impacts of other state and Federal projects in the vicinity. The projected continued coastwide decline of forested wetlands would contribute to the deterioration of substrate upon which oil, gas, and utilities (e.g., water pipelines, telephone, electric transmission wires, and other) are constructed. The loss of storm buffering provided by wetlands could result in the need for greater expenditures for maintaining and repairing existing infrastructure (USACE 2009). However, these impacts would be somewhat offset by other state and Federal restoration projects within the vicinity of the Study Area.

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

Ongoing documentation of the impacts associated with the Deepwater Horizon Oil spill can be found in several governmental sources. The USFWS Situation Report for August 2, 2010

(http://www.fws.gov/home/dhoilspill/pdfs/MondayAugust22010.pdf)

indicates the following environmental-related Deepwater Horizon oil spill information: 563 personnel are actively engaged in the response, working to protect wildlife and their habitats, including 36 national wildlife refuges. They are also assessing the damage from the oil spill in preparation for the work that will be needed to restore the Gulf of Mexico. Some 1,643 visibly oiled birds have been collected alive by the U.S. Fish and Wildlife Service, the states and our partners in response to the Deepwater Horizon oil spill.

- Overall number of personnel responding: approximately 30,100
- Total vessels responding: more than 4,500
- Total boom deployed: more than 2,155 miles
- Boom available: more than 856 miles
- Oily water recovered: more than 34.7 million gallons
- Estimated 11.14 million gallons of oil burned
- Estimated total of more than 1.84 million gallons of dispersant used including:
    - Estimated more than 1.07 million gallons surface dispersant used
    - Estimated more than 771,000 gallons of sub-sea dispersant used:
- Estimated approximately 632 miles of Gulf Coast shoreline is currently oiled—approximately 365 miles in Louisiana, 111 miles in Mississippi, 68 miles in Alabama, and 88 miles in Florida.

As is evident from the numerous ongoing actions, the dynamic nature of the impacts associated with the Deepwater Horizon oil spill will likely require additional consideration in the near future for USACE Civil Works projects.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on oil, gas, and utilities.

Indirect

The indirect impacts of Alternative 2 include preventing the deterioration of substrate upon which oil, gas, and utilities are constructed associated with sediment inputs from the diversion. This would also provide better protect of the pipelines during future storm surge events.

Cumulative

Cumulative impacts would be the synergistic effect of implementing this alternative with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. Cumulative impacts include the regional prevention of land subsidence and protection from storm surge.

Alternative 4

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 6

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

Alternative 4B

Direct

The direct impacts of this alternative would be similar to those described for Alternative 2.

Indirect

The indirect impacts of this alternative would be similar to those described for Alternative 2.

Cumulative

The cumulative impacts of this alternative would be similar to those described for Alternative 2.

5.16 Flood Control and Hurricane Protection

No Action Alternative (not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp)

Direct

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp), there would be no direct impacts to flood control and hurricane protection.

Indirect

Under the No Action Alternative (no freshwater diversion into the southeastern Maurepas Swamp), there would be a continued degradation of coastal forest habitat within the study area. Forested wetlands provide some unknown level of hurricane and tropical storm abatement (USACE 2009). Consequently, there could be an increase in storm surge and risk of flooding due to coastal land loss. As populations continue to migrate to coastal communities, increasing investments in hurricane and flood control levees, pump stations, and other flood control facilities would be required.

Cumulative

Cumulative impacts would include the continued degradation of wetlands, which may result in localized storm surge and increased wave heights offset to some undeterminable extent by the benefits and impacts of other state and federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

The direct impacts of Alternative 2 include the construction of a temporary levee during the construction of the intake structure and placement of a culvert in the existing east levee. After construction is complete, the levee will be restored to the previous functional dimensions.

Indirect

The indirect impacts from Alternative 2, increasing the productivity and health of the Maurepas Swamp, could provide buffering capacity against future storm surge, as suggested by current research (e.g., USACE, 2009). The extent to which storm surge protection would be provided is uncertain. In swamp management measures (i.e., berm cuts) would help distribute water throughout the swamp and lower water

levels, and combined with increased swamp building, would minimize the risk of impairment to adjacent drainage ditches due to rising water levels.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on flood control and hurricane protection as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.** Construction of the St. James Hurricane Protection Levee in its current alignment would provide significant protection to human and environmental resources within the study area.

Alternative 4

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

Alternative 6

Direct

There would be no direct impacts of Alternative 6 on flood control and hurricane protection.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

Alternative 4B

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

5.17 Natural Resources

5.17.1 Commercial Fisheries

No Action Alternative (not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp , would have no direct impacts on commercial fisheries.

Indirect

Indirect impacts would result in the persistence of existing conditions including the continued conversion of existing wetlands to open water habitats, restricted water circulation, and decreased water quality. The Coast 2050 Report (LCWCRTF & WCRA, 1999) does not predict that coastal wetland loss will impact most commercially important species within the Upper Pontchartrain Basin, projecting stable populations of blue crab and channel catfish to 2050; historical and future population trends for Gulf menhaden were unknown.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on commercial fisheries with the additive combination of coastwide fishery habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2**. Sharp declines are predicted in Louisiana fisheries productivity with wetland habitat loss (USACE, 2004). It is estimated that over 75 percent of Louisiana's commercially harvested fish and shellfish populations are dependent on coastal wetlands during at least some portion of their life cycle. Globally, overfishing and habitat change has resulted in the depletion of 90% of the world's seafood resources, with 38% of the species studied experiencing greater than 90% depletion, and 7% becoming extinct (Worm et al., 2006). This trend is expected to continue under the No Action Alternative. Regional benefits to commercial fisheries would be provided by other restoration projects in the area to a lesser extent than under the action alternative.

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on commercial fisheries.

Indirect

Indirect impacts of Alternative 2 would be increases in fisheries productivity due to increased nutrient inputs and wetland building processes. Commercial fisheries would benefit in the long term through augmentation of food webs and increasing larval fish habitat (Caffey and Schexnayder 2002). Short term declines in some commercial fisheries may occur due to displacement.

Cumulative

Cumulative impacts would be the synergistic effect of implementing Alternative 2 with the additive combination of impacts and benefits for overall net acres created, nourished, and protected by other Federal, state, local, and private restoration efforts as summarized in **Section 5.1.2**. The benefits of other diversion projects in the area will also increase productivity which would benefit commercial fisheries in the long term. These projects will result in positive cumulative impacts on commercial fishery in the Lake Pontchartrain Basin. Overall increases in commercial fisheries will be not be spatially localized to individual project areas due to migration of fish within the basin.

Alternative 4

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

Alternative 6

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

Alternative 4B

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

5.17.2 Oyster Leases

No Action Alternative (Future without Project Conditions)

Direct

The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no direct impacts on oyster leases.

Indirect

There would be no indirect impacts of the No Action Alternative on oyster leases.

Cumulative

Cumulative impacts would be the synergistic effect of the No Action Alternative on oyster leases with the additive combination of coastwide fishery habitat losses and degradation, as well as the benefits and impacts of other state and Federal projects in the vicinity, as detailed in **Section 5.1.2.**

Alternative 2

Direct

There would be no direct impacts of Alternative 2 on oyster leases.

Indirect

There would be no indirect impacts of Alternative 2 on oyster leases.

Cumulative

There would be no cumulative impact of Alternative 2 on oyster leases.

Alternative 4

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative

Cumulative impacts would be similar to Alternative 2.

Alternative 6

Direct

Direct impacts would be similar to Alternative 2.

Indirect

Indirect impacts would be similar to Alternative 2.

Cumulative
Cumulative impacts would be similar to Alternative 2.

Alternative 4B
Direct
Direct impacts would be similar to Alternative 2.

Indirect
Indirect impacts would be similar to Alternative 2.

Cumulative
Cumulative impacts would be similar to Alternative 2.

5.18 Hazardous, Toxic, and Radioactive Wastes

*[Phase I ESA Findings-**Appendix M**]*

No Action Alternative (not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp)

Direct
The condition with the No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, regarding the potential for HTRW is dependent on site-specific HTRW discovery. Based on previous HTRW research in the study area, and investigations for the present study, the potential to encounter HTRW is low in most of the study area. During the database search, one underground storage tank was identified adjacent to the South Bridge transmission canal route. Site access to some of the properties along this diversion route was pending as of the date the Phase I ESA was finalized and there for has not been completed in this area. A Phase I ESA has found the No Action Alternative, not implementing a freshwater diversion into the study area in southeastern Maurepas Swamp, would have no direct impacts on HTRW in the distribution area and the Romeville transmission canal route.

Indirect
The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no indirect impacts on HTRW in the distribution area and the diversion at Romeville.

Cumulative
The No Action Alternative, no freshwater diversion into the southeastern Maurepas Swamp, would have no cumulative impacts on HTRW in the distribution area and the diversion at Romeville.

Alternative 2

Direct

Consistent with ER 1165-2-132, an HTRW investigation of the study area was conducted. Based upon findings from this investigation, the potential for direct impacts to the study area from implementation of Alternative 2 would be low.

Indirect

Consistent with ER 1165-2-132, an HTRW investigation of the study area was conducted. Based upon findings from this investigation, the potential for indirect impacts to the study area from implementation of Alternative 2 would likely continue to be low into the future.

Cumulative

Consistent with ER 1165-2-132, an HTRW investigation of the study area was conducted. Based upon findings from this investigation, the potential for cumulative impacts to the study area from implementation of Alternative 2 would likely continue to be low into the future.

Alternative 4

Direct

The direct impacts would be similar to those described in Alternative 2 with the following exceptions. During the database search, one underground storage tank was identified adjacent to the South Bridge transmission canal route. Site access to some of the properties along this diversion route was pending as of the date the Phase I ESA was finalized and therefore has not been completed in this area.

Indirect

The indirect impacts would be similar to those described in Alternative 2 with the following exceptions. During the database search, one underground storage tank was identified adjacent to the South Bridge transmission canal route. Site access to some of the properties along this diversion route was pending as of the date the Phase I ESA was finalized and therefore has not been completed in this area.

Cumulative

The cumulative impacts would be similar to those described in Alternative 2 with the following exceptions. During the database search, one underground storage tank was identified adjacent to the South Bridge transmission canal route. Site access to some of the properties along this diversion route was pending as of the date the Phase I ESA was finalized and therefore has not been completed in this area.

Alternative 6

Direct

The direct impacts would be similar to those described in Alternative 4.

Indirect
The indirect impacts would be similar to those described in Alternative 4.

Cumulative
The cumulative impacts would be similar to those described in Alternative 4.

Alternative 4B
Direct
The direct impacts would be similar to those described in Alternative 4.

Indirect
The indirect impacts would be similar to those described in Alternative 4.

Cumulative
The cumulative impacts would be similar to those described in Alternative 4.

5.19 Unavoidable Adverse Effects

Wetland impacts were avoided and minimized to the extent possible in the preliminary design of the Recommended Plan. With avoidance and minimization of wetland impacts the Recommended Plan would have 53 acres (21 ha) of unavoidable wetland impacts due to construction of the Romeville diversion canal. Construction of the Romeville diversion canal is the best way to divert water from the Mississippi River to southeastern Maurepas Swamp. The wetlands that will be impacted by construction of the Romeville canal are not part of Maurepas Swamp (that will be improved). The improvement of 21,369 acres (8,648 ha) of this baldcypress-tupelo swamp, that are in various stages of deterioration, will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal. There would be no other unavoidable adverse impacts as a result of the implementation of reasonable alternatives for this project.

5.20 Relationship of Short-Term Uses and Long-Term Productivity

NEPA Section 102(2)(c)(iv) and 40 CFR 1502.16 require that an EIS include a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This section describes how the Proposed Action would affect the short-term use and the long-term productivity of the environment.

In reference to the Proposed Action, "short-term" refers to the temporary phase of construction of the proposed project, while "long-term" refers to the operational life of the proposed project and beyond. Section 3 of this document evaluates the direct, indirect and cumulative effects that could result from the Proposed Action.

Construction of the Proposed Action would result in short-term construction-related impacts within parts of the project area and would include to some extent interference with local traffic, minor limited air emissions, increases in ambient noise levels, dust generation, disturbance of wildlife, increased storm runoff, and disturbance of recreational and other public facilities. These impacts would be temporary and would occur only during construction, and are not expected to alter the long-term productivity of the natural environment.

The Proposed Action would assist in the long-term productivity of the Blind River and Maurepas Swamp ecological community by improving the water quantity, water quality, nutrients, and sediments. This in turn will facilitate the growth of the swamp and specifically baldcypress and tupelo trees. The Proposed Action would also result in enhancing the long-term productivity of the natural communities throughout the region. These long-term beneficial effects of the Proposed Action would outweigh the minimal and mitigable short-term impacts to the environment resulting primarily from project construction.

5.21 Irreversible and Irretrievable Commitments of Resources

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., extinction of a threatened or endangered species or the disturbance of a cultural site). The proposed project would result in few direct and indirect commitments of resources; these would be related mainly to construction components. For the proposed alternatives, most resource commitments are neither irreversible nor irretrievable. Most impacts are short term and temporary. Others that may have a longer effect can be reduced through appropriate measures. There is no irreversible or irretrievable commitment of resources which would preclude formulation or implementation of reasonable alternatives for this project.

5.22 Mitigation

Compensatory mitigation is not needed for this project. Wetland impacts were avoided and minimized to the extent possible in the preliminary design of the Recommended Plan. The Recommended Plan will impact 53 acres (21ha) of wetlands with construction of the Romeville diversion canal. The wetlands that will be impacted are not part of Maurepas Swamp (that will be improved). The improvement of 21,369 acres (8,648 ha) of this baldcypress-tupelo swamp, that are in various stages of deterioration, will mitigate for the wetland impacts resulting from construction of the Romeville diversion canal.

5.23 Environmental Consequences Summary

The environmental analysis evaluates and compares, from a qualitative and quantitative perspective, the alternative plans and the No Action Alternative carried over for detailed analysis. Impact analysis described is based on a combination of scientific and engineering analyses, professional judgment, and previously compiled information.

The impacts of the No Action Alternative, not implementing the diversion, would result in the persistence of existing conditions, including a limited ability to drain and persistent flooding that conflict with historic drying cycles in the swamp, short circuiting of the natural drainage patterns, ponding and stagnant waters in some areas, and minimal contribution and circulation of nutrients and sediments in the swamp. Blind River and Maurepas Swamp would continue to deteriorate. Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the Mississippi River that brought freshwater, sediment and nutrients to the swamp. Minimal soil building and moderately high subsidence rates that resulted in a net lowering of ground surface elevation would continue and the swamp will continue to be persistently inundated. The limited ability to drain and the persistent flooding that exists in the swamp would continue. Under the existing conditions the frequency of dry out conditions (water levels below 0.5 ft) would occur only 1 percent of the time. This occurrence would limit seedling survival and recruitment. The sediment deficit has and would continue to result in both subsidence and a disruption of natural processes that promote productivity and diversity in the swamp ecosystem. Increases in relative sea level due to continued subsidence and sea level rise would continue to extend flood duration and elevate flood stage within Maurepas Swamp, accompanied by impoundment of hypoxic, nutrient-deficient water.

Additionally under the No Action Alternative there would be a gradual conversion of existing forested wetlands to severely degraded and fragmented swamp forest habitats. Based on the habitat condition classes for the study area (20-30 years to marsh and 30-50 years to marsh), this includes the conversion of 11,228 acres of forested swamp to marsh. As interior forested wetlands convert to marsh and open water, there would be an expected loss of habitat for species dependent on swamp forest habitat.

Under the No Action Alternative, the current water quality conditions would persist; wetlands would still be affected by natural and man-made factors that would have both beneficial and detrimental effects on water quality conditions. Existing wetland communities would continue to diminish. Increased impoundment and limited circulation due to limited freshwater inputs and relative sea level rise would continue to result in anoxic conditions, detrimental to fish and other aquatic organisms. Other diversion projects would work to offset some of the changes in water quality such as decreases in DO and nutrients. Because of the spatial separation between these diversion projects and the Blind River/Maurepas Swamp, the effects of these diversion projects on the study area may be minimal.

Impacts of Alternative 2 on water quality would be the persistence of changes to water quality due to the diversion over time. For Alternative 2, the estimated percent load reduction for nitrate and TN ranged from 82-96% and 50-65%, respectively. The percent load reduction for TP ranged from 19-32%. These values are a little less than removal efficiency estimates provided by Day et al. (2006), that were based on Lane et al. (2003), which were 73% for TN and 43% for TP for removal efficiency as a function of loading rates for data from both Mississippi River diversions and wetland wastewater treatment systems. The loading rates evaluated for nitrate, TN, and TP were 18-34 g-N/m2/yr, 24-45 g-N/m2/yr, and 2-4 g-P/m2/yr, respectively, and were greater than the loading rates presented by Day et al. (2006). The lower removal efficiency estimates reflect the fact that maximum removal efficiency occurs at low loading rates and decreases at higher loading rates. Wetlands also provide assimilation of metals. Increased delivery of freshwater to the swamp will also increase circulation and dissolved oxygen levels in the swamp and in Blind River. Impacts of Alternative 4 would be similar to those described for Alternative 2. However, for Alternative 4 estimates of the percent load reduction for nitrate and TN ranged from 89-98% and 56-70%, respectively. The percent load reduction for TP ranged from 23-40%. The loading rates for nitrate, TN, and TP ranged from 14-27 g-N/m2/yr, 18-35 g-N/m2/yr, and 2-3 g-P/m2/yr, respectively. Impacts of Alternative 6 would be similar to those described for Alternative 2. However, for Alternative 6 estimates of the percent load reduction for nitrate and TN ranged from 85-97% and 52-66%, respectively. The percent load for TP ranged from 20-34%. The loading rates for nitrate, TN, and TP ranged from 17-32 g-N/m2/yr, 22-41 g-N/m2/yr, and 2-4 g-P/m2/yr, respectively. Impacts of Alternative 4B would be similar to those described for Alternative 2. However, for Alternative 4B estimates of the percent load reduction for nitrate and TN ranged from 86-97% and 53-67%, respectively. The percent load reduction for TP ranged from 21-34%. The loading rates for nitrate, TN, and TP ranged from 17-31 g-N/m2/yr, 22-40 g-N/m2/yr, and 2-4 g-P/m2/yr, respectively.

Direct impacts of Alternative 2 include 106.9 acres of permanent impact to prime and unique farmland based on NRCS data. These areas would be loss due to the construction of the Romeville Transmission Pathway. The direct impact of Alternative 2 on sedimentation and erosion would include increases in sediment in the Blind River and Maurepas Swamp. Based on estimates from a 3,000 cfs diversion supplying 16 kg/s of sediment continuously throughout the year, the annual estimate of sediment load to Blind River and Maurepas Swamp would be approximately 505,000,000 kg/yr. Because the diversion would not be operated continuously, this estimate is higher than the sediment load under the likely diversion operation schedule. There would be construction impacts to approximately 53 acres (21 ha) of forested wetland along the transmission canal.

The indirect impacts of Alternative 2 include increased hydrologic connectivity throughout the system. Excavation of berm gaps would increase the flow of water out of the swamp and reduce water levels during low stage periods in Lake Maurepas, at which time diversion inflow would be halted. Under this alternative,

the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur 23 percent of the time. This would allow for increased recruitment of baldcypress and water tupelo. Additionally, pulsing of the system would enhance productivity and nutrient assimilation in the swamp and thereby improve water quality in Blind River. Increased delivery of freshwater to the swamp will provide nutrients and sediments to the swamp that will enhance productivity and accretion (swamp building). It will also increase circulation of water in the swamp and in Blind River and prevent backflow of saline waters from Lake Maurepas. Swamp building (accretion) would approximately offset subsidence and eustatic sea level rise. Indirectly, this process would minimize the further degradation of wetland vegetation resources in the distribution area due to impoundment and support increased productivity. By maintaining relatively lower water levels in the study area, an increase would be realized in the probability of baldcypress and water tupelo seedling survival, recruitment, and thus forest stability. Forest productivity would also increase substantially due to the greater frequency of periodic drawdown and flow through the system. Drawdown would create opportunities for baldcypress and water tupelo germination and growth. Flow through of diverted water would facilitate seed dispersal. An increase in nutrient availability and productivity would indirectly increase wetland plant resistance to and recovery from herbivore, parasite, disease, and other damage. Importantly, diverted water would also reduce the probability of damage to wetland vegetation resources caused by backflow of saline waters from Lake Maurepas. An increase in forest health would sustain and increase the relatively high basal areas observed throughout most of the study area, which indirectly would reduce the risk of windthrow damage to midstory and understory wetland plants in storms events (Shaffer et al. 2007; personal communication, Dr. Gary Shaffer, 2009).

The Wetland Value Assessment Methodology swamp Model (WVA) was used to contrast the effects of each alternative on wetland vegetation resources within the distribution area over the 50-year project life. Model runs were based on assumptions derived from trends discussed above, field sampling efforts in the study area and Maurepas Swamp, hydrologic modeling, and mapping of habitat conditions in the distribution area. Alternative 2 would provide benefits to approximately 21,369 acres (8,648 ha) of forested wetland. Under the WVA methodology, this alternative would yield a net gain of 6,421 average annual habitat units (AAHUs) over the No Action Alternative.

The direct and indirect impacts of Alternative 4 would be similar to those described for Alternative 2 with the following exceptions. There would be 121.7 acres of impacts to prime and unique farmland and approximately 271 acres (110 ha) of forested wetlands due to the construction of the Sunshine Bridge Transmission Pathway. Under this alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur 20 percent of the time. Additionally, Alternative 4 would provide benefits to approximately 21,206 acres (8,582 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 6,124 AAHUs over the No Action Alternative.

The direct and indirect impacts of Alternative 6 would be similar to those described for Alternative 2 with the following exceptions. There would be a total of 228.6 acres of impacts to prime and unique farmland and impacts to approximately 287 acres (116 ha) of forested wetland due to the construction of dual transmission pathways. Under this alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur 19 percent of the time. Additionally, Alternative 6 would provide benefits to approximately 21,243 acres (8,597 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 7,114 AAHUs over the No Action Alternative.

The direct and indirect impacts of Alternative 4B would be similar to those described for Alternative 2 with the following exceptions. There would be construction impacts to approximately 306 acres (124 ha) of forested wetland along the transmission canal. Under this alternative, the frequency of dry out conditions necessary for tree seedling survival (water levels below 0.5 feet) would occur 19 percent of the time. Additionally, Alternative 4B would provide benefits to approximately 21,243 acres (8,597 ha) of forested wetland. Under the WVA methodology, this alternative would provide a net gain of 7,103 AAHUs over the No Action Alternative.

6.0 PUBLIC INVOLVEMENT*

6.1 NEPA Scoping

A Notice of Intent to prepare a SEIS for the Small Diversion at Convent/Blind River, Louisiana, was published on December 22, 2008, in the Federal Register (Volume 73, Number 246, Pages 78339-78340).

A project kick-off meeting was held on December 4, 2008 and a public scoping meeting was organized and hosted in accordance with NEPA on February 12, 2009. Public meeting announcements were published on January 31, 2009 and February 7, 2009 in the Times-Picayune, on January 30, 2009 in the Baton Rouge Advocate, on February 2, 2009 in the Lutcher News-Examiner, and on February 4, 2009 in the Vacherie Enterprise. The public notice was mailed to the stakeholder and NEPA mailing list for New Orleans District on January 7, 2009. Scoping meeting notices were also placed on the website http://www.lca.gov/Convent.aspx.

The scoping comment period began with the filing of the Notice of Intent and continues through release of the DSEIS for public comment. A Public scoping meeting was held on February 12, 2009 in Convent, Louisiana. Approximately 36 stakeholders attended. A total of 83 comments were received during the comment period; 12 multi-part comments were expressed at the scoping meetings and 10 multi-part written (letter, fax and email) and verbal comments were received during the comment period.

Comments were evaluated for recurring themes to gain an understanding of the key issues to address in the DSEIS.

The comments were categorized according to their applicability to the DSEIS. DSEIS categories include: Purpose and Need; Alternatives; Affected Environment; Environmental Consequences; and Consultation, Coordination, and Compliance with Regulations. An individual scoping comment may be categorized under more than one DSEIS subject matter heading, but no one comment was assigned to more than three categories.

Purpose and Need – The most common comment received indicated great support for the project. "Very much in favor of this project, with a number of us on the state level in favor also." Several respondents stressed the urgency of project implementation. "I've watched this area degrade over the years and to me this project can't happen quick enough."

Alternatives – Concerns related to baldcypress regeneration and management of local hydrology dominated the comments received in this category. "To accommodate changing goals and restoration needs for the region, each diversion structure, as well as the outfall management system, should be designed to incorporate operational flexibility to address changing environmental conditions

through an adaptive management program." Comments were also received regarding the similarity of this project to the Davis Pond diversion project. Several comments were positive in nature, stating that the project should be a "cookie cutter" version of the successful Davis Pond project; whereas others were concerned about the lack of hydrological management of that project. "Please figure out drainages better than what has happened at diversions like Davis Pond."

Affected Environment – The majority of comments received in this category concerned hydrology and drainage issues. "There are also a number of small canals in this area that are completely choked up. They are no longer helping at all in the natural drainage of the swamp." Some concerns were also raised regarding the effect of existing area structures, such as Interstate 10 and the effect of the logging industry on the study area. It should be noted that very few comments were designated as relating to the affected environment category alone and that most of the comments related to the affect of the no action alternative rather than the affect of the proposed action.

Environmental Consequences – Some concerns were raised regarding the proposed action's impact on area wildlife. Pallid Sturgeons, Gulf sturgeons, the Bald Eagle and Colonial Nesting Waterbirds were mentioned as sensitive receptors in the area. "Regarding the Bald Eagle: Disturbance may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements." Consult National Bald Eagle Management Guidelines to minimize potential impact." Some comments were also related to drainage issues. "My concern is that it would be fighting the natural drainage that wants to come off of high ground. And with that, you would stifle the flushing effect that needs to happen in these canals, bringing off all the pollutants coming off the occupied areas up in here."

Consultation, Coordination, and Compliance with Regulations – Some calls were made for further hydrological studies in the area. "The Louisiana Wildlife Federation urges the LDWF and the Louisiana Department of Transportation to act jointly in leading an effort to restore the natural hydrology of the McElroy Swamp in the Maurepas Basin of Southeast Louisiana and to assume leadership in organizing the other state and Federal agencies, along with private landowners to conduct a drainage study and develop a restoration plan for the McElroy Swamp watershed area." Other comments related to the urgency of project implementation and the funding of the project. "You mentioned the project was authorized under WRDA. Is it fully funded now? If not, can the State put this into the stimulus package to get it built faster?"

Table 6-1 displays the categorization of specific comments by DSEIS subject matter. The most comments were expressed regarding alternatives followed by Affected Environment; Environmental Consequences; and Purpose and Need and Consultation, Coordination and Compliance with Regulations.

Table 6-1: Categorization of Scoping Comments by DSEIS Subject Matter

Source of Scoping Comment	PN	ALT	AE	EC	CC	Totals
Scoping Meeting	14	19	20	5	6	**64**
Scoping Comment Cards	4	9	5	3	2	**23**
Scoping Comment Letters	0	7	3	11	10	**31**
Totals	**18**	**35**	**28**	**19**	**18**	**118**

Legend: **PN** = Purpose and Need, **ALT** = Alternatives, **AE** = Affected Environment, **EC** = Environmental Consequences, & **CC** = Consultation, Coordination, and Compliance with Regulations

NOTE: A single scoping comment may be categorized under multiple PDSEIS subject matter headings

The scoping comments were documented in a Scoping Report and describe the public's concerns about the restoration effort and strategies for restoration efforts. See Appendix C for the Scoping Report. All registered scoping meeting participants, as well as those providing written or verbal comments, were provided a copy of the Scoping Report. In addition, the Scoping Report will be posted on the study website at http://www.lca.gov/Convent.aspx.

6.2 Other Public Comments, Areas of Controversy, unresolved issues

The following meetings were held to provide opportunities for the public, landowners, NGOs, agencies, the Parishes and other interested parties to see progress on the project and to solicit feedback from the attendees.

- St. James Parish –July 10, 2008
- Ascension Parish – July 30, 2008
- Scoping Meeting – February 12, 2009
- Gulf States Maritime Association – April 28, 2009
- Ascension Parish – June 10, 2009
- U.S. Coast Guard - September 3, 2009
- Pontchartrain Levee District – September 11, 2009
- Public Interest Groups - St. James –September 15, 2009
- Public Interest Groups - Ascension –October 19, 2009
- Focus Group- April 29, 2010

- Public Meeting - June 15, 2010

6.2.1 Land owner involvement

Land/property owners attended the NEPA scoping meeting, and comments received from them are accounted for in the summary presented in Section 6.1.

6.2.2 Non-Governmental Organization (NGO) Involvement

In addition to the formal scoping meeting, two meetings were held in an effort to update recreational user groups on the project for specific input on potential benefits to the project study area. The intent of these meetings was to provide an update on study progress and solicit feedback prior to selection of the final plan. Presentations given to both the Louisiana Wildlife Federation and the East Ascension Sportsman League included representatives from other local groups including but not limited to the following:

- East Ascension Bass Club
- Timberton Hunting Club
- McElroy Hunting Club
- Romeville Hunting Club
- Panama Hunting Club
- Boyce Machinery
- Robert Family property
- St. James Boat Club
- Local Ducks Unlimited (East and West Ascension Chapters)
- Local National Wild Turkey Federation (Blind River Boss Gobblers Chapter)

The first public group meeting was held at the St. James Parish Courthouse on September 15, 2009. Twenty-five attendees were present and represented some of the groups listed above, some were camp owners, and some were other interested local residents.

Comments that were recurring throughout this meeting included the following:

- No action will certainly lead to continued degradation; the diversion is needed without a doubt
- A drainage plan must accompany the diversion project; the swamp needs freshwater but also needs to be able to drain sufficiently
- Generations that have watched the swamp degrade, with decreased duck populations and smaller deer; they want to see improved fishing and hunting conditions; improve the water quality; provide some high-ground areas as refuges for animals during high water

- This entire group was in support of implementing a diversion to improve swamp conditions

The second public group meeting was held at the American Legion Hall in Gonzales on October 19, 2009. A project status update was presented to the East Ascension Sportsman's League as part of their monthly meeting. Over 75 attendees were present, many of which also belong to some of the other public groups that were identified previously. The audience overwhelmingly voiced the need for this diversion as a means to improve water quality and swamp health with many of the same comments received at the first public group meeting.

Based on comments received from both public group attendees, it is very apparent that the main recreational feature(s) associated with the swamp include fishing and hunting.

6.2.3 Parish Involvement

St. James Parish has been involved in the study since its inception. Parish involvement included their active participation on the PDT; weekly updates were provided for their review and input. The Parish also supported the public meeting events by providing meeting facilities, and they provided valuable input from the Parish to the public meeting attendees supportive of PDT decisions. Parish personnel also provided necessary boat access and guided the field teams through swamp areas for environmental and biological assessment and monitoring station placement

6.3 Public Comments on the Draft SEIS

The DSEIS was released to the public on May 21, 2010, followed by a 45-day public review period. Comments from this review period were incorporated into this SEIS. Comments received and the responses to them are included in Appendix G.

7.0 COORDINATION AND COMPLIANCE*

This chapter documents the coordination and compliance efforts regarding statutory authorities including environmental laws, regulation, executive orders, policies, rules, and guidance. Consistency of the Tentatively Selected Plan (TSP)/Recommended Plan with other Louisiana coastal restoration efforts is also described.

7.1 USACE Principles and Guidelines (P&G)

The guidance for conducting Civil Works planning studies (ER 1105-2-100) requires the systematic formulation of alternative plans that contribute to the Federal objective. In order to ensure that sound decisions are made with respect to development of alternatives and ultimately plan selection, the plan formulation process requires a systematic and repeatable approach. The Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) describe the USACE study process and requirements.

Planning for this feasibility study has been conducted in accordance with the ER 1105-2-100 guidance. This report is a summary of the integrated feasibility study and SEIS conducted for this project. Policy reviews have been conducted to ensure compliance with applicable USACE policies.

7.2 Environmental Coordination and Compliance

Following completion of the final integrated report, the Assistant Secretary of the Army for Civil Works will issue a written Record of Decision (ROD) concerning the proposed action. The ROD will be issued within a framework of laws, regulations, executive orders, policies, rules, and other guidance. These authorities establish regulatory compliance standards for environmental resources pertaining directly to USACE management of water resources development projects, or provide planning guidance for the management of environmental resources. Full compliance with statutory authorities will be accomplished upon review of the integrated feasibility study and environmental impact statement by appropriate agencies and the signing of a ROD.

7.2.1 U.S. Fish and Wildlife Coordination Act

The USACE and the USFWS have formally committed to work together to conserve, protect, and restore fish and wildlife resources while ensuring environmental sustainability of our Nation's water resources under the January 22, 2003, Partnership Agreement for Water Resources and Fish and Wildlife. Accordingly, the USFWS indicated agreement to serve as a Cooperating Agency (per NEPA section 1501.6) in developing the FS/SEIS for the proposed project in accordance with applicable NEPA and CEQ guidance. Participation of the USFWS includes 1)

participating in meetings and field trips to obtain baseline information on project-area fish and wildlife resources; 2) evaluating the proposed project's impacts to wetlands and associated fish and wildlife resources, and assisting in the development of measures to avoid, minimize, and/or compensate for those impacts; and 3) providing technical assistance in the development of a Biological Assessment describing the impacts of the proposed activity to Federally listed threatened or endangered species and/or their critical habitat. In the January, 20, 2009, letter, the USFWS also provided specific guidance on avoiding impacts to West Indian manatee (*Trichechus manatus*), the pallid sturgeon (*Scaphirhynchus albus*) Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), bald eagle (*Haliaeetus leucocephalus*), and colonial nesting waterbirds. The U.S. Fish and Wildlife Draft and Final Coordination Letter and Report are provided in **Appendix B**. The coordination act letter report outlines the service's position and recommendations as follows:

The TSP will benefit the fish and wildlife resources that depend on the Maurepas Swamp by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increase organic production, increase biological productivity, and reduce conversion of swamp habitat to open water. Approximately 21,369 acres would benefit from the proposed project resulting in 6,421 AAHUs of swamp habitat at the end of the project life. The Service supports implementation of Alternative 2, a 3,000 cfs diversion at Romeville, provided the following fish and wildlife recommendations are implemented concurrently with project implementation:

1. *Because of the expedited schedule, we recommend that the Corps continue to coordinate with the agencies during the remaining Feasibility phase and the Preconstruction, Engineering, and Design (PED) phase to ensure any new project features, development of the operational plan, finalization of the monitoring and adaptive management plan, and/or changes in the design fully incorporate adequate fish and wildlife conservation measures and that those features can be adequately evaluated with regards to impacts to fish and wildlife resources.*

2. *We recommend that hydrologic modeling efforts better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit under the proposed operational plan. Those hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and conduct detailed impacts analysis. Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease).*

3. *To accommodate changing goals and restoration needs for the region, we recommend that the diversion structure, as well as the outfall management system, be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.*

4. *We recommend that water levels and swamp floor elevations be determined on a refined scale and incorporated into the hydrologic modeling.*

5. *We recommend that hydrologic modeling address future with and without project salinity conditions.*

6. *If the proposed project feature is changed significantly, is not implemented within one year of the Endangered Species Act consultation letter, or additional modeling reveals additional potential impacts, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.*

7. *Should additional hydrodynamic modeling determine impacts to Lake Maurepas water quality (e.g., salinity and temperature), we recommend that the Corps reinitiate coordination with the NMFS regarding EFH consultation.*

8. *Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).*

9. *To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and*

their nests, and should avoid affecting them during the breeding season.

10. *Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.*

11. *Please coordinate with the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on the Maurepas Swamp Wildlife Management Area (WMA).*

12. *Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.*

13. *Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable. Land clearing for access to the maintenance canals should be limited to one side of the channel bank to minimize fish and wildlife impacts.*

14. *Project designs for cross culverts proposed under U.S. Highway 61 and the Kansas City Southern Railroad and other bridge openings and water control structures should incorporate fish and wildlife passage. We recommend coordinating with the natural resource agencies during the PED phase to ensure fish and wildlife conservation measures are incorporated into the design of those structures.*

15. *Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) and any adaptive management and monitoring plans should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.*

16. *A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.*

References to the above USFWS recommendations and how each was addressed are as follows: Recommendations 1 and 2 are addressed in Sections 3.8.2.1. Recommendations 3, 4, 9, 10, 11, 12, 13 and 15 are all addressed in Section 3.8.3. Comments 5; 6, 7 & 8 are addressed in Section 3.8.2. Comment 14 is addressed in Section 3.7.3 and Comment 16 in Section 3.7.7.

7.2.2 Clean Water Act – Section 401 Water Quality

Under provisions of the Clean Water Act (33 U.S.C. § 1251), any project that involves placing dredged or fill material in waters of the United States or wetlands, or mechanized clearing of wetlands would require a water quality certification from the Louisiana Department of Environmental Quality (LDEQ), Office of Environmental Services. A public notice for the proposed action was issued. An application for water quality certification was provided to the LDEQ with the draft FS/SEIS, and stated that the proposed placement of fill material into waters of the state will not violate established water quality standards. Issuance of an LDEQ state Water Quality Certification was received September 20, 2010 (**Appendix D**).

7.2.3 Clean Water Act – Section 404(b)(1)

The USACE is responsible for administering regulations under Section 404(b)(1) of the Clean Water Act. Potential project-related impacts subject to these regulations, such as the discharge of dredged material onto spoil banks and the placement of rock for erosion protection, have been evaluated in compliance with Section 404(b)(1) of the Clean Water Act (**Appendix D**). The evaluation of potential impacts to water quality indicated that, on the basis of the guidelines, the proposed disposal sites for the discharge of excavated and previously dredged material and stone comply with the requirement of these guidelines, with the inclusion of appropriate and practicable methods to minimize adverse effects to the aquatic ecosystem.

7.2.4 Coastal Zone Management Act of 1972

Section 307 of the Coastal Zone Management Act (CZM) of 1972 (16 U.S.C. 1456(c)(1)(A)) directs Federal agencies proposing activities or development projects (including civil work activities), whether within or outside the coastal zone, must assure that those activities or projects are consistent, to the maximum extent

practicable, with the approved state coastal zone management program. A Consistency Determination is included with this report (**Appendix E**) and was submitted to the LDNR for consistency review. Implementation of the Recommended Plan is considered consistent, to the maximum extent practicable, with the approved Louisiana state coastal management program. A consistency determination was issued August 5, 2010.

7.2.5 Endangered Species Act of 1973

Compliance with the ESA (7 U.S.C. 136; 16 U.S.C. 460 et seq.) has been coordinated with the USFWS and the NMFS for those species under their respective jurisdictions. The use of Chapter 6 Coordination and Compliance with Environmental Requirements FEIS June 2009 6 – 5 recommended primary activity exclusion zones and timing restrictions would be utilized, to the maximum extent practicable, to avoid project construction impacts to any threatened or endangered species or their critical habitat within the proposed action area. The CEMVN will continue to closely coordinate and consult with the USFWS and the NMFS regarding threatened and endangered species under their jurisdiction that may be potentially impacted by the proposed action. Although Gulf sturgeon, pallid sturgeon and West Indian manatee may be found in the proposed action area, the only endangered species with a high potential for adverse impacts from the Recommended Plan is pallid sturgeon. Multi-project research is currently underway to determine the potential for diversion impacts to this species.

Formal consultation on the pallid sturgeon has been conducted and a Biological Opinion (Appendix A) was received on September 23, 2010 from the USFWS. The USFWS determined that the level of expected take is not likely to result in jeopardy to the pallid sturgeon.

7.2.6 Magnuson-Stevens Fishery Conservation and Management Act of 1996; and the Magnuson-Stevens Act Reauthorization of 2006 (EFH)

As directed by the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 104-297), the CEMVN has coordinated with the NMFS and that agency's experts on various marine organisms, as well as EFH. The NMFS provided a letter dated February 20, 2009, to help guide the development of the FS/SEIS for the proposed action (**Appendix C**). The NMFS identified blue crab, striped mullet and Gulf menhaden as estuarine-dependent fisheries species that use freshwater habitats in the project vicinity. The analysis of potential impacts of the Recommended Plan on EFH is described in **Section 4.2.10 EFH**.

7.2.7 Clean Air Act – Air Quality Determination

Compliance with the Clean Air Act (42 U.S.C.A. §§7401) has been fully coordinated with the Air Quality Section of the LDEQ (see also **Section 4.2.4 Air Quality**). As required by Louisiana Administrative Code, Title 33 (LAC 33:III.1405 B), an air quality applicability determination is being made for the Recommended Plan. This

includes consideration of the proposed action for the category of general conformity, in accordance with the Louisiana General Conformity, State Implementation Plan (LDEQ, 1994). An air quality determination will be calculated, based upon direct and indirect air emissions. Generally, since no other indirect Federal action, such as licensing or subsequent actions would likely be required or related to the restoration construction actions, it is likely that indirect emissions, if they would occur, would be negligible. Therefore, the air applicability determination analysis will be based upon direct emission for estimated construction hours. Considering that total emissions for each work item separately (or even when all work items are summed) would not exceed the threshold limit applicable to Volatile Organic Compounds (VOC) for parishes where the most stringent requirement (50 tons per year in serious non-attainment parishes) is in effect, (see General Conformity, State Implementation Plan, Section 1405 B.2), the VOC emissions for the proposed construction would be classified as de minimus and no further action would be required.

7.2.8 National Historic Preservation Act of 1966

In compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, and 36CFR 800, Federal agencies are required to identify and consider potential effects that their undertakings might have on significant historic properties, district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. Additionally, a Federal agency shall consult with any tribe that attaches religious and cultural significance to such properties. Agencies shall afford the State Historic Preservation Officer (SHPO) and tribes a reasonable opportunity to comment before decisions are made. Accordingly, the proposed action is being coordinated with the SHPO and tribes, initiation letters are presented in **Appendix F**.

7.2.9 Farmland Protection Policy Act (Prime and Unique Farmlands)

The purpose of the Farmland Protection Policy Act (7 U.S.C. 658) is to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses. Coordination is on-going with NRCS regarding farmlands in the study area so not impact these farmlands when implementing the TSP/Recommended plan.

7.2.10 Executive Order 13186 – Migratory Bird Habitat Protection

Executive Order 13186 proclaims the intent to support the conservation of previous migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions. This Executive Order requires environmental analyses of Federal actions required by the NEPA or other established environmental review processes to evaluate the effects of actions and agency plans on migratory birds, with emphasis

on species of concern. In addition, each Federal agency shall restore and enhance the habitat of migratory birds, as practicable.

7.2.11 Executive Order 12898 – Environmental Justice

Concern with environmental justice issues can be traced to Title VI, Section 601 of the Civil Rights Act of 1964 (Public Law 88-352):

"No person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."

On February 11, 1994, President Clinton issued Executive Order 12898 regarding Federal actions to address environmental justice issues in minority populations and low-income populations:

"To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands."

Executive Order 12898 is designed to focus Federal attention on the environmental and human health conditions in minority communities and low-income communities. The order is also intended to promote non discrimination in Federal programs substantially affecting human health and the environment, and to provide minority communities and low income communities access to public information on, and an opportunity for public participation in, matters relating to human health or environmental planning, regulations, and enforcement. Potential environmental justice issues have been considered throughout the entire study process, and will continue to be considered through project implementation. As part of the NEPA process, a scoping input request was provided to the public and interested parties. The scoping comments did not identify any potential environmental justice issues. The CEMVN is committed to ensuring that any potential environmental justice issues are addressed as the study proceeds. The proposed freshwater diversion and wetland restoration measures would equally impact all potential users (e.g., commercial and recreational fishers) in the area. There would be no potential environmental justice issues from implementing the Recommended Plan.

7.2.12 Executive Order 13112 – Invasive Species

On February 3, 1999, President Clinton issued Executive Order 13112 to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause by establishing the National Invasive Species Council. The Recommended Plan is consistent with Executive Order 13112 to the extent practicable and permitted by law and subject to the availability of appropriations, and within Administration budgetary limits. The Recommended Plan will use relevant programs and authorities to prevent the introduction of invasive species and not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere, unless the USACE has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species, and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

7.2.13 Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

All real estate interests acquired for construction of the TSP/Recommended Plan will be in accordance with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act), as amended in 42 USC 4601-4655, and the Uniform Regulations contained in 49 C.F.R. Part 24. The Uniform Act sets forth procedures for the acquisition of private property for public use and specifically requires that the acquiring agency appraise the real property interests it wishes to acquire and provide the owner a written summary of the basis for the amount established as just compensation.

7.2.14 Louisiana State Rare, Threatened, and Endangered Species, and Natural Communities Coordination

The CEMVN reviewed the database maintained by the LNHP that provides the most recent listing and locations for rare, threatened and endangered species of plants and animals and natural communities within the State of Louisiana. The proposed action would not adversely impact any rare, threatened or endangered species, or unique natural communities. The proposed action would increase the extent of baldcypress-tupelo swamp, which is identified as rare to secure natural communities for St. James and Ascension Parishes (see also Section **4.2.6 Coastal Vegetation Resources**).

7.2.15 Section 122 Rivers and Harbors Act

The U.S. Army Corps of Engineers (USACE) began regulating activities in navigable waters with the Rivers and Harbors Act of 1899. The act includes waters defined as navigable by the U.S. Coast Guard (USCG) but may also include rivers that were historically navigable or those which, with modification, may be available for future use to transport interstate commerce.

- Section 9 empowers USCG to regulate the construction of bridges and causeways within or across navigable waterways as determined by that agency through navigable waterway permits. The General Bridge Act of 1946 has more recent rules and regulations that direct staff through the bridge application process for Section 9 permits.
- Section 10 empowers USACE to regulate all work on structures in or affecting the course, condition, or capacity of navigable waters of the U.S. through navigable waterway permits.

The proposed action does not in any way disrupt or impede navigable waterways or maritime commerce.

7.2.16 Floodplain Management

Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms and generally include requirements for zoning, subdivision or building, and special-purpose floodplain ordinances.

A community's agreement to adopt and enforce floodplain management ordinances, particularly with respect to new construction, is an important element in making flood insurance available to home and business owners. Currently over 20,100 communities voluntarily adopt and enforce local floodplain management ordinances that provide flood loss reduction building standards for new and existing development.

The proposed action does not in any way influence any existing flood plain management programs.

7.2.17 Protection of Wetlands

An order given by President Carter in 1977 to avoid the adverse impacts associated with the destruction or modification of wetlands. The proposed action would not adversely impact wetlands and would actually improve natural wetlands.

7.2.18 Protection of Children from Environmental Health and Safety Risks

Executive Order (E.O.) 13045 - Protection of Children from Environmental Health Risks and Safety Risks - was issued by President William J. Clinton in 1997. The order applies to economically significant rules under E.O. 12866 that concern an environmental health or safety risk that EPA has reason to believe may disproportionately affect children. Environmental health risks or safety risks refer to risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest (such as the air we breathe, the

food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to). When promulgating a rule of this description, EPA must evaluate the effects of the planned regulation on children and explain why the regulation is preferable to potentially effective and reasonably feasible alternatives. The proposed action does not affect children in any way.

8.0 CONCLUSIONS AND DETERMINATIONS*

8.1 Areas of Controversy and Unresolved Issues

The Mississippi River levee system has cut off the Maurepas Swamp (and Blind River) from the natural periodic, near annual flooding by the Mississippi River. Past construction of logging trails, drainage channels, pipelines and other utilities, and roads through the swamp have further disrupted the natural flow and drainage patterns, and impacted the biological productivity of the swamp. Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates. The overall project objective is to reverse the trend of deterioration of southeastern Maurepas Swamp and Blind River. Meetings and discussions with the public and local, state and federal agencies and the Project Development Team (PDT) indicate support for the project and did not identify any areas of controversy or unresolved issues.

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

8.2 Conclusions

The Recommended Plan, Alternative 2, best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Environmental Operating Principles; and is within the cost and scope of the Congressional mandate provided in WRDA 2007 (Public Law 110-114) for a small diversion at Convent/Blind River, to reverse the trend of deterioration in the southeast part of the Maurepas Swamp. Alternative 2, a 3,000 cfs diversion at Romeville, has six major components: a diversion structure, a transmission canal, control structures, approximately 30 berm gaps, cross culverts at four locations along U.S. highway 61 and instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. The Recommended Plan would improve a total of

21,369 acres (8,648 ha) of baldcypress-tupelo swamp that are in various stages of deterioration. The Recommended Plan would improve 3,295 acres (1,333 ha) of baldcypress-tupelo swamp that would become marsh in 20 to 30 years without project implementation, 7,934 acres (3,211 ha) of baldcypress-tupelo swamp that would become marsh in 30 to 50 years without project implementation, and 10,140 acres (4,104 ha) of baldcypress-tupelo swamp that would become marsh in greater than 50 years without project implementation.

8.3 Recommendations

LCA Small Diversion at Convent/Blind River recommended and described herein to restore the natural ecology within the Maurepas swamp be constructed as a Federal project, with such modifications thereof as in the discretion of the Commander, USACE may be advisable. The project total first cost, based on October 2010 price levels, is estimated at $116,791,000. The estimated fully funded cost of the Recommended Plan is $123,140,000. The Non-Federal Sponsor shall, prior to implementation, agree to perform the items of local cooperation as were stated in Section 3.9.2.

The recommendation contained herein reflects the information available at this time, price levels as specified in the FS/SEIS, and current departmental policies governing the formulation of the project. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher levels of review within the Executive Branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for implementation funding.

Edward Fleming

Colonel, U.S. Army

District Engineer

9.0 DISTRIBUTION LIST AND OTHER*

9.1 Distribution List

The LCA Small Diversion at Convent/Blind River Integrated Feasibility Report and Supplemental Environmental Impact Statement (SEIS) will be distributed to Federal, state, parish, and local agencies; tribes; businesses; libraries; museums; universities; environmental organizations, groups and individuals; and scoping participants. The complete distribution list would be available upon request from the U.S. Army Corps of Engineers at the following address.

U.S. Army Corps of Engineers
New Orleans District
P.O. Box 60267
New Orleans, Louisiana 70160-0267

9.2 List of Preparers

Many individuals were involved with the completion of this document. The following selection contains a listing of those people who assisted in writing the LCA Small Diversion at Convent/Blind River Integrated Feasibility Report and SEIS.

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9.4 Glossary

Acceptability	Adequate to satisfy a need, requirement, or standard. One of the USACE requirements for a project.
Adaptive Management	An interdisciplinary approach acknowledging our insufficient information base for decision-making; that uncertainty and change in managed resources are inevitable; and that new uncertainties will emerge. An iterative approach that includes monitoring and involves scientists, engineers and others who provide information and recommendations that are incorporated into management actions; results are then followed with further research, recommendations and management actions, and so on.
Air Quality Determination	The Louisiana Department of Environmental Quality ensures that projects do not adversely affect air quality through this determination as a requirement of the Clean Air Act.
Alternative Plan	A set of one of more management measures within a subprovince functioning together to address one or more objectives.
Anthropogenic	Caused by human activity.
Average Annual Habitat Unit (AAHU)	Represent a numerical combination of habitat quality and quantity (acres) existing at any given point in time. The habitat units resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs).
Benefits	Valuation of positive performance measures.
Benthic	Living on or in sea, lake, or stream bottoms.

Biomass	The total mass of living matter (plant and animal) within a given unit of environmental area.
Bottomland Hardwood Forest	Low-lying forested wetlands found along streams and rivers.
Brackish Marsh	Intertidal plant community typically found in the area of the estuary where salinity ranges between 4-15 ppt.
Clean Water Act Section 404 (b) (1)	There are several sections of this Act which pertain to regulating impacts to wetlands. The discharge of dredged or fill material into waters of the United States is subject to permitting specified under Title IV (Permits and Licenses) of this Act and specifically under Section 404 (Discharges of Dredge or Fill Material) of the Act.
Coastal Zone Consistency Determination	The U.S. Environmental Protection Agency reviews plans for activities in the coastal zone to ensure they are consistent with Federally approved State Coastal Management Programs under Section 307(c)(3)(B) of the Coastal Zone Management Act.
Coastwide Plan	Combination of alternative plans assembled to address an objective or set of objectives across the entire Louisiana Coast.
Comprehensive Plan	Same as coast-wide Plan.
Conditional Authorization	Authorization for implementation of a project subject to approval of the project feasibility-level decision document by the Assistant Secretary of the Army for Civil Works.
Congressional Authorization	Authorization for investigation to prepare necessary feasibility-level report to be recommended for authorization of potential future project construction by

	Congress.
Connectivity	Property of ecosystems that allows for exchange of resources and organisms throughout the broader ecosystem.
Control Structure	A gate, lock, or weir that controls the flow of water.
Cumulative Impacts	The combined effect of all direct and indirect impacts to a resource over time.
Datum	A point, line, or surface used as a reference, as in surveying, mapping, or geology.
Decomposition	Breakdown or decay of organic materials.
Degradation Phase	The phase of the deltaic cycle when sediments are no longer delivered to a delta, and it experiences erosion, dieback, or breakup of marshes.
Deltaic Cycle	The repeating pattern of delta development, progression, and abandonment. As sediments are deposited at the mouth of the distributary channels, the delta progresses seaward. The main channel then switches to a new course with a shorter reach to the depositional basin. Abandoned delta lobes decrease in elevation due to continued subsidence and sediment compaction, resulting in retreat of the shoreline. Abandoned lobes may be partially or wholly covered by new lobes during later deltaic cycles.
Deltaic Deposits	Mud and sand deposited at the mouth of a river.
Deltaic Plain	The land formed and reworked as the Mississippi River switched channels in the eastern part of the Louisiana coastal area.

Detritus	The remains of plant material that has been destroyed or broken up.
Dewatering	The process of dredged sediments compacting while losing water after being deposited.
Discharge	The volume of fluid passing a point per unit of time, commonly expressed in cubic feet per second, millions of gallons per day, or gallons per minute.
Dissolved Oxygen	Oxygen dissolved in water, available for respiration by aquatic organisms. One of the most important indicators of the condition of a water body.
Direct Impacts	Those effects that result from the initial construction of a measure (e.g., marsh destroyed during the dredging of a canal). Contrast with "Indirect Impacts."
Diversion	A turning aside or alteration of the natural course or flow of water. In coastal restoration this usually consists of such actions as channeling water through a canal, pipe, or conduit to introduce water and water-borne resources into a receiving area.
Dredged material embankments (Dredged material berms, Side-cast Banks, Excavated Material Banks)	Dredged material removed from canals and piled in a linear mound along the edge of canals.
Dynamic	Characterized by continuous change and activity.
Ecological	Refers to the relationship between living things and their

	environment.
Economic	Of or relating to the production, development, and management of material wealth, as of a country, household, or business enterprise.
Ecosystem	An organic community of plants and animals viewed within its physical environment (habitat); the ecosystem results from the interaction between soil, climate, vegetation, and animal life.
Ecosystem Restoration	Activities that seek to return an organic community of plants and animals and their habitat to a previously existing or improved natural condition or function.
Effectiveness	Having an intended or expected effect. One of the USACE requirements for a project.
Efficiency	The quality of exhibiting a high ratio of output to input. One of the USACE requirements for a project.
Egress	A path or opening for going out; an exit.
Embankment	A linear mound of earth or stone existing or built to hold back water or to support a roadway.
Encroachment	Entering gradually into an area not previously occupied, such as a plant species distribution changing in response to environmental factors such as salinity.
Endangered Species	Animals and plants that are threatened with extinction.
Enhance	To augment or increase/heighten the existing state of an area.

Environmental Impact Statement (EIS)	A document that describes the positive and negative environmental effects of a proposed action and the possible alternatives to that action. The EIS is used by the Federal government and addresses social issues as well as environmental ones.
Estuary	A semi-enclosed body of water with freshwater input and a connection to the sea where fresh water and salt water mix.
Estuarine	Related to an estuary.
Evaporation	The process by which any substance is converted from a liquid state into, and carried off in, vapor; as, the evaporation of water.
Exotic Species	Animal and plant species not native to the area; usually undesirable (e.g., hyacinth, nutria, tallow tree, giant salvinia).
Feasibility Report	A description of a proposed action, previously outlined in a general fashion in a Reconnaissance Report, that will satisfy the Federal interest and address the problems and needs identified for an area. It must include an assessment of impacts to the environment (either in an Environmental Assessment, or the more robust Environmental Impact Statement), an analysis of alternative methods of completion, and the selection of a Recommended Plan through the use of a cost-effectiveness analysis.
Feature	A constructible increment of an alternative plan.

Final Array	The final grouping of the most effective coast wide plans from which a final recommendation can be made.
Fresh Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 0-3 ppt.
Geomorphic	Related to the geological surface configuration.
Goals	Statements on what to accomplish and/or what is needed to address a problem without specific detail.
Gradient	A slope; a series of progressively increasing or decreasing differences in a system or organism.
Habitat	The place where an organism lives; part of physical environment in which a plant or animal lives.
Habitat Loss	The disappearance of places where target groups of organisms live. In coastal restoration, usually refers to the conversion of marsh or swamp to open water.
Habitat Units (HUs)	Represent a numerical combination of quality (HSI) and quantity (acres) existing at any given point in time. The HUs resulting from the future without- and future with-project scenarios are annualized, averaged over the project life, to determine Average Annual Habitat Units (AAHUs). The "benefit" of a project can be quantified by comparing AAHUs between the future without- and future with-project scenarios. The difference in AAHUs between the two scenarios represents the net benefit attributable to the project in terms of habitat quantity and quality.
Hazardous, Toxic, and Radioactive Wastes (HTRW)	Wastes that contain toxic constituents, or that may cause hazardous chemical reactions, including explosive or flammable materials, or radioactive wastes, which,

	improperly managed may present a hazard to human health or the environment.
Headland	A point of land projecting into the sea or other expanse of water, still connected with the mainland.
Herbaceous	A plant with no persistent woody stem above ground.
Hydrodynamic	The continuous change or movement of water.
Hydrology	The pattern of water movement on the earth's surface, in the soil and underlying rocks, and in the atmosphere.
Hypoxia	The condition of low dissolved oxygen concentrations.
Indirect Impacts	Those effects that are not as a direct result of project construction, but occur as secondary impacts due to changes in the environment brought about by the construction. Contrast with "Direct Impacts."
Infrastructure	The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools, post offices, and prisons.
Inorganic	Not derived from living organisms; mineral; matter other than plant or animal.
Intermediate Marsh	Intertidal herbaceous plant community typically found in that area of the estuary with salinity ranging from 2-5 ppt.
Intertidal	Alternately flooded and exposed by tides.

Invertebrates	Animals without backbones, including shrimp, crabs, oysters, and worms.
Larvae	The stage in some animal's life cycles between egg and adult (most invertebrates).
Levee	A linear mound of earth or stone built to prevent a river from overflowing; a long, broad, low ridge built by a stream on its flood plain along one or both banks of its channel in time of flood.
Maintain	To keep in existing state.
Methodology	A set of practices, procedures, and rules.
Mineral Substrate	Soil composed predominately of mineral rather than organic materials; less than 20 percent organic material.
Mudflats	Flat, unvegetated wetlands subject to periodic flooding and minor wave action.
National Ecosystem Restoration (NER)	USACE standard for cost-effectiveness based on ecosystem, not economic, benefits.
National Environmental Policy Act (NEPA)	Ensures that Federal agencies consider the environmental impacts of their actions and decisions. NEPA requires all Federal agencies to consider the values of environmental preservation for all significant actions and prescribes procedural measures to ensure that those values are fully respected.
Net Gain	The amount of cumulative land gain less land loss, when gain is greater than loss.
Net Loss	The amount of cumulative land gain less land loss, when

	gain is less than loss.
No Action Alternative	The alternative in the NEPA document which describes the ecosystem of the coastal area if no restoration efforts/projects were done.
Nursery	A place for larval or juvenile animals to live, eat, and grow.
Objectives	More specific statements than "Goals," describing how to achieve the desired targets.
Organic	Composed of or derived from living things.
Oxidation of Organic Matter	The decomposition (rotting, breaking down) of plant material through exposure to oxygen.
Oxygen-depleted	Situation of low oxygen concentrations where living organisms are stressed.
Potable Water	Water that is fit to drink.
ppt	Parts per thousand. The salinity of ocean water is approximately 35 ppt.
Prime Farmland	Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. One of the categories of concern in the NEPA document.
Principles	Framing statements that can be used to evaluate alternatives while considering issues that affect them. Used along with targets and assessments of ecosystem needs to provide guidance in formulation of alternative

	plans.
Productivity	Growth of plants and animals.
Progradation	The phase during the deltaic cycle where land is being actively accreted through deposition of river sediments near the mouth.
Programmatic Environmental Impact Statement (PEIS)	And Environmental Impact Statement that supports a broad authorization for action, contingent on more specific detailing of impacts from specific measures.
Province	A major division of the coastal area of Louisiana. (e.g.,. Deltaic Plain and Chenier Plain).
Quantitative	Able to assign a specific number; susceptible to measurement.
Reduce	To diminish the rate or speed of a process.
Rehabilitate	To focus on historical or pre-existing ecosystems as models or references while emphasizing the reparation of ecosystem processes, productivity and service.
Relative Sea Level Rise	The sum of the sinking of the land (subsidence) and eustatic sea level rise; the change in average water level with respect to the surface.
Restore	Return a wetland to an approximation of its condition or function prior to disturbance by modifying conditions responsible for the loss or change; re-establish the function and structure of that ecosystem.
Salinity	The concentration of dissolved salts in a body of water,

	commonly expressed as parts per thousand.
Salt Marshes	See Saline Marsh.
Scoping	Soliciting and receiving public input to determine issues, resources, impacts, and alternatives to be addressed in the draft EIS.
Sea level	Long-term average position of the sea surface.
Sheet Flow	Flow of water, sediment, and nutrients across a flooded wetland surface, as opposed to through channels.
SEIS	Typically prepared after either a Final EIS or Record of Decision has been issued and new environmental impacts that were not considered in the original EIS are discovered, requiring the lead agency to re-evaluate its initial decision and consider new alternatives to avoid or mitigate the new impacts. Supplemental EISs are also prepared when the size and scope of a Federal action changes, or when all of the proposed alternatives in an EIS are deemed to have unacceptable environmental impacts and new alternatives are proposed.
Social	Relating to human society and its modes of organization.
Socioeconomic	Involving both social and economic factors.
Stabilize	To fix the level or fluctuation of; to make stable.
State Historic Preservation Office (SHPO)	The part of the Louisiana Department of Culture, Recreation, and Tourism that oversees consultation and compliance with Section 106 of the National Historic Preservation Act for Federally funded, permitted, or approved projects.
Storm Surge	An abnormal and sudden rise of the sea along a shore as a

	result of the winds of a storm.
Strategy	Ecosystem restoration concept from the Coast 2050 Plan.
Stream Gaging Data	Records of water levels in streams and rivers.
Submergence	Going under water.
Subprovince	The divisions of the two Provinces (see "Province") into smaller groupings: 1) east of the Mississippi River; 2) west of the Mississippi River to Bayou Lafourche; 3) Bayou Lafourche to Freshwater Bayou; 4) Freshwater Bayou to Sabine River.
Subsidence	The gradual downward settling or sinking of the Earth's surface with little or no horizontal motion.
Sustain	To support and provide with nourishment to keep in existence; maintain.
Target	A desired ecosystem state that meets an objective or set of objectives.
Terrestrial Habitat	The land area or environment where an organism lives; as distinct from water or air habitats.
Toxicity	The measure of how poisonous something is.
Transpiration	The process by which water passes through living plants into the atmosphere.
Turbidity	The level of suspended sediments in water; opposite of clarity or clearness.
Upland	A general term for non-wetland elevated land above low

areas along streams or between hills.

Water Resources Development Act (WRDA)	A bill passed by Congress that provides authorization and/or appropriation for projects related to the conservation and development of water and related resources.
Weir	A low head dam placed across a canal or river to raise, divert, regulate or measure the flow of water.

9.5 Acronyms

AAHU	Average Annual Habitat Unit
Ac	acres
ACM	Articulate concrete mattress
ADCIRC	Advanced circulation model
ADCM	Acoustic Doppler current meter
AM	Adaptive Management
ARE	Area of Potential Effect
APHIS	Animal and Plant Health Inspection Service
AQD	Air Quality Division
AQI	Air Quality Index
ARDC	Amite River Diversion Canal
ASA, CW	Assistant Secretary of Army, Civil Works
ASTM	American Society for Testing and Materials
BAI	Basal area increment
BMP	Best Management Practice
BOD	Biological Oxygen Demand
CECW-PB	Corps of Engineers Civil Works Policy Branch
CEMVN	Civil Engineering Mississippi Valley New Orleans
CE	Categorical Exclusions
CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIAP	Coastal Impact Assistance Program
CITES	Convention on International Trade in

	Endangered Species Of wild Fauna and Flora
CMD	Coastal Management Division
CN RR	Canadian National Railroad
COL	Colonies
CO-OPS	Center for Operational Oceanographic Products and Services
CPRA	Coastal Protection and Restoration Authority
CRMS	Coast-wide Reference Monitoring System
Cfs	Cubic feet per second
CWPPRA	Coastal Wetlands Planning, Protection, and Restoration Act
CW	Civil Works
CZM	Coastal Zone Management Act
DA	Diversion Alignment
DBH	Diameter at breast height
DEQ	Department of Environmental Quality
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DOTD	Department of Transportation and Development
DS	Distribution System
DSEIS	Draft Supplemental Environmental Impact Statement
DV	Diversion System
EA	Environmental Assessment
EASL	East Ascension Sportsman League
E&D	Engineering and Design
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ELEV.	Elevation
EO	Executive Order
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
ESA	Environmental Site Assessment
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FMC	Fishery management council
FMP	Fishery management plan
FPEIS	Final Programmatic Environmental Impact Statement
FS	Feasibility Study
FWP	Fish and Wildlife Propagation

FY	Fiscal Year
GIWW	Gulf Intracoastal Waterway
GCLV	Gulf Coast Joint Venture
GOM	Gulf of Mexico
Ha	Hectares
HEP	Habitat Evaluation Procedures
HES	Habitat Evaluation System
HHS	U.S. Department of Health and Human Services
HQUSACE	Headquarters, US Army Corps of Engineers
HIS	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Waste
HU	Habitat Unit
HWY	Highway
I	Interstate
IWR	Institute for Water Resources
KCS RR	Kansas City Southern Railroad
Km	Kilometers
Kg	Kilograms
L	Liter
LA	Louisiana
LAC	Louisiana Administrative Code
LACPR	Louisiana Coastal Protection and Restoration
LADAF	Louisiana Department of Agriculture and Forestry
LAGIC	Louisiana Geographic Information Center
LAMP	Louisiana Amphibian Monitoring Program
LCA	Louisiana Coastal Area
LCWCRTF	Louisiana Coastal Wetlands Conservation and Restoration Task Force
LDEQ	Louisiana Department of Environmental Quality
LDNR or LADNR	Louisiana Department of Natural Resources
LDWF or LADWF	Louisiana Department of Wildlife and Fisheries
LERRD	Lands, Easements, Rights of Way and Disposal Sites
LFC	Louisiana Forestry Commission
LIDAR	Light detection and ranging
LNHP	The Natural Heritage Program
LPBF	Lake Pontchartrain Basin Foundation

LPP	Locally Preferred Plan
LNG	Liquefied natural gas
LSU	Louisiana State University
M	Monitoring
MCACES	Micro-Computer Aided Cost Estimating System
MCL	Maximum Contaminant Level
MCY	Million Cubic Yards
Mg	Milligrams
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MRC	Mississippi River Commission
MRGO	Mississippi River Gulf Outlet
MR&T	Mississippi River and Tributaries Project
MSA	Metropolitan statistical areas
MTBE	Methyl-t-butyl ether
MVD	US Army Corps of Engineers, Mississippi Valley Division
MVN	US Army Corps of Engineers, Mississippi Valley Division, New Orleans
NA	No Action
NA	Not Available
NAAQS	National Ambient Air Quality Standards
NASS	National Agricultural Statistics Service
NAVD	North American Vertical Datum
NAVD88	North American Vertical Datum of 1988
NAWFMP	North American Waterfowl Management Plan
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGO	Non-governmental Organization
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Agency
NPMS	National Pipeline Mapping System
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Units
NWRC	National Wetland Research Center
O&M	Operation and Maintenance
OMRR&R	Operation, maintenance, repair, rehabilitation, and replacement
OCPR	Office of Coastal Protection and

	Restoration
ONR	Outstanding Natural Resource
ORCS	Old River Control Structure
PCR	Primary Contact Recreation
PCU	Pollution Control Unit
PEIS	Programmatic Environmental Impact Statement
PDDFS	Pre-Decisional Draft Feasibility Study
PDT	Project Development Team
PED	Preconstruction, engineering, and design
P&G	Principles and Guidelines
PHMSA	Pipeline and Hazardous Material Safety Administration
PL	Public Law
PLD	Pontchartrain Levee District
PM	Project Manager
PMP	Project Management Plan
PPA	Project Partnership Agreement
PPPMD	Planning, Programs & Project Management Division
Psu	Practical salinity units
QCP	Quality Control Plan
RA	Recreational Access
RE	Real Estate
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RR	Railroad
RSET	Rod-surface elevation table
RSLR	Relative Sea Level Rise
SA	Study Area
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SCR	Secondary Contact Recreation
SD	Standard Deviation
SET	Surface elevation table
SHPO	State Historic Preservation Officer
SM	Sediment Management
SONRIS	Strategic Online Natural Resources Information System
S&A	Supervision & Administration
S&T	Science and Technology
SU	Standard Units
THPO	Tribal Historic Preservation Officer
TMDL	Total Daily Mass Load
TN	Total Nitrogen

TP	Total Phosphorous
TS	Transmission System
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
TY	Target Year
UDV	Unit Daily Value
US	United States
USACE	U.S. Army Corps of Engineers
USACE-MVN	U.S. Army Corps of Engineers – Mississippi Valley New Orleans District
USAED	U.S. Army Engineer District
U.S.C.	United States Code
U.S.C.A.	United States Code Annotated
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOT	United States Department of Transportation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VM	Vegetation Management
VOC	Volatile Organic Compounds
WCRA	Wetlands Conservation and Restoration Authority
WQ	Water Quality
WM	Water Management
WMA	Wildlife Management Area
WRDA	Water Resources Development Act
WVA	Wetland Value Assessment

MAIN REPORT

ATTACHMENT 1

Non-Federal Sponsor's Letter of Intent

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CPRA
Coastal Protection and Restoration Authority of Louisiana

Colonel Edward R. Fleming
New Orleans District
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

August 9. 2010

Dear Col. Fleming:

The State of Louisiana is pleased to offer its continuing support of the Louisiana Coastal Area (LCA) Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects as authorized in the Water Resources Development Act of 2007 (WRDA 2007). These projects are a critical part of the overall LCA Program and a vital component in rehabilitating the natural system of coastal Louisiana that serves to protect the economic and energy security of both the state and nation, the safety of more than 2 million Louisiana residents, the ecological balance of the Gulf region, and the survival of a unique culture.

This letter, while not legally binding on the State as an obligation of future funds appropriated by the State Legislature, declares our full support for the LCA Multi-purpose Operation of the Houma Canal Lock, Terrebonne Basin Barrier Shoreline Restoration, Small Diversion at Convent/Blind River, Amite River Diversion Canal Modification, Medium Diversion at White's Ditch, and Convey Atchafalaya River Water to Northern Terrebonne Marshes projects as described in the draft reports dated August 2010, with cost sharing as required in WRDA 2007. Accordingly, the State acknowledges that the projects require the non-Federal sponsor to contribute 35% of the total project costs, including all lands, easements, rights-of-way, relocations, and any improvements on lands, easements, and rights-of-way required for disposal of dredged material. The State also acknowledges that it will be required to perform all activities necessary to operate, maintain, rehabilitate, repair and replace the projects at the State's expense, including the performance of renourishment for the Terrebonne Basin Barrier Shoreline Restoration Project features as described in the feasibility report for that project. The State of Louisiana fully supports these projects, and the Coastal Protection and Restoration Authority will make diligent efforts to secure all necessary funding, including asking the State legislature for additional appropriations if necessary. Nevertheless, the Coastal Protection and Restoration Authority and the State of Louisiana reserve the right to seek the enactment of Federal law to reduce the non-Federal cost share.

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

Respectfully,



Garret Graves
Chair
Coastal Protection and Restoration Authority

Integrated Feasibility Study and Supplemental Environmental Impact Statement

For the

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

(APPENDICES A – M)

The responsible lead Federal agency for this study is the U. S. Army Engineer District, *New Orleans*. The Non-Federal Sponsor for the study is *the Louisiana Coastal Protection and Restoration Authority*. The responsible cooperating Federal agency is the *U.S. Fish and Wildlife Service*. This report is a combined feasibility report and environmental impact statement complying with requirements of the U.S. Army Corps of Engineers (USACE) and the Council of Environmental Quality (CEQ), and is intended to reduce duplication and paperwork. An asterisk (*) in the table of contents notes paragraphs that are required for National Environmental Policy Act (NEPA) compliance.

October 2010

U.S Army Corps of Engineers
New Orleans District

Coastal Protection and Restoration Authority

Volume IV

APPENDIX A:

Biological Assessment

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Appendix A
Biological Assessment

Small Diversion at Convent/Blind River Project, Louisiana Coastal Area

1.0 Authority

This Supplemental Environmental Impact Statement (SEIS) for the LCA Small Diversion at Convent / Blind River project was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality's (CEQ) Regulations (40 CFR 1500-1508), as reflected in the United States Army Corps of Engineers (USACE) Engineering Regulation, ER 200-2-2. As the study proceeds this SEIS and subsequent iterations of this document will be closely coordinated between the U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District (CEMVN) and other Federal, state, and local agencies, interested parties, and affected individuals. Additionally, it is expected that the U.S. Fish and Wildlife Service (USFWS) will be a cooperating agency. This BA provides information to decision-makers to make determinations on whether to proceed with the engineering and design portions of the project.

Title VII of the Water Resources Development Act (WRDA) of 2007 authorizes the Louisiana Coastal Area Near-term Restoration Plan. The authority includes requirements for comprehensive coastal restoration planning, program governance, project modification investigations, a Science and Technology (S&T) program, restoration project construction, a program for beneficial use of dredged material, feasibility studies for restoration plan components, and other program elements.

The Convent/Blind River Diversion Project is proposed to be a small freshwater diversion from the Mississippi River to the Maurepas Swamp, with a flow rate of 1,000 to 5,000 cfs. The purpose of the project is to reintroduce freshwater, sediment, and nutrients to the swamp, approximating the natural historic flooding cycle to rebuild wetlands at a rate greater than the subsidence rate. This is to improve biological productivity and reverse the current trend of degradation and restore the Swamp.

2.0 Location and General Description of the Project Area

The project area is in the Mississippi River Deltaic Plain in the Upper Lake Pontchartrain Sub-basin. The project area is within St. John the Baptist, St. James, and Ascension Parishes. The project area consists portions of the Maurepas Swamp and Blind River southwest of I-10 (**Figure A.1**).

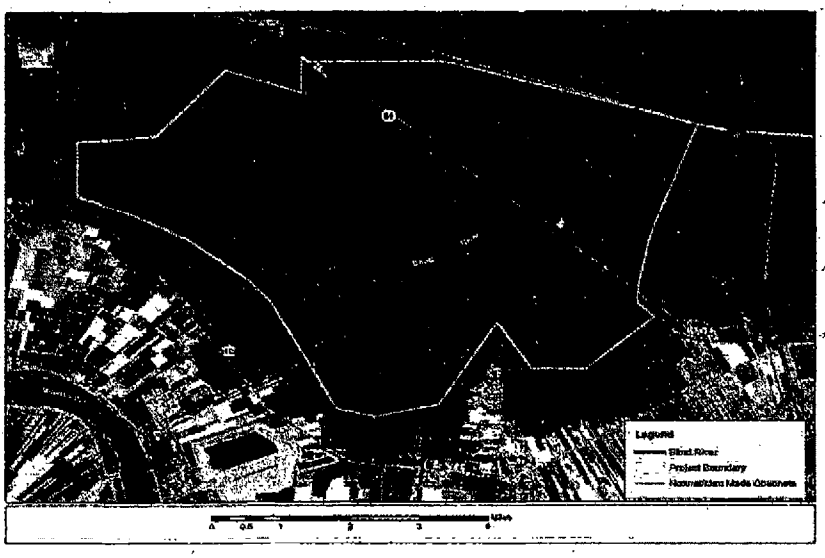


Figure A.1 Project Area

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along Mississippi River/Airline Highway corridor. Development along this corridor in the project area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of baldcypress-tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

As with all of the rapidly disappearing coastal wetlands in Louisiana, the south Maurepas area has been subject to extensive consideration in recent years pursuant to federal and state restoration initiatives. Rapid deterioration of the Maurepas Swamp is expected to continue unless a restoration effort is formulated and implemented as soon as possible and has been noted in several programmatic reports including the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, 1993), the Louisiana Coast 2050 report (1998), which provided a more strategic and participation-based approach to restoration, and the Mississippi River Sediment, Nutrient and Freshwater Diversion study (1999), which looked specifically at projects for restoration by means of diverting Mississippi River water into wetlands, including the south Maurepas swamps. All these studies have identified the south Maurepas as

an area where wetlands vegetation (especially the cypress-tupelo swamp) is stressed and dying, and in need of restoration.

3.0 Proposed Action

The main components of the tentatively selected plan (TSP), a 3,000 cfs diversion from the Mississippi River at Romeville, consist of three gated culverts, a 3-mile long transmission canal, five concrete drainage control structures, thirty new berm gaps approximately 500 feet wide each, the widening of 160 existing berm gaps and three culverts at the railroad/Hwy 61 crossing (Figure A-2).

4.0 Species Descriptions

Within the State of Louisiana there are thirty animal and three plant species (some with critical habitats) under the jurisdiction of the USFWS and/or the NMFS that are presently classified as endangered or threatened. The USFWS and the NMFS share jurisdictional responsibility for sea turtles and the Gulf sturgeon. After coordination with state and federal agencies, it has been determined that the proposed action would potentially impact the Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), pallid sturgeon (*Scaphirhynchus albus)* and West Indian manatee (*Trichechus manatus*). Therefore, more detailed descriptions of listed species follow.

4.1 Gulf Sturgeon

Status:

On September 30, 1991, the Gulf sturgeon was listed as a threatened species under the ESA, and the USFWS designated critical habitat for this species throughout its range on February 28, 2003. In Louisiana, Gulf sturgeon critical habitat includes the Pearl River System in Washington and St. Tammany Parishes, the Bogue Chitto River, as well as Lake Pontchartrain, Lake Borgne, Lake Catherine, and the Rigolets (Federal Register Volume 68, No. 53). According to the final critical habitat designation, elements essential for Gulf sturgeon conservation are habitat components supporting feeding, resting, sheltering, reproduction, and migration.

Species and Habitat Description:

The Gulf sturgeon, also known as the Gulf of Mexico sturgeon, is an anadromous fish (i.e. a fish that breeds in freshwater after migrating from marine or estuarine environments). The Gulf sturgeon inhabits coastal rivers from Louisiana to Florida during spring and summer, and the estuaries, bays, and marine environments of the Gulf of Mexico during fall and winter. It is a nearly cylindrical, primitive fish embedded with bony plates or scutes. The head ends in a hard, extended snout; the mouth is inferior and protrusible and is preceded by four conspicuous barbels. The tail (caudal fin) is distinctly asymmetrical; the upper lobe is longer than the lower lobe (heterocercal). Adults range from 4 to 8 feet (1.2 to 2.4 meters) in length, with adult females larger than adult males.

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years of age (Huff, 1975). Age at sexual maturity for females ranges from 8 to 17 years, and for

males from 7 to 21 years (Huff, 1975). In the spring (from late February to mid-April) when the river surface temperatures are 63 to 70 degrees Fahrenheit (°F) (17 to 21 degrees Celsius [°C]), sexually mature, males and females migrate into rivers to spawn (Carr, Tatman, and Chapman, 1996). It is believed that Gulf sturgeon exhibit a spawning periodicity similar to Atlantic sturgeon, with females spawning at intervals ranging from every 3 to 5 years, and males every 1 to 5 years (Smith, 1985, see http://www.fws.gov).

Gulf sturgeon eggs are demersal (i.e. they sink to the bottom), adhesive, and vary in color from gray to brown to black (Vladykov and Greeley, 1963; Huff, 1975; Parauka et al., 1991). Sturgeon require hard substrates for eggs to adhere to and to provide shelter for developing larvae (Sulak and Clugston, 1998, see http://www.fws.gov). Young-of-the-year Gulf sturgeon appear to disperse widely, using extensive portions of the river as nursery habitat. They are typically found on sandbars and sand shoals over rippled bottom and in shallow, relatively open, unstructured areas.

Gulf sturgeon feeding habits in freshwater vary depending on the fish's life history stage. Young-of-the-year Gulf sturgeon remain in freshwater feeding on aquatic invertebrates and detritus approximately 10 to 12 months after spawning occurs (Mason and Clugston, 1993; Sulak and Clugston, 1999, see http://www.fws.gov). Juveniles less than 11 lbs (5 kg) are believed to forage extensively and exploit scarce food resources throughout the river, including aquatic insects (e.g., mayflies and caddis flies), worms (oligochaetes), and bivalve mollusks (Huff, 1975; Mason and Clugston, 1993). Subadults (age 6 to sexual maturity) and adults (sexually mature) only feed in marine and estuarine habitats and are thought to forage opportunistically (Huff, 1975) on primarily benthic invertebrates. Gut content analyses have indicated that, at this life stage, the Gulf sturgeon's diet is predominantly amphipods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans (Huff, 1975; Mason and Clugston, 1993; Carr, Tatman, and Chapman, 1996b, see http://www.fws.gov; Fox et al., 2000, see http://www.fws.gov; Fox et al., 2002, see http://www.fws.gov).

When river temperatures drop in the fall to about 63 to 72°F (17 to 22°C), Gulf sturgeon return to the coastal shelf areas of the Gulf of Mexico (Carr, Tatman, and Chapman, 1996, see http://www.fws.gov). Most subadult and adult Gulf sturgeon spend the cooler months in estuarine areas, bays, or the Gulf of Mexico feeding. (Odenkirk, 1989; Foster, 1993; Clugston et al., 1995; Fox et al., 2002, see http://www.fws.gov). Winter habitats used by Gulf sturgeon coincide with the habitats of their prey. Non-spawning sturgeon appear to feed longer in the estuaries and bays prior to moving into the rivers than spawning adults (Fox et al. 2000, in USACE 2006).

Range and Population Dynamics:
Historically, the Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Its present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi, east to the Suwannee River in Florida, with infrequent

sightings occurring west of the Mississippi River. In the late 19th century and early 20th century, the Gulf sturgeon supported an important commercial fishery, providing eggs for caviar, flesh for smoked fish, and swim bladders for isinglass, a gelatin used in food products and glues (Huff, 1975; Carr, 1983). Gulf sturgeon numbers declined due to over fishing throughout most of the 20th century. After 1950, the decline was exacerbated by habitat loss associated with the construction of water control structures, such as dams and sills. In several rivers throughout the species' range, dams have severely restricted sturgeon access to historic migration routes and spawning areas (Boschung, 1976; Wooley and Crateau, 1985; McDowall, 1988). Gulf sturgeon exhibit a high degree of fidelity, with over 99 percent returning to spawn in the same river system in which they were hatched (USACE, 2006).

Sampling was conducted for Gulf sturgeon in Lake Maurepas during November 2005 through June 2006 using gill nets with stretch mesh panels and otter trawls (Kirk et al. 2007). Concurrently, mobile sonic telemetry along a systematic grid was used to locate any of approximately 40 Gulf sturgeon telemetry tagged in the Pearl River system during 2001 through 2006. No Gulf sturgeon were detected (via telemetry) nor captured using trawls or experimental gill nets in Lake Maurepas (Kirk et al. 2007).

Management and Protection:
Life history characteristics of Gulf sturgeon may complicate and protract recovery efforts. Gulf sturgeon cannot establish a breeding population rapidly because of the amount of time it takes them to reach sexual maturity. Further, Gulf sturgeon appear to be river-specific spawners, although immature Gulf sturgeon occasionally exhibit plasticity in movement from one river to another. Therefore, natural repopulation by Gulf sturgeon migrating from other rivers may be non-existent or very low. The take of Gulf sturgeon is prohibited in the state waters of Louisiana, Mississippi, Alabama, and Florida. Section 6(a) of the ESA provides for extended cooperation with states for the purpose of conserving threatened and endangered species. Under that provision, the Departments of the Interior and Commerce may enter into cooperative agreements with a state, provided that state has an established program for the conservation of a listed species. The agreements authorize the states to implement the authorities and actions of the ESA relative to the listed species recovery. Specifically, the states are authorized: 1) to conduct investigations to determine the status and requirements for survival of resident species of fish and wildlife (this may include candidate species for listing), and 2) to establish programs, including acquisition of land or aquatic habitat or interests for the conservation of fish and wildlife. Federal funding is also provided to states under those agreements to implement the approved programs. All four of the above mentioned states have entered into Section 6 agreements with the USFWS.

4.2 Pallid Sturgeon

Status:
The pallid sturgeon was listed as endangered by the U.S. Endangered Species Act on June 9, 1990. The species is adapted to large, free-flowing turbid rivers with a diverse

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assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. The decline of this species is attributed to flood control and navigation projects, pollution, and overexploitation for caviar (Dryer and Sandvol 1993). Natural reproduction and recruitment is extremely low and long term trends have populations declining at a rate of 25-50 percent. Ongoing stocking of hatchery-produced sturgeons is an attempt to supplement natural populations.

Species and Habitat Description:
The pallid sturgeon is a large fish with a heterocercal tail, a long slender caudal peduncle, a flat shovel-shaped snout, four fringed barbells on the snout, a ventral mouth, and large bony scutes on the head, back, and sides. It is similar in appearance to the shovelnose sturgeon. The pallid sturgeon feeds opportunistically on aquatic insects, crustaceans, mollusks, annelids, fish eggs, and sometimes other fish.

The pallid sturgeon occupies large, turbid, free-flowing riverine habitat. It occurs in strong current over firm gravel or sandy substrate. Pallid sturgeons tend to select main channel habitats in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River.

Spawning season goes from June to August. Specific characteristics of spawning habitat have not been documented. Larvae drift downstream from the hatching site. Males sexually mature in 3-4 years and females likely take at least several years to mature. Individuals probably spawn at intervals of several years, resulting in very slow reproductive rates. The pallid sturgeon is known to live up to 41 years in the wild.

The pallid sturgeon was formerly harvested commercially and is considered a fine eating fish. In addition, its roe is considered suitable for caviar and its size makes it a desirable trophy sport fish. Despite being protected throughout its range, illegal harvests continue to threaten the small remaining populations.

Range and Population Dynamics:
The range of the pallid sturgeon includes the Mississippi and Missouri Rivers and several of their major tributaries. Substantial populations are also found in the Atchafalaya River in central Louisiana. Population numbers have been estimated to be as few as 6,000 individuals or as many as 21,000 (Lee et al. 1980; Killgore et al. 2007). Sampling has revealed that the largest population occurs in the Atchafalaya River. This southern population numbers in the few thousands. Pallid sturgeon have been documented in the Mississippi River as far south as Donaldsonville, Louisiana, but likely occur below New Orleans albeit at relatively low numbers. Populations in the lower Mississippi River are probably stable but long-term studies are required to fully evaluate population trends and habitat preferences (Killgore et al. 2007).

Natural reproduction is evident in some areas along the Missouri, Mississippi, and Atchafalaya rivers, but natural recruitment continues to be limited throughout the

range. As a result, the wild population is declining. It remains to be seen whether or not ongoing releases of hatchery-reared juveniles will lead to increases in the spawning population.

As of November 2009, the ERDC Ecological Fish Surveying Team has been unable to sample the Mississippi River for pallid sturgeon near the proposed Blind River/Convent diversion sites due to high river stages. Sampling is planned to resume once river conditions improve (Thomas Parker, personal communication, 11/10/09). However, in 2005-2006, Pallid sturgeon in the Mississippi River were sampled with trawls and trotlines. Age-0 and juvenile pallid sturgeon were sampled during August 2005 and monthly from April through June 2006. Abundance was measured in cooler months (December 2005 through April 2006) using trotlines. Sites included: sandy bars above and below the Hope Canal diversion site, in the main channel at the bridge at Gramercy, Louisiana, and near a petroleum loading dock close to the proposed Hope Canal diversion site (Kirk et al. 2007).

Extensive trawling captured no age-0 or juvenile pallid sturgeon at any location in the Mississippi River near the proposed water diversion site. A total of 10 pallid and 24 shovelnose sturgeon were captured using trotlines from early December of 2005 through April 2006 (Kirk et al. 2007). These fish were captured at a single location: at the edge of the main channel of the Mississippi River at the Gramercy Bridge. 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 (Kirk et al. 2007). The sloping bottom was predominately sand with some gravel.

Sub-adult and adult and pallid sturgeon are relatively abundant in the project area, but no small sturgeon were collected. Juvenile pallid sturgeon are rarely collected during surveys of naturally reproducing populations, and low numbers of juveniles is presumably due to specialized habitat requirements and very rapid growth of young fish. Spawning habitat of pallid sturgeon (i.e., gravel beds in swift water) was not apparent in the project area, and it is possible that juveniles do not occur in the area because spawning is taking place elsewhere (Kirk et al. 2007).

Management and Protection:
The pallid sturgeon is now federally protected throughout its range. Illegal harvesting and the construction of water diversions continue to be major threats caviar (Dryer and Sandvol 1993). Lack of accurate population information has made conservation measures difficult. Monitoring programs utilizing trawling sampling methods are being conducted in the lower Mississippi River near the Convent/Blind River project site to help ascertain accurate population numbers.

In an effort to elevate population numbers, hundreds of thousands of juveniles are produced and released annually via artificial propagation and captive spawning of wild-caught adults in accordance with the pallid sturgeon stocking and augmentation plan. Hatchery-reared pallid sturgeons appear to be essential in preventing local

extirpation in portions of its range and have been used to re-establish the species in localized areas. However, it is too early to determine if these captive-raised fish will spawn and naturally reproduce.

4.3 West Indian Manatee

Status:

The West Indian manatee was listed as endangered throughout its range for both the Florida and Antillean subspecies in 1967, and received Federal protection with the passage of the ESA in 1973. Critical habitat was designated in 1976, 1994, 1998, 2002, and 2003 for the Florida subspecies.

Species and Habitat Description:

The West Indian manatee is a large gray or brown aquatic mammal. Adults average approximately 10 feet (3 m) in length and weigh up to 2,200 pounds (999 kg). They have no hind limbs, and their forelimbs are modified as flippers. Manatee tails are flattened horizontally and rounded. Their body is covered with sparse hairs and their muzzles with stiff whiskers (USFWS, 2001c). The nostrils, located on the upper snout, open and close by means of muscular valves as the animal surfaces and dives (Husar, 1977; Hartman, 1979). Manatees will consume any aquatic vegetation (i.e., submerged, floating, and emergent) available to them and sometimes even shoreline vegetation. Although primarily herbivorous, they will occasionally feed on fish. Manatees may spend about five hours a day feeding, and may consume four to nine percent of their body weight per day.

Observations of mating herds indicate that females mate with a number of males during their 2- to 4-week estrus period, and then they go through a pregnancy estimated to last 12 to 14 months (O'Shea et al., 1992). Births occur during all months of the year with a slight drop during winter months. Manatee cows usually bear a single calf, but 1.5 percent of births are twins. Calves reach sexual maturity at three to six years of age. Mature females may give birth every two to five years (USFWS, 2001c).

Manatees inhabit both salt and freshwater of sufficient depth (5 feet [1.5 m] to usually less than 20 feet [6.1 m]) throughout their range. Shallow grassbeds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats (USFWS, 2001c). They may also be encountered in canals, rivers, estuarine habitats, saltwater bays, and have been observed as much as 3.7 miles (6.0 km) off the Florida Gulf Coast. Between October and April, Florida manatees concentrate in areas of warmer water. Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges. During warmer months they appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water. Manatees may not need fresh water, but they are frequently observed drinking water from hoses, sewage outfalls, and culverts.

Range and Population Dynamics:
Between October and April, Florida manatees concentrate in areas of warmer water. During these winter months, the United States' manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. Severe cold fronts have been known to kill manatees when the animals did not have access to warm water refuges. During the summer months, they migrate as far north as coastal Virginia on the east coast and the Louisiana coast in the Gulf of Mexico (USFWS, 2001c). They appear to choose areas based on an adequate food supply, water depth, and proximity to fresh water.

During summer months, manatees disperse from winter aggregation areas, and are commonly found almost anywhere in Florida where water depths and access channels are greater than 3.3 to 6.6 feet (1.0 to 2.0 m) (O'Shea, 1988). In the warmer months, manatees usually occur alone or in pairs, although interacting groups of five to ten animals are not unusual (USFWS 2001c).

In the early 1980s, scientists tried to develop procedures for estimating the overall manatee population in the southeastern United States (USFWS, 2001c). The best estimate throughout the State of Florida was 1,200 manatees (Reynolds and Wilcox, 1987). In the early 1990s, the State of Florida initiated a statewide aerial survey in potential winter habitats during periods of severe cold weather (Ackerman, 1995), and the highest count of 3,276 manatees was recorded in January 2001.

Manatee occurrences appear to be increasing, and they have been regularly reported Amite, Blind, Tchefuncte and Tickfaw Rivers, and in canals in adjacent coastal marshes of Louisiana. (USFWS letter, march 4, 2010). While rare, the potential exists for the manatee to be within the project area.

Management and Protection:
The most significant problem faced by manatees is death or injury from boat strikes (USFWS, 2001c). Populations may also be adversely affected by cold weather and red tide outbreaks. Minimum flows and levels for warm water refuges need to be established to ensure their long-term availability for manatees. Their survival will depend on maintaining the ecosystems and habitat sufficient to support a viable manatee population (USFWS, 2001c). The focus of recovery is on implementing, monitoring, and addressing the effectiveness of conservation measures to reduce or remove threats that will lead to a healthy and self-sustaining population (USFWS, 2001c).

In addition to protection under the ESA, the West Indian manatee is protected under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA establishes a national policy for the maintenance of health and stability of marine ecosystems and for obtaining and maintaining optimum sustainable populations of marine mammals. It includes a moratorium on the taking of marine mammals. The recovery planning under the ESA includes conservation planning under the MMPA (USFWS, 2001c).

4.4 Bald Eagle

Status:

Except for the distinct Sonoran Desert population segment in Arizona, the bald eagle was removed throughout its range from the federal list of U.S. threatened and endangered species on August 9, 2007. To ensure the eagles continue to thrive, the U.S. Fish and Wildlife Service is working with the Louisiana Department of Wildlife and Fisheries to monitor eagles for at least five years. If it appears that bald eagles again need the protection of the Endangered Species Act, the service can propose to relist the species. Even though they are delisted, the bald eagle is still protected by the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. These laws require measures to continue to prevent bald eagle take resulting from human activities.

Species and Habitat Description:

Adult bald eagles have a dark brown body and distinctive white head and tail. Unlike their parents, juveniles have mottled brown and white plumage. As they mature, juvenile eagles gradually acquire their adult plumage over the course of five years. Most bald eagles reach breeding age at 4-5 years old, but many delay breeding until much older. In the wild, bald eagles may live 15 to 25 years.

Bald eagles are opportunistic feeders with fish comprising the majority of their diet. They will also prey on waterfowl, shorebirds, colonial waterbirds, small mammals, turtles, and carrion. Because they rely on vision to hunt, eagles typically locate their prey from a perch and then swoop down and strike.

In the southeast, bald eagles generally nest and breed between October and May. The nesting season begins with courtship and nest building. During the nesting season, eagles occupy and defend a territory. A territory may include an active nest and alternative nests that are built and maintained but not used every year. Nests are usually located near large bodies of water in mature or old-growth trees, snags, and rock outcrops. In the project site, nests are located in the tallest cypress trees with limbs that can support a nest that can weigh more than 1000 pounds. Most egg laying is completed by November and the eggs hatch at the end of the year. Clutch size generally ranges from 1-3 and incubation lasts 5 weeks, by both sexes but the female rarely leaves the nest. The eggs incubate for about 35 day. The laying of eggs to first flight normally takes 16 to 18 weeks. Eagles grow fast and can fly after 78 to 80 days. Active eagle nests in Louisiana are currently producing eaglets at an average rate of 1.32 per nest per year.

Bald eagles prefer habitats close to coastal areas, bays, rivers, lakes, or other bodies of water that reflect an availability of prey sources. By May, most eagles in Louisiana have left the state and spend summers in the northern states. Communal roost sites are common, especially in sheltered sites during the winter.

Range and Population Dynamics:
In 1972, there were only six or seven nesting sites in Louisiana. The Louisiana Department of Wildlife and Fisheries began making aerial surveys to monitor known existing eagles in 1984. By 1985, the number of active nests had increased to 18. In 2004, there were 234 known nests. Terrebonne Parish in south Louisiana is believed to contain the most breeding pairs and hosts about 60 active nesting sites.

Eagles appear to be expanding into newer areas near interior fresh-water lakes and reservoirs. Most of the known nests are located in the marshes between the Mississippi River and Vermillion Bay. Those marshes are attractive to eagles because of abundant food sources and large cypress trees which are used as nesting sites.

Management and Protection:
The U.S. Fish and Wildlife Service also provides management guidelines and conservation measures to protect the bald eagle when they are most sensitive to human disturbance—during the nesting and wintering periods. The bald eagle nesting period consists of 5 phases: courtship and nest building, egg laying, incubation and hatching, early nestling, and late nestling. Eagles are most sensitive to human disturbance during the courtship and nest building phase. It is during this period that eagles are most likely to abandon nest sites. In Louisiana, this phase generally occurs between October and January. Even if human disturbance is avoided during the critical first phase, eagles continue to be extremely sensitive until the young have fledged in April.

4.5 Wading Bird Colonies

Common colonial wading birds that have been observed in southern Maurepas Swamp include black-crowned night-heron, great blue heron, great egret, green heron, little blue heron, snowy egret, tri-colored heron, white ibis, and yellow-crowned night-heron, with anhinga a commonly associated water bird. Despite the high species richness, densities are typically low, and large nesting colonies are absent or rare within the swamp, suggesting that suitable habitat may be limited (Stouffer et al 2005).

Although wading bird nesting colonies were not observed within the project area, several wading bird species have nesting colonies located within an 8 mile radius to the project site (**Figure A.2**). The status of these colonies, located to the north and east of the project area, is unknown (LNHP 2004). The species represented include the

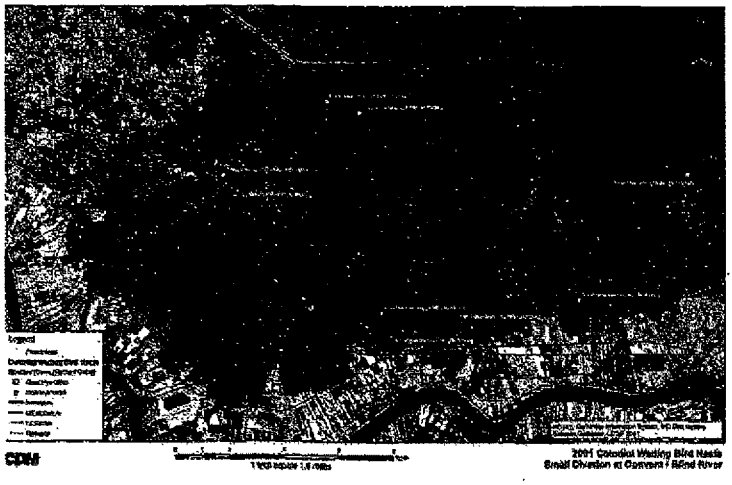


Figure A.2. Location of Nearby Wading Bird Colonies

great blue heron, great egret, and little blue heron. Although these species are not listed as threatened or endangered, these breeding and nesting areas are of special interest and efforts should be made to lessen impacts. Brief species descriptions are included below:

Great Blue Heron:
According to a 2001 survey, there are nine great blue heron colonial nesting sites located in close proximity to the blind river diversion project area. Nesting colonies are often comprised of a few to hundreds of pairs and may include other heron species. Nests are generally located high in trees or on rock ledges in swamps and forested areas close to foraging habitat. Clutch size is 3-7 and both parents incubate the eggs over the 25-29 day period. Both parents also tend to the young which stay in the nest for 60-90 days. Fledging success depends importantly on the success of parents in providing sufficient food when nestlings are 2-6 weeks old. The great blue heron is considered secure and common in the region and is a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

Little Blue Heron:
According to a 2001 survey, there is one recorded little blue heron colonial nesting site located approximately four miles to the east of the project site north of US-61. Little blue herons are wading birds that prefer low gradient, shallow freshwater habitats in which they forage for small aquatic animals and insects. Nests are often found in trees and shrubs to about 4 meters above the ground or water, primarily adjacent to freshwater foraging areas. Clutch size is 3-6 and both sexes incubate the eggs during the 22-24 day incubation period. The young can leave the nest within 12

days and fledge within 4 weeks. Although not observed as frequently as the great blue heron, the little blue heron is considered secure and common in the region and is a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

Great Egret:
According to a 2001 survey, there is one recorded great egret nesting colony located approximate one mile north of the project site to the north of I-10. This colony is the closest of all recorded nearby rookeries, and therefore, is the most likely to be affected by the implementation of the diversions. They prefer low gradient, shallow water habitats including marshes, wooded swamplands, and tidal estuaries. Great egrets generally nest in tall trees with other colonial water birds. They commonly return to the same colony sites year after year. Clutch size of 2-3 is common, and incubation of the eggs by both parents lasts 23-25 days. Young are fledged at 6 weeks. Great egrets are considered common and secure throughout Louisiana and are a species of least concern. Population numbers have been increasing in the area and are predicted to remain stable through at least 2050 (2050 Report).

5.0 Potential Effects of the Proposed Action

The potential exists that any of the endangered or threatened species listed or species of special note may be present during proposed construction activities. However, while individuals may be affected, it is unlikely that whole populations would be adversely affected by implementation of the proposed action.

5.1 Gulf Sturgeon

Potential Impacts of Water Diversion:

According to NMFS, there is no critical habitat designated for Gulf sturgeon in the Blind River project area (Kimberly Clements, personal communication, 8/4/09). In addition, the USACE Engineer Research and Development Center developed a report in June 2008 that evaluated the potential impacts of Lake Maurepas diversion projects to Gulf and pallid sturgeon. The report determined Gulf sturgeon were unlikely to be affected by the diversion due to their absence in nearby stretch of the Mississippi River.

A risk assessment for entrainment of Gulf sturgeon was not performed since this species is unlikely to be in this reach of the Mississippi River and thus unlikely to be entrained. However, Gulf sturgeon are likely use or move through Lake Maurepas from tributary rivers on their annual migration to and from marine habitats. Therefore, potential project effects on the water quality of Lake Maurepas and their impacts on sturgeon must be examined. In that regard, a review of the literature of Gulf sturgeon movements is instructive in understanding when Gulf sturgeon are likely to use Lake Maurepas and thus be influenced by project impacts (i.e. decreasing salinity and lower water temperatures).

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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 (ERDC 2008). Since these fish are moving into or out of saline habitats and are not feeding, changes in temperature or salinity caused by the diversion of water from the Mississippi River seem unlikely to adversely impact their populations.

5.2 Pallid Sturgeon

Adult pallid sturgeon were collected only near the steep, vertical banks (sandbar "reefs") close to the Gramercy bridge. This habitat is similar to the littoral habitat of the proposed Blind River/Convent diversion sites. Consequently the probability of use of the site where the diversion structure will be constructed is high and very certain for sub-adult and adult fish.

Potential Impacts of Water Diversion:

Susceptibility of fish to the proposed culvert is high for juveniles, sub-adults and adults. Pallid sturgeon in the Mississippi River are frequently found in the vicinity of man-made structures (e.g., dikes). Such structures provide attractive areas of shelter from main channel water velocities. They also provide hard, permanent substrates for benthic invertebrates and fishes eaten by pallid sturgeon (Hoover et al. 2007). The likelihood that pallid sturgeon of any size would exploit a culvert (and any associated embayment) as a refuge and/or feeding ground is high.

Susceptibility to water velocities in the culvert is high for juveniles, but only moderate for sub-adults and adults due to greater swimming capabilities of larger fish. Swimming speeds, based on endurance, however, are highly variable among (and within) age classes. Escape speeds (i.e., swimming speeds that can be maintained for up to one minute) have been measured for juvenile pallid sturgeon 74-205 mm FL and range from 35-75 cm/s (Hoover et al. 2005). Escape speeds for sub-adult and adult pallid sturgeon have not been measured but are probably in excess of 120 cm/s. This estimate is based on data for shovelnose sturgeon which have nearly identical swimming endurance to pallid sturgeon (Adams et al. 1997). If flows approach this range, entrainment of most juveniles and some of the slower-swimming larger fish would be likely.

Risk of pallid sturgeon entrainment could be reduced in several ways. Withdrawal of water from the surface of the river would make entrainment less likely since pallid sturgeon swim close to the river bottom and rarely approach the water's surface (Kirk et al. 2007). Also, larger gates, or a greater number of gates, to distribute flow would make it possible for sturgeon to resist flow by creating water velocities lower than recorded and estimated escape speeds (Kirk et al. 2007). Rough or complex substrates (e.g., scarified concrete, rip rap, etc.) directly in front of the gates would also enable pallid sturgeon to resist entraining flows by providing low-velocity boundary layers and by enabling alternative low-energy station-holding behaviors such as creeping,

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hunkering, and tail-bracing to be used by fish (Hoover et al. 2005). Seasonal restrictions on diversion could minimize likelihood of entraining spawning adults (e.g., early spring) or juveniles (e.g., late spring, early summer).

Since some entrainment of pallid sturgeon is possible, mitigation strategies should at least be considered and studied. Due to brood stock availability, genetic and behavioral considerations, and a lack of understanding of sturgeon demographics, culture and release of pallid sturgeon should be a last option (Kirk et al. 2007). Mitigation resources would be better used in gaining an improved understanding of pallid sturgeon demographics, swimming capabilities, and the hydraulic characteristics of the diversion structure (Kirk et al. 2007). If studies show that the local population of pallid sturgeon is robust, then some incidental losses will likely have little impact upon the population.

Due to documented populations near the diversion site, the proposed project activities have the potential to adversely affect pallid sturgeon. However, the entrainment risk is low for juveniles due to low likelihood of occurrence in the project area, and moderate for sub-adults and adults due to presumed lower limits on swimming capabilities of some individual fish

5.3 West Indian Manatee (*Trichechus manatus)*

Should any manatees be encountered during the proposed activities, an on-board observer would notify the proper personnel, and harmful activities (e.g., dredging) would be temporarily suspended until the animal(s) moves out of the area of operations. Any disturbance to the manatee would only be temporary during construction activities, and would result in temporary displacement. The manatees would likely move and relocate to other nearby areas for foraging or resting purposes.

Because the West Indian manatee may occur in the project vicinity, the Contractor shall instruct all personnel associated with the project of the potential presence of manatees in the area, and the need to avoid collisions with these animals. All construction personnel shall be advised that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. The Contractor shall be held responsible for any manatee harmed, harassed, or killed as a result of construction activities not conducted in accordance with these specifications.

Special Operating Conditions If Manatees Are Present in the Project Area

If a manatee(s) is sighted within 100 yards of the project area, all appropriate precautions shall be implemented by construction personnel to ensure protection of the manatee. These precautions include the operation of all moving equipment no closer than 50 ft of a manatee. If a manatee is closer than 50 ft to moving equipment or the project area, the equipment will be shut down and all construction activities will cease. Construction activities will not resume until the manatee has departed and the 50-foot buffer has been re-established.

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In addition, if a manatee(s) is sighted in the project area, all vessels associated with the project shall operate at "no wake/idle" speeds at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom, and vessels will follow routes of deep water whenever possible. If siltation barriers are used, they will be made of material in which manatees cannot become entangled, are properly secured, and are regularly monitored to avoid manatee entrapment. Any sightings of manatees, or collisions with a manatee, should be reported immediately to the Corps of Engineers.

5.4 Bald Eagle

The local population of nesting Bald Eagles in the Maurepas Swamp has increased steadily since 1988, and productivity is stable (Stouffer et al. 2005). In 2005-2006, the 17 active Bald Eagle nests in Maurepas Swamp constituted nearly 6% of the active nests in Louisiana (Stouffer et al. 2005). Three active nests have been located within project boundaries, and October 2009 field surveys documented several eagle observations One of the nests, nest 134B, is located far enough away from proposed construction activities that impacts should be minimal. However two nests, nest 393 and 174 (presently inactive at last report), are located relatively close to diversion alternatives. Nest 393, in particular, is located within several hundred yards of the terminus of the proposed Romeville diversion alternative. Therefore, measures must be taken to avoid impacting the eagles, especially during the breeding season. Specific measures will be discussed below.

Effects of Diversion Construction on Bald Eagles

Construction activities within the project area that encompasses the Maurepas Swamp may come into contact with bald eagles. Bald eagles migrate north in mid-May and do not return to the project area until October. It is prudent to complete construction in bald eagle nesting areas during non-nesting periods. If construction activities must be completed during nesting and rearing months, the U.S. Fish and Wildlife Service has guidelines and recommendations that will be followed (USFWS 2006).

According to The USFWS National Bald Eagle Management Guidelines, the proposed action would fall under "Category A," which includes construction of roads, trails, canals, power lines, and other linear activities, and alteration of shorelines or wetlands. Table 1 provides the guidelines for activities in Category A..

Table 1. Closest distances activities in Category A should be conducted relative to the location of a bald eagle nest.

Visibility	**If there is no similar activity within 1 mile of the nest**	**If there is similar activity closer than 1 mile from the nest**
If the activity will be visible from	660 feet. Landscape buffers are recommended	660 feet, or as close as existing tolerated activity for similar scope.

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the nest		Landscape buffers are recommended.
If the activity will not be visible from the nest	330 feet. Clearing, external construction, and landscaping between 330 feet and 660 feet should be done outside breeding season.	330 feet, or as close as existing tolerated activity of similar scope. Clearing, external construction, and landscaping within 660 feet should be done outside breeding season

Source, USFWS, 2007.

Effects of Diversion Operation on Bald Eagles

Diversion canal operation is expected to decrease salinity in the Maurepas Swamp, which should have positive effects on Bald Eagles. Watts et al. (2006) found that population growth, nesting density and productivity of Bald Eagles was negatively correlated with salinity in Chesapeake Bay. One reason for the correlation between decreased eagle productivity and salinity may be the long term effects of saltwater intrusion on forest health and nest tree survival. Some nesting territories on the southern and eastern shores of Lake Maurepas, where salinity and baldcypress mortality are highest, may be completely deforested in less than a decade if current trends continue (Shaffer et al. 2003). The size and health of the Bald Eagle population in Maurepas Swamp depends on the population of suitable nest trees (Stouffer et al. 2005). Suitable snags may be utilized but they will eventually fall during large storm events. Therefore, it is essential that salinity be reduced to produce replacement nest trees to maintain the Bald Eagle population in Maurepas Swamp. In addition, a reduction in salinity may increase the populations of preferred, freshwater forage fish, thus increasing Bald Eagle population growth rates and breeding density (Stouffer et al. 2005).

Diversion of Mississippi River water into Maurepas Swamp may expose Bald Eagles to elevated levels of several aquatic contaminants including metals, polycyclic aromatic hydrocarbons, pesticides, herbicides, and volatile organic compounds (Stouffer et al. 2005). A screening-level risk assessment for Bald Eagles suggested there is a low magnitude risk associated with diverting Mississippi River water into Maurepas Swamp based on maximum concentrations of Mercury, Nickel, and DDX (Battelle 2005). Mercury concentrations in fish sampled from Lake Maurepas were lower than those from the Mississippi River, so Bald Eagles should not be at greater risk of exposure from a diversion of water into the swamp (Battelle 2005). In addition, Bald Eagles have been observed flying out of Maurepas Swamp to foraging sites along the Mississippi River. This suggests that some resident Bald Eagles will not

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experience increased risk of exposure to environmental contaminants from diversion operation.

5.5 Wading Bird Colonies

Effects of Diversion Construction on Wading Birds

Diversion construction is not expected to negatively impact any active nesting wading bird colonies.

Effects of Diversion Operation on Wading Birds

Diversion operation is expected to increase primary productivity of the Maurepas Swamp ecosystem (Stouffer et al. 2005). This should benefit wading bird populations by restoring diminishing suitable swamp forest habitat and increasing abundance of forage fish and crayfish in the affected area. Increased food availability should increase the carrying capacity of wading birds within the Maurepas Swamp.

However, the deeply flooded area near the diversion outfall will be unavailable for foraging for most wading birds during diversion operation. Fortunately, most wading birds are able to disperse many miles to alternative foraging areas and can return during periods of diversion inactivity. The abundance and availability of foraging habitat and prey items for wading birds in the constructed diversion canal will depend on the velocity and turbidity of the water. It is expected that foraging habitat and prey availability will be at a maximum when the diversion is operated at low flow volume.

Diversion operation is expected to increase the productivity of herbaceous vegetation in the interior swamp. This may eventually result in increased elevation and could reduce the amount of area with standing water in Maurepas Swamp for foraging wading birds (Stouffer et al. 2005). In the short-term, increased vegetation may reduce foraging habitat for wading birds that utilize open, interior sites. These negative impacts should be offset by increased food availability and nesting sites.

Wading bird colonies are frequently situated over water, which provides protection against predation. Therefore, increased flooding may generate more suitable nesting habitat in Maurepas Swamp.

Chemical contaminants in water diverted into Maurepas Swamp from the Mississippi River are of concern to higher-order predators that may bioaccumulate these toxins. Eggshell thinning and nest success of common wading bird species in Maurepas Swamp do not appear to be significantly affected by contaminants (Stouffer et al. 2005). This may be due to the fact that most of these species, except the Great Blue Heron, forage upon smaller fish than top avian predators. However, Great Blue Heron populations should not be negatively affected by high toxin concentrations as they appear to be lower in the Mississippi River than in the Maurepas Swamp (Battelle 2005).

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506
July 7, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

Please reference the letter and attached Biological Assessment (BA) dated May 21, 2010, sent by Mr. Richard Boe, Acting, Chief of your Environmental Branch requesting our concurrence with your determination of effects of the proposed Small Diversion at Convent/Blind River to the endangered pallid sturgeon (*Scaphirynchus albus*). You have determined that the project is likely to adversely affect this species. The Fish and Wildlife Services (Service) comments are provided in accordance with Section 7 of the Endangered Species Act (87 stat. 884 as amended; 16 U.S.C. 1531 et seq.).

The proposed project involves the construction of a small sized (up to 5,000 cubic feet per second [cfs]) freshwater diversion located at approximately River Mile (RM) 163 near Romeville, Louisiana for the purpose of restoring freshwater flow into a portion of the Maurepas Basin. The proposed operating plan has not been fully developed. Informal consultation between the US Army Corps of Engineers (Corps) and the Service has been ongoing since 2008; however, no coordination has been conducted for the proposed project.

According to your BA pallid sturgeon are known to be relatively abundant in the vicinity of the proposed diversion. Furthermore, recent sampling has confirmed at least one pallid sturgeon has been entrained in the Davis Pond Freshwater Diversion (RM 118). The Corps concluded that the Small Diversion at Convent/Blind River is likely (i.e., has the potential) to adversely affect the pallid sturgeon. Considering the above information and the information on the swimming ability of sturgeon presented in the BA, the Service concurs with the Corps' conclusion.

In order to ensure compliance with the Endangered Species Act, and to ensure the Service has sufficient information required to initiate formal consultation the following information will be required:

1) The distance and velocity of flow fields extending from the structure into the river should be determined, if feasible. This determination should be done at the proposed discharges (and various structure openings to achieve those discharges) to determine

potential entrainment throughout the diversion's operation. A comparison of those flow fields with the swimming capabilities of sturgeon should be conducted.

2) Data gathered at existing diversions by the Service's Baton Rouge Fish and Wildlife Conservation Office and by Nicholls State University was not examined within the BA. That information should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured and their movements can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, sub-adult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs as would vary with river stages throughout the year and an estimate of the number of days the structure will be at those areas based on the river's hydrograph.

6) Compare the above calculated (Number 5) average area of opening throughout the year with the Mississippi River channels cross sectional area at proposed diversions location.

7) Compare main channel flow (cfs) to water diverted (cfs) to calculate percent of latitudinal flow diverted.

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculation of catch-per-unit-effort.

9) A detailed and current description of the proposed project (e.g., operational plan) including a plat depicting the precise location and dimensions and a cross-section showing the bottom elevations of the structure and outfall channel.

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable, and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Investigate potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and outfall channel.

12) The relative abundance of pallid sturgeon compared to the shovelnose sturgeon and other fish species in the Lower Mississippi River. The relative abundance should be presented by sampling gear type and by stage of growth (e.g., juvenile, sub-adult, etc.).

The formal consultation process for the project will not begin until we receive the above information, or a statement explaining why that information cannot be made available. We will confirm our receipt of that information; our notification letter to you will also outline the dates within which formal consultation on the proposed action should be complete and our biological opinion delivered.

Section 7 of the ESA allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion. As a reminder, the ESA requires that after initiation of formal consultation the Federal action agency may not make any irreversible or irretrievable commitment of resources that limits future options. This practice insures agency actions do not preclude the formulation or implementation of reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered and threatened species or destroying or modifying their critical habitats.

If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact David Walther of this office at 337/291-3122.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: FWS, Ecological Services, Jackson, MS
FWS, Fish and Wildlife Resource Office, Baton Rouge, LA
ERDC, Vicksburg, MS
LDWF, Natural Heritage Program, Baton Rouge, LA
OPCR, Baton Rouge, LA

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

July 16, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post office Box 60267
New Orleans, LA 70160-0267

Dear Colonel Lee:

This letter acknowledges the U.S. Fish and Wildlife Service's (Service) July 14, 2010, receipt of your agency's July 14, 2010, letter requesting initiation of formal Section 7 consultation under the Endangered Species Act (Act) of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). That letter provided additional project and species information necessary to initiate consultation. The consultation concerns the effects of the proposed Louisiana Coastal Area, Small Diversion at Convent/Blind River, project. In the May 21, 2010, letter and attached Biological Assessment (BA), the Service received initial project and species information concerning potential impacts to the endangered sturgeon (*Scaphirynchus albus*). We responded via a July 7, 2010, letter indicating the need to initiation consultation and requesting additional information. All information required of you to initiate consultation was included with your agency's letters or is accessible for our consideration and reference.

Section 7 allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion (unless we mutually agree to an extension). Therefore, we expect to provide you with our biological opinion no later than October 13, 2010. However, we recognize that the legislatively mandated study schedule (i.e., study completion within three years from authorization) was developed to respond to the significant and ongoing rapid loss of coastal wetlands, therefore, we remain committed to working closely with the Corps to meet those deadlines and ensure that the authorization of coastal restoration projects is achieved.

We appreciate the cooperation and coordination of your staff during the past several months. If you have any questions or concerns about this consultation or the consultation process in general, please contact Jennifer Hogue (337/291-3144) or David Walther (337/291-3122) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: LDWF, Natural Heritage Program, Baton Rouge, LA
FWS, Ecological Services, Jackson, MS

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

September 23, 2010

Colonel Edward R. Fleming
District Commander
U.S. Army Corps of Engineers
Post office Box 60267
New Orleans, LA 70160-0267

Dear Colonel Fleming:

This document is the Fish and Wildlife Service's (Service) biological opinion based on our review of the New Orleans District Corps of Engineers' (Corps), proposed Small Diversion at Convent/Blind River located in St. John the Baptist, St. James, and Ascension Parishes, Louisiana, and its effects on the endangered pallid sturgeon (*Scaphirhynchus albus*) per section 7 of the Endangered Species Act (Act) of 1973. as amended (16 U.S.C. 1531 et seq.). Your May 21, 2010, request for formal consultation was received on May 21, 2010. Additional information necessary to initiate consultation was provided by letter dated July 7, 2010.

This biological opinion is based on information provided in the May 21, 2010, biological assessment (BA), the July 14, 2010, letter providing supplemental information, the subsequent telephone conversation of August 27, 2010, regarding reasonable and prudent measures and methods for estimation of take, e-mail between the Service and the Corps, and other sources of information. A complete administrative record of this consultation is on file at the Ecological Services office in Lafayette, Louisiana.

Consultation History

FWS Log No: 2010-F-2997
Date Started: May 21, 2010 **Ecosystem**: Lower Mississippi River
Action Agency: U.S. Corps of Engineers, New Orleans District
Project Title: Small Diversion at Convent/Blind River
County: St. John the Baptist, St. James, and Ascension Parishes

The Biological Assessment was sent to us by members of the Army Corps of Engineers (Corps) on May 21, 2010. They determined that the project described herein was "Likely to affect, but not adversely affect" the listed pallid sturgeon. The U.S. Fish and Wildlife Service did not concur with

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this initial determination due to lack of information provided in the Biological Assessment and because of the reported catches of entrained pallid sturgeon in other diversions. The letter of nonconcurrence was sent by the Service to the Corps on July 7, 2010.

A meeting was held by the Corps on July 8, 2010 to discuss the path forward on the consultation. A timeline was established to ensure any missing information could be indentified and acquired in a timely manner.

Additional information and request to initiate formal consultation on the Small Diversion at Convent/Blind River and the Medium Diversion at White Ditch and their possible affects on the pallid sturgeon was received on July 19, 2010. An email exchange between the Service and the Corps occurred on July 16, 2010 on three different methods that could be used to estimate take.

An email was sent out by the Service to members of the Corps on August 18, 2010 with a list of possible reasonable and prudent measures that could be incorporated to reduce possible take.

A follow-up conference call was held on August 27, 2010 with Thomas Parker, Jan Hoover and Jack Killgore to discuss minimization measures and methods for estimating take.

A conference call with Dr. Boyd Kynard was held Sept 7, 2010 to further discuss bypass systems and fish passage.

Table 1. Species and critical habitat evaluated for effects and those where the Service has concurred with a not likely to be adversely affected determination.

SPECIES or CRITICAL HABITAT*	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT NOT LIKELY TO BE ADVERSELY AFFECTED
Gulf Sturgeon	*Present*	*Concur*
West Indian Manatee	*Present*	*Concur*

**The above species and critical habitat not impacted by this action will not be discussed further in this biological opinion.*

BIOLOGICAL OPINION

DESCRIPTION OF PROPOSED ACTION

The Small Diversion at Convent/Blind River is located at Mississippi River Mile (Rmi) 163 in the Mississippi River Deltaic Plain in the Upper Lake Ponchartrain. The project area covers three parishes in Louisiana; St. John the Baptist, St. James, and Ascension Parishes. The Maraupas Swamp

contains a large contiguous track of cypress tupelo trees and is used for hunting, fishing and other recreational activities. The swamp has been showing signs of stress and accretion rates are not high enough to overcome subsidence rates. The proposed project would restore a more natural hydrologic regime and should help restore sediment imputs and reduce salt stress on the trees via the restoration of Mississippi River water flow into the area.

The Small Diversion at Convent/Blind River would be capable of diverting up to 5,000 cfs through 3 gated culverts and into a three mile long channel. Channel features include five concrete drainage control structures, thirty new berm gaps approximately 500 feet wide, the widening of 160 existing berms and three culverts at the railroad/Highway 61 crossing.

The Small Diversion at Convent/Blind River would be located near the town of Romeville and would be capable of diverting up to 3,000 cfs diversion. It has six major components: a diversion structure, a transmission canal, control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along U.S. highway 61 and instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp. Only those features that are located within the vicinity of the diversion structure are described in detail below; the remaining features (i.e., berm gaps, culverts, and distribution system) while part of the project are primarily for conveyance and distribution of water to ensure ecological benefits and should not materially impact pallid sturgeon.

The diversion would consist of open channel that would divert freshwater from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal (See Appendix). The primary hydraulic elements of the project inlcude: 3 – 10' x 10' multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44; 3 – 10'x10' cast iron sluice gates with motor operators on the culvert inlets and trash racks also near the culvert inlet. The trash rack will be considerably larger in total area than the culverts and will be sloped at a distance approximately 10 feet from the face of the culverts.

The inlet canal would cross the Mississippi River batture to the box culvert and the box culvert will extend under the levee and road (LA 44) and discharge into the transmission canal approximately 100 feet east of the road. Erosion protection will be provided as needed at locations with higher flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance, and at the culvert outlet. The conceptual design shows the inlet channel from the Mississippi River a distance of approximately 300 feet, to be concrete lined. This lining is not to protect from inlet velocities caused by the diversion, but from the velocities of the Mississippi River which can range from 4 to 6 feet per second. Ancillary elements at the diversion culvert facility include a gate tower to raise the sluice gate operators and operator access above the Mississippi River flood stage, a steel sheet pile cut-off wall in the levee to reduce the potential for seepage and piping (loss of fines), and stop logs both upstream and downstream of the sluice gates to isolate them for maintenance. The diversion site will include an access driveway, a site road for access to the top of the levee, fence, drainage, lighting, a security system, and a control building.

The transmission canal will transfer the diverted water approximately three miles from the diversion

to an existing drainage channel at the swamp's edge. The transmission canal will be designed with a 25 percent factor of safety for the flow rate to avoid overtopping the berms. This is in anticipation that as the Mississippi River stage varies, the diversion control system will not control the flow rate to the precise design value. For the 3,000 cfs diversion, the transmission canal will be designed for 3,750 cfs. The canal will be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2- foot freeboard. The top width will be approximately 250 feet. The hydraulic grade line will be above natural ground for most of the route. Therefore, embankments or berms with 12-foot wide tops will be constructed on both sides of the canal. The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125, a local highway; both crossings will consist of 8 – 12' x 8' reinforced concrete box culverts.

The culvert is currently set at elevation 0 MSL and the top is at elevation 10 MSL so at the operating point of 11 MSL in the River the diversion will deliver 3000 cubic feet per second. The diversion gates are automatically adjusted to maintain the 3000 cubic feet per second with changing levels of the Mississippi River and changing downstream tidal conditions from Lake Maurepas. The diversion is planned to be operated continuously between March through October each year. The actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements.

The following table shows the calculated flow and culvert cross section area for the River stages below 11 feet MSL:

Blind River Diversion Culverts Flow -Stage Relationship

Stage in Mississippi River (feet)	Culvert Cross Section (sq. feet)	Discharge Flow Rate (cubic feet / sec.)	Velocity at Face of Culverts (Feet / Sec.)	Annual Average Percent Exceedence (%)
>11	For River stages greater than 11 the gates will be automatically controlled to limit flows to 3000 cubic feet per second			
11	300	3000	10	47
10	300	2900	9.7	49
9	270	2600	9.6	51
8	240	2300	9.6	56
7	210	1800	8.6	61
6	180	1300	7.2	68
5	150	1000	6.7	74
4	120	800	6.7	80
<4	For River stages less than 4, flows are negligible and depend on Lake Maurepas tidal variations.			

The diversion is planned to be operated continuously between March through October each year but the actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements.

STATUS OF THE SPECIES/CRITICAL HABITAT

Species Description

Pallid Sturgeon are a bottom-oriented, large river obligate fish inhabiting the Missouri and Mississippi Rivers from Montana to Louisiana (Kallemeyn 1983, USFWS 2007) and the Atchafalaya River (Reed and Ewing 1993, USFWS 2007). It was proposed for listing as an endangered species on August 30, 1989 (54 FR 35901-35904) and was listed as endangered on October 9, 1990 (55 FR 36641-36647). The reasons for listing were the apparent lack of recruitment for over 15 years, and

the habitat threats existing at the time of listing. Destruction and alteration of habitats by human modification of the river system is believed to be the primary cause of declines in reproduction, growth, and survival of the pallid sturgeon; however, commercial harvest, and hybridization in parts of its range also affected the population. Critical habitat has not been proposed or designated for the pallid sturgeon. The Service conducted a 5-year review of this species' endangered status in 2007 and determined that no status change was needed at that time.

Life History

Taxonomy and Genetics

The pallid sturgeon, one of the largest fish found in the Missouri-Mississippi River drainage, grows to lengths of over 6 feet (ft) (1.8 meters [m]), can weigh in excess of 80 pounds (lbs) (36 kilograms [kg]), and can be described as having a flattened, shovel-shaped snout, a long, slender, and completely armored caudal peduncle, and lacking a spiracle (Smith 1979). Though pallid sturgeon could potentially grow very large, most historical and recent published catches report pallid sturgeon weights of up to 30 lbs (Paul Hartfield, per comm.). As with other sturgeon, the mouth is toothless, protrusible, and ventrally positioned under the snout. The skeletal structure is primarily cartilaginous (Gilbraith et al. 1988). Pallid sturgeon are similar in appearance to the more common and darker shovelnose sturgeon (*S. platyrhynchus*) prompting a Similarity of Appearance rule passed in 2010 (75 FR 53598-53606). Pflieger (1975) reported the principal features distinguishing pallid sturgeon from shovelnose sturgeon as the paucity of dermal ossifications on the belly, 24 or more anal fin rays, and 37 or more dorsal fin rays. Forbes and Richardson (1905) noted that pallid sturgeon contain 20 to 22 ribs while the shovelnose sturgeon has only 10 to 11 ribs. The air bladder was also noted as being relatively smaller in the pallid sturgeon. Those authors recorded differences between the pallid and shovelnose sturgeon in the number of ventral radials, relative depth of lateral scutes, orbital space size, proportional lengths of inner and outer barbels, mouth width, proportion of head width to head length, and proportion of head length to body length.

While these morphological differences are commonly used to distinguish pallid sturgeon from shovelnose sturgeon (Bailey and Cross 1954, Keenlyne et al. 1994) visual differences can sometimes be difficult to note because of geographic variation, allometric growth, and hybridization between shovelnose and pallid sturgeon. Genetic testing can be another tool to further identify individuals though this technology needs further development. Since the pallid sturgeon was listed in 1990, however, geneticists and ichthyologists have worked to refine testing procedures and develop the materials to definitively distinguish and identify these two fish species. The following briefly summarizes the results of the more recent studies.

Campton et al. (2000) concluded that mitochondrial DNA (mDNA) analyses provide the first molecular genetic evidence for distinguishing Scaphirhynchus species. The results of that study indicate significant reproductive isolation between pallid and shovelnose sturgeon in areas of natural sympatry.

McQuown et al. (2000) developed a microsatellite database for use in genetic studies of various

sturgeon species, including *Scaphirhynchus*. With the use of microsatellites, they found a high degree of polymorphism within each species.

Tranah et al. (2001) conducted a study utilizing five nuclear DNA microsatellite loci to measure genetic variability within and among populations of pallid and shovelnose sturgeon at the northern and southern extremes of their sympatric ranges. Their results indicated that pallid and shovelnose sturgeon are genetically distinct at three sympatric locations. They also found evidence in the upper Missouri River (2 populations were genetically distinct from pallid sturgeon in the Atchafalaya River) suggesting that northern and southern pallid sturgeon populations are reproductively isolated. Furthermore, shovelnose sturgeons from the three populations were genetically indistinguishable and showed no population structure (Tranah et al. 2001). Tranah et al. (2001) also noted that sturgeon from the Atchafalaya River that were morphologically determined to be hybrids were genetically different from pallid sturgeon but were not statistically distinguishable from shovelnose sturgeon. However, Tranah (2001) states that morphologically intermediate Atchafalaya River sturgeon appeared to be genetically intermediate to pallid and shovelnose sturgeon, suggesting these individuals were possibly hybrids.

Simons et al. (2001) conducted a phylogenetic study of the genus *Scaphirhynchus*. They could not establish hierarchical relationships based on mtDNA that are consistent with morphological data; however, their results are consistent with the hypothesis of a low rate of evolution between *Scaphirhynchus* species, and reflect recent hybridization between shovelnose and pallid sturgeon. They state that such hybridization is probably due to habitat degradation, but provide no supporting information as to the specific mechanism or causes of hybridization between the two species.

USFWS (2007) summarized additional genetic information; the following three paragraphs present that survey. The presence of sturgeon that appear to be morphologically intermediate between pallid and shovelnose sturgeon, were presumed to represent pallid-shovelnose sturgeon hybrids (Keenlyne et al. 1994, Carlson et al. 1985) and spurred an effort to determine the genetic origins of these fish. Tranah et al. (2004) combined the data from Campton et al. (2000) and Tranah et al. (2001) and added 4 additional microsatellite loci to the data set to determine the genetic origins of 10 morphologically intermediate sturgeon collected from the Atchafalaya River. All fish were classified as pallid, shovelnose or hybrid sturgeon via the hybrid index method of Campton (1987). Results of Tranah et al. (2004) support earlier morphometric-based conclusions on the presences of hybrids (Keenlyne et al. 1994) suggesting intercrossing or gene flow between the two species is more pronounced in the middle Mississippi and Atchafalaya Rivers than elsewhere. Tranah et al. (2004) also suggested that while shovelnose and pallid sturgeon are distinct morphologically, they are undergoing hybridization in the lower Mississippi and Atchafalaya Rivers.

Morphometric data also may indicate hybridization in the lower Missouri River (Grady et al. 2001a; Grady et al. 2001b; Doyle and Starostka 2003) based on the presence of morphologically intermediate sturgeon. The extent to which these hybrids are going beyond the first generation (introgressive hybridization) is currently unknown. Tranah et al. (2004) suggest that female pallid sturgeon are mating with shovelnose sturgeon males and the hybrids are subsequently backcrossing with the more numerous shovelnose sturgeon. This finding should be treated as preliminary because

a small number of fish classified morphologically as hybrids were examined. Allendorf et al. (2001) theorized that pallid and shovelnose sturgeon in the lower Mississippi River have not evolved reproductive isolation to the same degree as pallid and shovelnose sturgeon in the upper Missouri River and suggested there may be no pure pallid sturgeon in the lower Mississippi River because all sturgeon located in that reach comprise a hybrid swarm. Although microsatellite studies have provided evidence of hybridization between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers (Tranah et al. 2001; Heist and Schrey 2006a and b, Schrey and Heist 2007), these and other studies (Ray et al. 2007) have also demonstrated that shovelnose and pallid sturgeon remain genetically distinct from each other in the Missouri, Mississippi, and Atchafalaya Rivers, and a third group, hybrids/intermediates, are present.

Recent studies (Murphy et al., 2007, Kuhajda et al. 2007) have shown that at least some proportion of morphological variation in pallid sturgeon is due to allometric growth and/or geographic variation which has been mistaken for hybridization. Hartfield and Kuhajda (2009) found that the morphological variation considered as evidence of hybridization has been present in Mississippi River pallid sturgeon population for more than a century. They also found that hybridization rates between pallid and shovelnose sturgeon have been overestimated based on character indices because they do not account for allometric growth or for natural variation within or between populations within each species (Hartfield and Kuhajda 2009).

More information is needed on the evolutionary dynamics of intermediate forms between pallid and shovelnose sturgeon to understand the role and effects of hybridization on the status of pallid sturgeon (USFWS 2007, Hartfield and Kuhajda 2009).

Age, Growth and Reproduction

Pallid sturgeon, like most sturgeon species, are considered long lived species with slow growth and low reproductive rates. Studying the reproduction of these species has been difficult and exact details continue to elude researchers. Some recent studies have made an effort to explore pallid sturgeon reproduction (Deloney et al. 2009); however, even basic parameters such as spawning locations, substrate preference, water temperature, or time of year have not been well documented yet. Much of what has been learned about pallid sturgeon reproduction has been from tracking sexually mature sturgeon and captures of larval sturgeon. Age, growth and possible spawning events of captured fish can be determined from cross-sections of pectoral fin rays and sexual maturity of adult fish can be determined from visual inspection or use of an endoscope.

Fogle (1963) estimated growth rates (using cross sections of pectoral fin rays from six pallid sturgeon from Lake Oahe in South Dakota) were relatively rapid during the first 4 years, but that growth decreased to approximately 2.8- in. (70 mm) per-year between ages 5 and 10. Carlson and Pflieger (1981) presented data (n=8) from the Missouri and Mississippi Rivers in Missouri that showed slightly slower growth than from pallid sturgeon in South Dakota. Keenlyne and Jenkins (1993) found that male pallid sturgeon from Louisiana, Missouri, and North Dakota showed rapid growth from age-5 to age-7. The rapid growth slowed once the fish reached sexual maturity.

In 1998, a 66-lb (30-kg), 63-in (160-cm), female pallid sturgeon captured from North Dakota was aged following mortality. Dennis Scarneccia, with the University of Idaho, used techniques developed for white sturgeon and estimated the age at over 50 years and possibly as high as 60 (USFWS 2002).

Killgore et al. (2007a), aged pallid sturgeon from the Middle and Lower Mississippi River and found that fish of the same age but from the Lower Mississippi River were of a smaller size. However, as fish grew older, the size difference between the fishes from those two river reaches appeared to be reduced. In the Lower Mississippi River, size at sexual maturity (9 years) for females was estimated to be approximately 26.8 inches (680 mm), while males were approximately 24.4 inches (620 mm) at sexual maturity (7 years). Growth rates for fish greater than 11 years were much less than younger fish.

Kallemeyn (1983) reported that male pallid sturgeon reach sexual maturity at 21- to 23- in (53.3 to 58.4 cm); however, size and age of females at sexual maturity were unknown at that time. Conte et al. (1988) indicated that females of most sturgeon in North America do not mature until 7 years of age and typically require several years for eggs to mature between spawnings. The age of sexual maturity and intervals between spawning were estimated for nine pallid sturgeon by recording what were interpreted to be spawning events from pectoral fin ray cross sections. Sexual maturity for males was estimated to be 7 to 9 years, with 2- to 3- year intervals between spawning years. Females were estimated to reach sexual maturity in 15 to 20 years, with 3- to 10- year intervals between spawning years (Keenlyne and Jenkins 1993). Time of sexual maturity and the age intervals between spawning years is likely to be influenced by available forage, environmental conditions and other factors (USFWS 1993), and thus, likely varies to some degree between river reaches.

It can be difficult to isolate the exact cues for spawning because certain environmental factors can not be isolated; though it has been widely hypothesized that increases in discharge, photoperiod, and increases in water temperature may be possible cues that trigger upstream spawning migrations. Berg (1981) published that shovelnose sturgeon spawning migrations occur in response to increased flows in June. Similarly, Bramblett (1996) stated that discharge and photoperiod may be important environmental cues for the timing of movements for both shovelnose and pallid sturgeon; though, direct links between discharge and pallid sturgeon reproductive physiology have not been fully substantiated (Deloney et al. 2009). It has also been hypothesized that increases in water temperature may cue migrations and spawning events because water temperature changes are more predictable and usually coincide with changes in discharge, changes in photoperiod, and time of year (Deloney et al. 2009). Bramblett (1996) found a typical pattern of movement for pallid sturgeon was to move upstream into the Yellowstone River and out of the Missouri River in the early spring during increasing discharge and photoperiod; reside in the Yellowstone River during high discharge; and to move downstream, back into the Missouri River during late summer; though pallid sturgeon generally move long distances and it is unclear whether this movement is for spawning.

Pallid sturgeon are thought to spawn in the spring or early summer. All sturgeon species are multiple spawners, and release their eggs at intervals. Time of spawning for pallid sturgeon has not been well-documented, but is believed to occur sometime between March and July, depending on location

(Forbes and Richardson 1905, Gilbraith et al. 1988; Keenlyne and Jenkins 1993). Sexually mature pallid sturgeon have been observed in the Yellowstone River in western North Dakota during late May and early June when water temperatures ranged from 60-65°F (15.5-18.5°C) (USFWS 2000). A male pallid sturgeon in the Missouri River near Williston, ND, was observed running milt in late May 1991 (USFWS 2000). Deloney et al. (2009) noted the recapture of two tagged female pallid sturgeon in 2007 in the lower Missouri River that had spawned out completely sometime between late April and mid-May near Sioux City, Iowa and Ponca State Park, Nebraska. Keenlyne and Jenkins (1993) estimate that spawning probably begins in March in the lower Mississippi and Atchafalaya Rivers; in late April or early May in the lower Missouri and middle Mississippi Rivers; and in late May or early June in the upper Missouri River. However, catches of one seven day and one nine day post-hatch larval sturgeons near Vicksburg, Mississippi on May 20 indicated that hatching occurred on the 13 and 11 of May (Snyder 1994 in Constant et al., 1997). Another larval sturgeon captured at White Castle, Louisiana was collected on the 15 of May (Zimpfer et al., 1988 in Constant et al., 1997). Other larval sturgeon recently captured between Greenville and Vicksburg, Mississippi indicate hatching occurred in early to mid-May (Paul Hartfield personal comment). Incubation time of spawned eggs can vary but usually lasts 3 to 5 days (Columbia Environmental Research Center 2008, Dean 2004). Because pallid sturgeon eggs are adhesive, the younger the larvae captured, the greater chance it was spawned near its site of capture. Based on these larval catches, that span almost twenty years, it is most probable that hatching occurs in early to late May in the Lower Mississippi River. More recently, the capture of *Scaphirhynchus* larvae and post-larvae in the Mississippi River during fall months, as well as spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (Paul Hartfield, USFWS, per. comm. 2006). Ongoing sampling efforts by ERDC (2010) documented young-of-year (< 56 days old) sturgeon throughout the entire summer. Tripp et al. (2009) documented female shovelnose sturgeon with ripe eggs and males that were milting and a single age-0 sturgeon in the fall.

The adhesive eggs are released in deep channels or rapids and are left unattended (Gilbraith et al. 1988). The larvae of *Scaphirhynchus* are pelagic, exhibiting swim-up and drift behavior immediately after hatching. Downstream drift of larval pallid sturgeon begins at day-0 at hatching and continues up to day-13, with a decline after day-8 (Kynard et al., 2002, 2005). Field studies of drift dynamics and behavior of larvae pallid sturgeon, conducted in a Missouri River side channel, suggested that they may drift 152 to 329 miles (mi) (245 to 530 kilometer [km]) depending on water velocity, during the first 11 days, and tend to become more benthic between days 11-17 (Braaten et al., 2008), suggesting that river distance and suitable habitat available below spawning areas may be important to survival of *Scaphirhynchus* larvae, and a key factor in recruitment success of river sturgeon.

Keenlyne et al. (1992) estimated fecundity for a female pallid sturgeon taken from the upper Missouri River. The authors found the mass of mature eggs weighed 69 oz (1,952 g), which represented 11.4 percent of total body weight. Total fecundity was estimated at 170,000 eggs for this female. Females may take up to 10 years between spawnings, depending on the quality and quantity of food available in their natural habitat (Keenlyne and Jenkins 1993). Therefore, fecundity of a female may vary considerably, with an individual female spawning only a few times during her normal life span (Duffy et al. 1996).

Gathering evidence of successful pallid sturgeon reproduction and recruitment has been difficult throughout the range of the species and captures have generally been low suggesting lack of reproduction or low recruitment. However, as knowledge of sturgeon spawning physiology has improved and the ability of sampling gear to detect larval sturgeon has improved, researchers have begun to capture increasing numbers of larval sturgeon in the Middle Mississippi River and the Lower Mississippi River (Herzog, pers. comm., Hartfield pers. comm., Killgore, pers. comm.) and in the Missouri River. In 1998, the Missouri Department of Conservation (MDC) collected a young-of-the-year pallid sturgeon at approximate river mile 49.5 south of Cape Girardeau in the middle Mississippi River (Petersen and Herzog 1999). Hesse and Mestl (1993) collected two sturgeon larvae from the Missouri River adjacent to Nebraska between 1983 and 1991. Those larvae were among 147,000 fish larvae collected during filtration of 18,340,014 cu ft (519,400 cu m) of river water. Gardner and Stewart (1987) collected no sturgeon larvae in 339 samples from the Missouri River, or in 77 samples from tributary streams, where 3,124 and 5,526 fish larvae were collected, respectively. During the summer of 1998 and 1999, several pallid sturgeon larvae were collected from the lower Missouri River in Missouri (USFWS 2000) suggesting that pallid sturgeon are reproducing in the Missouri River. In three years of sampling in/near Lisbon Chute on the Missouri River, the Service's Columbia Missouri Fishery Resources Office collected over 10,000 small fishes utilizing seines, benthic trawls and fyke nets. In processing 9,855 of these fishes, 1 confirmed and 2 probable larval pallid sturgeon have been identified (USFWS 2000). Similarly, Deloney et al. (2009) tracked gravid females in the Missouri River and made observations on their readiness. Subsequent recaptures showed they had spawned out in the Missouri river near the apex of their upstream migrations. Larval collections performed as part of the same study had several age-0 larval sturgeon collected below the confluence of Big Sioux River into the Missouri River in Northwest Iowa. It is not clear whether the larvae were pallid sturgeon or shovelnose.

As captures of larval sturgeon have increased so has evidence of recruitment. In the Middle Mississippi River, pallid captures aged from 5 – 14 years; in the Lower Mississippi River, pallid captures aged from 3 – 21 years (Killgore et al. 2007a). Comparing Lower Mississippi River age-growth curves (Killgore et al. 2007a) to capture length data in the Lower Mississippi River and Atchafalaya River indicate multiple cohorts spanning almost 20 years (3 to 20 years). Annual capture of larval pallid, along with limited age data from the Lower Mississippi River indicate some level of regular annual recruitment of pallid sturgeon in the Lower Mississippi River. Similarly, recent work in the Atchafalaya River has revealed fish of several age groups, suggesting that some reproduction and recruitment may also occur in the Atchafalaya River. The only physical evidence of reproduction, however, was three gravid females (Constant et al. 1997). According to their data, pallid sturgeon collected in the Atchafalaya River and other areas of the Mississippi River have averaged less than 6.6 lbs (3 kg) and length-at-age estimates calculated according to Fogle (1963) indicated that even the smallest fish were over age 6, with the oldest perhaps over age 14. The age of fish susceptible to the sampling gear used in their study indicates the most recent recruitment of pallid sturgeon was from the 1988 year class (Constant et al. 1997).

In 1985, a shovelnose larva was collected at White Castle (approximately 30 miles upstream; River Mile 193) (Constant et al. 1997). Larval shovelnose sturgeon have also been collected in the vicinity of Vicksburg, Mississippi (River Mile 435) approximately 144 miles upstream of the diversion

(Constant et al., 1997, Hartfield personnel comment 2009). Ongoing sampling efforts by ERDC documented YOY sturgeon between Rmi 80 and 160 over multiple years (ERDC 2010) with YOY sturgeon being captured as far south as Rmi 195.5. The size and location of some of those YOY would indicate a more southern spawning site (e.g., White Castle, Rmi 193) than previously believed. This area would likely represent the most southern location of larger gravel deposits within the river.

Feeding

Carlson et al. (1985) determined composition of food categories, by volume and frequency of occurrence, in the diet of shovelnose sturgeon (n=234), pallid sturgeon (n=9), and hybrids (n=9). Although benthic macroinvertebrates characteristic of river habitats are important dietary components (Modde and Schmulbach 1977, Carlson et al. 1985), the occurrence of lake and terrestrial invertebrates in sturgeon stomachs suggest that drifting invertebrates may also be important forage organisms (Modde and Schmulbach 1977, Constant et al. 1997). Aquatic invertebrates (principally the immature stages of insects) compose most of the diet of shovelnose sturgeon, while adult pallid sturgeon and purported hybrids consume a greater proportion of fishes (mostly cyprinids) (Hoover et al., 2007). Grohs et al (2009) reported that pallid sturgeon in the Missouri River downstream of Fort Randall Dam, had high percent occurrences' of Diptera, Emphemeroptera and fish and that percent composition of fishes increased with pallid sturgeon body size. It was noted that between ages four and five in their study, pallid sturgeon shifted from predominately invertebrates to fishes. Other researchers also reported a higher incidence of fishes in the diet of adult pallid sturgeon than in the diet of shovelnose sturgeon (Cross 1967, Held 1969). Most piscivorous Missouri River species eat large quantities of aquatic insect larvae in early life and even as adults (Modde and Schmulbach 1977).

Movement

Pallid sturgeon exhibit seasonal variation in movement patterns based upon temperature and discharge (Bramblett 1996, Constant et al. 1997, Sheehan et al. 1998, Hurley 1996). The timing of pallid sturgeon movements and migration in the Lower Mississippi River may differ from that of other rivers (i.e. the Missouri River) and other portions of the Mississippi River (Constant et al., 1997). Migrations and movement in the Atchafalaya River was associated with water temperatures between 14^0 and 21^0 Celsius (C) (Constant et al,. 1997) and spring and early summer season (Schramm and Dunn 2008). Movement patterns also vary between spawning versus non-spawning years (Bramblett 1996). Bramblett (1996) reported an average home range of 48.8 mi (78 km) in the Yellowstone and upper Missouri Rivers while Sheehan et al. (1998) reported a home range of 21.2 mi (34 km) in the middle Mississippi River. Sheehan et al. (1998) speculated that because habitat in the Mississippi River is relatively uniform, large movements and home ranges may not be as beneficial in the Mississippi River as in the Yellowstone and Upper Missouri Rivers area, because study fish are not likely to encounter new habitats and thus have a smaller home range.

As large river fish, pallid sturgeon are capable of moving long distances in search of favorable habitat. Sheehan et al. (1998) noted one study fish moving along a 60.3 mi (97 km) stretch of river. Bramblett (1996) noted a maximum home range as large as 198.6 mi (319 km), with pallid sturgeon

moving up to 13 mi/day (21 km/day) and shovelnose sturgeon moving up to 9 mi/day (15 km/day). Schramm and Dunn (2008) documented one fish in the Atchafalaya River moving 96 mi. Dean (2007) reported the capture of a pallid sturgeon in the Atchafalaya River that was produced at the Blind Pony State Fish Hatchery in Missouri and released in 1997. Hoover et al. (2007) hypothesized that long-range movements during the spring may not just be associated with spawning but could also be associated with feeding.

Erickson (1992) found pallid sturgeon movement greater during the night while Bramblett (1996) observed greater movements during the day. The primary habitat difference suspected in those findings was turbidity. Erickson (1992) had secchi readings as high as 157 in. (400 cm) while Bramblett (1996) averaged 8 in (20 cm) and rarely exceeded 39 in (100 cm). Bramblett (1996) modeled the information from his study and found that predictive depth of pallid sturgeon was greater during the hours following sunrise and suggested that pallid sturgeon may be photophobic.

Hoover, et al. (2005) examined swimming performance of juvenile pallid sturgeon (maximum size 6.3 inches) at different velocities to determine possible entrainment by dredges. Minimum escape speeds for pallid sturgeon ranged from 1.6 to 1.7 feet per second (fps) and burst speeds were determined to range from 1.7 to 2.95 fps. Because they frequently failed to exhibit rheotaxis or orientation to the direction of flow (greater than 25 percent were non-swimmers); their ability to avoid entrainment based on swimming performance was determined to be relatively low. Adams (1999) also studied swim performance in juvenile pallid sturgeon. It was found that maximum sustained swimming speed was 0.328 fps and 0.82fps for their two groups of fish. The fish were found to transition to burst swimming speeds at 1.31 fps and 1.9 fps, respectively. White and Mefford (2002) examined swimming behavior and performance of shovelnose sturgeon ranging from 25.2 to 31.5 inches in length to aid in the design of a fish passage on the Yellowstone River. The ability of shovelnose sturgeon to navigate the length of the test flume was best (60 to 90 percent) over a smooth bottom followed by coarse sand, gravel and then cobble, but the small sample size and large variability precluded this from being a definitive conclusion. The greatest success at negotiating the flume was determined to occur between the range of 2 and 4 fps; however success at greater velocities, 6 fps, did occur. Failure to exhibit rheotaxis was also observed at velocities below 1.6 fps. Conversely, Adams et al. (1997) found all adult shovelnose to be positively rheotatic. Pallid sturgeon are believed to avoid areas that have no water velocity (Constant et al 1997) though Erickson (1992) observed individuals in low water velocities between .001 m/s to 0.3 m/s (DeLonay and Little 2002, cited in Quist 2004, Erickson 1992 cited in USFWS 2007, Backes et al., 1992, Constant et al. 1997). It's important to note that swim studies are often performed on hatchery fish or fish kept in tanks with low water velocity. Fish that are exercised and conditioned to higher water velocities can often sustain higher swim speeds (Boyd Kynard, personal comm. Sept 7, 2010).

Habitat use

The pallid sturgeon is adapted to the pre-development habitat conditions that historically existed in the Mississippi River and its tributaries. Those conditions can generally be described as large, free-flowing, warm water, turbid habitats with a diverse assemblage of physical attributes that were in a constant state of change (USFWS 1993; Mayden and Kuhajda 1997). Floodplains, backwaters,

chutes, sloughs, islands, sandbars and main channel waters formed the large-river ecosystem that provided the macrohabitat requirements for all life stages of pallid sturgeon and other large-river fish. Within this range, pallid sturgeon tend to select main channel habitats (Sheehan et al., 1998, USFWS 2007) in the Mississippi River and main channel areas with islands or sand bars in the upper Missouri River (Bramblett 1996, USFWS 2007). Pallid sturgeon typically remain in close contact with the substrate as this area provides food and refuge (Forbes and Richardson 1905, Schmulbach et al. 1975, Kallemeyn 1983, and Gilbraith et al. 1988).

The historic floodplain habitat of the Missouri and Mississippi Rivers provided important functions for the native large-river fish. Floodplains were the major sources of organic matter, sediments, and woody debris for the main stem rivers when flood condition flows crested their banks. The transition zone between the vegetated floodplain and the main channel included habitats with varied depths described as chutes, sloughs, or side channels. The chutes or sloughs between the islands and shore were shallower and had less current than the main channel. These areas provided valuable diversity to the fish habitat, and probably served as nursery and feeding areas for many aquatic species (Funk and Robinson 1974). The still waters in this transition zone allowed organic matter accumulations; important to macroinvertebrate production an important food source for both pallid sturgeon and shovelnose sturgeon (Carlson et al. 1985; Gardner and Stewart 1987). Flood condition flows connected those important habitats and allowed fish from the main channel to utilize those habitat areas and to exploit available food sources.

Pallid sturgeon were found to be more specific and restrictive in macrohabitat selection than shovelnose sturgeon (Bramblett 1996). According to that study, pallid sturgeon used river reaches with sinuous channel patterns, and islands and alluvial bars which generally have more diversity of depths, current velocities, and substrates than do relatively straight channels without islands or alluvial bars. The diversity of channel features such as backwaters and side channels was also higher. The subclimax riparian vegetation seres in those areas are indicative of a dynamic river channel and riparian zone (Johnson 1993).

Pallid sturgeon has have shown some preference in their selection of microhabitats and captures in the Mississippi River have been associated with islands, sand bars, gravel bars, and dikes in both the main channel and in secondary channels (USFWS 2007). In telemetry studies of pallid sturgeon on the middle Mississippi River, Sheehan et al. (1998) found a positive selection for main channel-border and downstream island-tips and also for depositional areas between wingdams and deep holes off wingdam tips. Those positive selections seem to correlate well with Carlson et al. (1985). Sheehan et al. (1998) speculated that areas between wingdam areas and downstream island-tips may be used as velocity refugia and/or feeding stations. Study sturgeon were found most often in main channel habitat; however, they exhibited selection against that habitat type. Their occurrence in such habitat was not surprising, considering that the main channel comprised approximately 65 percent of the available habitat in the study reach (Sheehan et al. 1998). Hurley (1996) also found that pallid sturgeon were selecting downstream island tips although they were not abundant within the study area.

Carlson et al. (1985) captured both pallid sturgeon and shovelnose sturgeon in gear-sets along

sandbars on the inside of riverbends, and in deeply scoured pools behind wing dams, indicating overlap of habitat-usage by the two species. Four of 11 pallids, however, were captured in gear-sets in swifter currents where shovelnose sturgeon were less numerous. Although pallid sturgeon and shovelnose sturgeon habitat use and movements are similar in certain aspects, important differences were noted by Bramblett (1996). Pallid sturgeon showed significant preferences during most times of the year for sandy substrates, particularly sand dunes, and avoided the gravel and cobble substrates preferred for spawning (Bramblett 1996). Constant et al. (1997) noted that pallid sturgeon spent considerable time associated with sand substrates. They noted that preference for sand substrates in low-slope areas suggests that pallid sturgeon use such areas as current refugia (e.g., use sand-wave troughs created as bed-material moves along the river bottom (Gordan et al. 1992)). Similarly, Shramm and Kuntz (2009) found that pallid sturgeon in the lower Mississippi River were associated with sand bar habitat and wing dikes, with sand bars preferred in spring and summer and island tips and wing dikes preferred in the fall and winter. The pallid sturgeon collected on the Yellowstone River in July 1991 by Watson and Stewart (1991) was over a bottom of mainly gravel and rock, which is the predominant substrate at that capture site. Reed and Ewing (1993) found sturgeon occurring in the man-made, rip-rap-lined outfall channels of the ORCC in Louisiana. Bramblett (1996) found that pallid sturgeon preferred sandy substrates, particularly sand dunes, and avoided substrates of gravel and cobble. In contrast, shovelnose sturgeon significantly preferred gravel and cobble substrates and avoided sand.

Constant et al. (1997) reporting on radio-tracked sturgeon, stated that they were most frequently found in low-slope areas and that such areas were used in proportion to their availability. No sturgeon were observed on extremely steep slopes. They found that sand made up over 80 percent of the substrate in low-slope areas where over 90 percent of pallid sturgeon were located. Constant et al. (1997) stated that the preference for sand substrates in low-slope areas suggest that pallid sturgeon use such areas as current refugia. Sand substrates were found to have lower invertebrate densities than substrates of silt-clay which were generally located on areas of steep slope which were exposed by swift currents. As such, it would have been energetically costly for pallid sturgeon to remain near those substrates for extended periods of time. Telemetry observations, however, showed 55 percent of sturgeon locations occurred within 32.8 feet (ft) (10 meters [m]) of steep slopes, suggesting that pallid sturgeon remained near areas of high food abundance (Constant et al. 1997).

Pallid sturgeon collected from the Missouri River above Garrison Reservoir in North Dakota during spring and fall seasons of 1988 to 1991 were found in deep pools at the downstream end of chutes and sandbars, and in the slower currents of near-shore areas. Those areas may have been providing good habitat for energy conservation and feeding (USFWS 1993). Sheehan et al. (1998) indicated that there were no shifts in habitat selection and avoidance by middle Mississippi River pallid sturgeon under three different discharge regimes (low, medium and high discharge ranges of 0 - 165 thousand cubic feet per second (Kcfs), 165 - 270 Kcfs and >270 Kcfs). Data collected by Constant et al. (1997) support prior observations that shovelnose sturgeon tolerate lower current velocities than pallid sturgeon (Carlson et al. 1985, Ruelle and Keenlyne 1994, Bramblett 1996). They (Constant et al. 1997) also found that pallid sturgeon catch-per-unit-effort (CPUE) declined following shutdown of the Old River Control Structure and that no pallid sturgeon were collected when velocity was

reduced to zero, although shovelnose sturgeon CPUE was highest at this time. Pallid sturgeon are believed to avoid areas that have very little or no water velocity (DeLonay and Little 2002, Quist 2004, Erickson 1992, USFWS 2003) and leave areas that no longer have flows (Backes et al., 1992).

Turbidity levels where pallid sturgeon have been found in South Dakota range from 31.3 to 137.6 Nephelometric Turbidity Units (NTU) (Erickson 1992). Pallid sturgeon avoid areas without turbidity and current (Bailey and Cross 1954, Erickson 1992). That behavior contributes to the rationale for why pallid sturgeon are no longer found in the Missouri River reservoirs, and have not expanded into other rivers in the Mississippi drainage, even though access is available (Duffy et al. 1996).

Findings from a study on the Missouri River in South Dakota indicate that pallid sturgeon most frequently occupy river bottoms where velocity ranges from 0 to 2.40 feet per second (ft/s) (0 to 0.73 meters per second [m/s]) (Erickson 1992). Other studies in Montana found that pallids are most frequently associated with water velocities ranging from 1.51 to 3.15 ft/s (0.46 to 0.96 m/s) (Clancey 1990). Bramblett (1996) noted pallid sturgeon occupying bottom velocities ranging from 0 to 4.49 ft/s (0 to 1.37 m/s). Those velocities are commonly found throughout the species' range.

Pallid sturgeon were frequently found in water depths of 6.6 to 19.7 ft (2 to 6 m) in South Dakota (Erickson 1992). In Montana, pallid sturgeon were captured from depths between 3.9 and 12.1 ft (1.2 to 3.7 m) in the summer, but they were captured in deeper waters during winter (Clancey 1990). Other pallid sturgeon collected in the upper Missouri, Yellowstone, and Platte Rivers were captured in depths between 3.2 and 24.9 ft (1 to 7.6 m) (Watson and Stewart 1991, USFWS 1993). Bramblett (1996) found pallid sturgeon in depths from 2.0 to 47.6 ft (0.6 to 14.5 m), in contrast to Constant et al. (1997) who found pallid sturgeon at mean depths of 49.9 ft (15.2 m) and observed pallid sturgeon using depths of 23.0 and 68.9 ft (7 and 21 m) with greater frequency than the frequency of occurrence of those depths. The range of depth used by pallid sturgeon is likely related to the available habitat within the river segment (USFWS 2000). Because of the varying total depth of the rivers throughout its range the above depth information may have limited applicability to the Lower Mississippi River unless depth is expressed as a percent of the total river depth. The calculated percent of total river depth utilized by pallid sturgeon is approximately 70 (Bramblett 1996 cited in Constant et al., 1997, Constant et al., 1997). Using that percentage compared to water depths at the Bonnet Carre Spillway during the 2008 opening would indicate that pallid sturgeon should not be found on the batture in front of the structure during its operation. While the presence of *Scaphirhynchus* species on batture areas was previously reported (Hartfield personal comment), the usage of this habitat was never been quantified (incidental usage or actively used) and no records of river sturgeon use of the batture were known to be documented in literature, therefore, until the 2008 opening of the Bonnet Carre it was believed that batture usage by pallid sturgeon was incidental. Incomplete knowledge of the pallid's life history, especially in the Lower Mississippi River, does not preclude high water usage of the batture as a feeding habitat or velocity refugia.

Pallid sturgeon inhabit areas where the water temperature ranges from 32° - 86°F (0°C to 30°C), which is the range of water temperature on the Missouri and Mississippi Rivers. Sheehan et al. (1998) noted that sturgeon habitat use in the middle Mississippi River did not change with changes in

temperature regimes and stated that temperature would not seem to have an affect on either habitat use or habitat selection by middle Mississippi River pallid sturgeon. Curtiss (1990) found no relation between surface water temperatures and depth used by shovelnose sturgeon on the Mississippi River, and no indication that shovelnose sturgeon were moving into deeper, cooler water (if available) as water temperature increased. Sheehan et al. (1990) found that swimming ability decreased and mortality increased for some river species below 39° Fahrenheit (F) (4°Celsius [C]). Hurley (1996) evaluated the habitat associations and movement of pallid sturgeon in the middle Mississippi River at water temperatures below 39°F (4°C), and above 39°F (4°C) yet below 50°F (10°C). Below 39°F (4°C), study sturgeon were found in association with current-disrupting habitat features such as downstream island-tips, wing dams, the main channel, and main channel border. Once winter temperatures rose above 39°F (4°C), habitat use became more restricted with main channel border and main channel comprising 87 percent of all relocations. When water temperatures rose to above 50°F (10°C) but below 68°F (20°C) during the spring, 40 percent of the contact relocations were in habitats between wing dams (Sheehan et al. 1990).

Population Dynamics

Much of the following information was taken from USFWS (2000, 2007). Because the pallid sturgeon was not recognized as a distinct species until 1905, it was not listed in early commercial fishery reports, so little is recorded about its abundance prior to that time. Even as late as the mid-1900s, it was common for pallid sturgeon to be tallied in commercial catch records as either shovelnose or lake sturgeon (Keenlyne 1995). Correspondence and notes of researchers suggest that the pallid sturgeon was still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). The literature indicates that declines in populations have occurred coincidentally with development of the Missouri and Mississippi River systems for flood control and navigation (Deacon et al. 1979, Keenlyne 1989). Forbes and Richardson (1905) and Bailey and Cross (1954) indicated that the species was never as common as the shovelnose sturgeon and their abundance can sometimes be reported in terms of a ratio of pallid sturgeon caught to shovelnose sturgeon caught.

Table 1. Historical records of pallid sturgeon catches. Duffy et al 1996

Efforts to Collect Pallid Sturgeon and Numbers Collected by Decade and Location 1905-1994.

DECADE	LOCATION	NUMBER OF REPORTS	NUMBER OF PALLID REPORTED
1905-1934	Mississippi River	3	15
1934-1964	Mississippi River	3	3
	Lower Missouri River	1	3
	Upper Missouri River	15	210
1965-1974	Mississippi River	1	1
	Upper Missouri River	10	154
1975-1984	Mississippi River	1	6
	Lower Missouri River	1	2
	Upper Missouri River	9	204
1985-1994	Mississippi River	1	1
	Atchafalaya River	2	28
	Upper Missouri River	20	219
TOTAL	Lower 1200 km	11	59
	Upper 2000 km	54	799

During systematic sampling on the Missouri and Yellowstone Rivers in 1905, the Montana Department of Game, Fish and Parks collected 10 (2.2 percent) pallid sturgeon compared to 444 shovelnose sturgeon (Liebelt 1995). Reed and Ewing (1993) collected 11 (11 percent) pallid sturgeon, 18 purported hybrids and 74 shovelnose sturgeon in the vicinity of the ORCC in Louisiana. Between 1991 and 2007 over 3,000 river sturgeon were captured at the ORCC with over 600 individuals (greater than 20 %) being identified as pallid sturgeon (Dean 2007). In 2007, Watson and Stewart (1991) noted one (0.29 percent) pallid sturgeon out of 350 sturgeon from the lower Yellowstone River in Montana. Killgore et al., 2007b caught one pallid sturgeon for every six shovelnose in the Mississippi River between New Orleans (Rmi 100) and the Atchafalaya River (Rmi 319). Kirk et al., 2008, calculated a pallid to shovelnose ratio of 1:2.4 from sampling in the Mississippi River at approximately Rmi 146.

Bailey and Cross (1954) provided information based on their personal observations on the proportion of pallid sturgeon to shovelnose sturgeon from the Kansas River at Lawrence, Kansas (8 percent; number of specimens not reported), and the Missouri River in South Dakota, 3 of 62 specimens (5 percent). For the Mississippi River at New Orleans, 3 of 4 specimens (75 percent) were reported as being pallid sturgeon, however, these numbers are based upon specimens within collections, and therefore, those ratios may not reflect actual ratios within the river. Fisher (1962) recorded 4 of 13 river sturgeons (31 percent) from the Missouri River in Missouri as pallid sturgeon. Comparable commercial catch records are not available for the upper river reaches where commercial fishing was light or nonexistent.

Constant et al. (1997) noted that in surveys of commercial catch, shovelnose sturgeon accounted for between 52 percent and 98 percent of the total sturgeon catch, with the remainder composed of similar portions of hybrids (2 percent to 21 percent) and pallid sturgeon (0 percent to 26 percent). The higher percentage found by Constant et al., (1997) is comparable to the longer term percentage found by Dean (2007) who found that between 1991 and 2007 greater than 20 percent of over 3,000 river sturgeon captured at the ORCC were identified as pallid sturgeon. As previously mentioned Killgore et al., 2007b, found for every pallid sturgeon caught six shovelnose sturgeon were also caught in the Mississippi River between New Orleans (Rmi 100) and the Atchafalaya River (Rmi 319). A more recent survey performed by ERDC, caught one pallid and three shovelnose between Rmi 70 and Rmi 100.

Data for the Missouri River continue to indicate that wild pallid sturgeon in the upper Missouri River are large, mature, and likely old individuals, and provide little to no evidence supporting a naturally self-sustaining population. There appears to be no natural wild population surviving in the mid to lower Missouri River though some recent studies have had gravid females release eggs near Sioux City, Iowa and between Kansas City, Missouri and the confluence (Deloney et al. 2009). Sampling in the lower Missouri River to the confluence with the Mississippi River during the past decade continues to confirm a small population of wild pallid sturgeon in the lower Missouri River. Pallid populations in the Missouri River are being augmented with hatchery produced fish in order to ensure persistence of the species until threats are adequately addressed to promote a self sustaining population. Data collected after the Recovery Plan was developed indicate that pallid sturgeon numbers are higher in the Mississippi and Atchafalaya Rivers than initially documented in 1993. However, this increase in collections can be associated with increased sampling efforts and not quantified with catch-per-unit effort data. When this species was listed, there were only 28 recognized records of pallid sturgeon from the Mississippi River, with no recognized records from the Atchafalaya River.

Hatchery-reared Releases

In recent years, pallid sturgeon populations have been augmented by release of hatchery-reared fish. In 1994, the Missouri Department of Conservation (MDC) released approximately 7,000 fingerlings in the Missouri and Mississippi Rivers and an additional 3,000 fingerlings were stocked in 1997. (Graham 1997, 1999). Since stocking in 1994, approximately 86 pallid sturgeon returns have been reported, mostly in the Mississippi River downstream of St. Louis (Graham 1999). Thirty-five, 12- to 14-inch fish raised at Natchitoches NFH were stocked in the lower Mississippi River in 1998 (Kilpatrick 1999). In 2004, the Natchitoches NFH stocked approximately 3,500 fish in the Atchafalaya River and 6,500 were stocked in the Mississippi River (Dean, 2004). Also in 1998, 745 hatchery-reared yearling pallid sturgeon were released at three sites in the Missouri River above Fort Peck Reservoir (Gardner 1999) and another 750 yearling sturgeon were released near the confluence of the Yellowstone and Missouri Rivers (USFWS 2000).

Despite stocking efforts, pallid sturgeon remain rare compared to the shovelnose sturgeon. In 1997 and 1998, the MDC, Long Term Resource Monitoring Station at Cape Girardeau collected 7 pallid sturgeon (0.45 percent) compared to 1,549 shovelnose sturgeon in the middle Mississippi River

(Petersen 1999). All seven were hatchery-origin pallid sturgeon (USFWS 2000). Current data indicate that hatchery-reared pallid sturgeon are essential to preventing local extirpation in portions of the range in the upper Missouri River and have been used to reestablish pallid sturgeon in a small portion of the species' range in lower sections of the Missouri River. Deloney et al. (2009) had placed radio tags in 4 gravid females of hatchery origin and observed 3 of these tagged fish perform upstream migrations. Subsequent recaptures proved that they had released their eggs near the apex of these movements.

Status and Distribution

The historic distribution of pallid sturgeon as described by Bailey and Cross (1954) included the Missouri River, the Mississippi River from the mouth of the Missouri River to the Gulf of Mexico, and the lower reaches of the Platte, Kansas, and Yellowstone Rivers. Though a possible sighting of a pallid sturgeon has occurred as far south as the Head of Passes on the Mississippi River, it is unclear at what salinity level their southerly movements are curtailed. Records also indicated pallid sturgeon were present in the Mississippi River at Grafton, Illinois, (Forbes and Richardson 1905) and as far north as Keokuk, Iowa before that reach of the river was converted into a series of locks and dams for commercial navigation (Bailey and Cross 1954, Coker 1930). In 1992, this species was documented from the Atchafalaya River in central Louisiana (Reed and Ewing 1993, USFWS 2007). Today, pallid sturgeon remain scarce but are widely distributed throughout their range (Constant et al. 1997). No critical habitat has been designated for the pallid sturgeon at this time.

Distribution

Carlson and Pflieger (1981) stated that pallid sturgeon are rare but widely distributed in both the Missouri River, and in the Mississippi River downstream from the mouth of the Missouri River. A comparison of pallid sturgeon and shovelnose sturgeon catch records provides an indication of the rarity of pallid sturgeon. At the time of their original description, pallid sturgeon composed 1 in 500 river sturgeon captured in the Mississippi River at Grafton, Illinois (Forbes and Richardson 1905). Pallid sturgeon were more abundant in the lower Missouri River near West Alton, MO, representing one-fifth of the river sturgeon captured (Forbes and Richardson 1905). Carlson et al. (1985) captured 4,355 river sturgeon in 12 sampling stations on the Missouri River and Mississippi Rivers. Field identification revealed 11 (0.25 percent) pallid sturgeon. Grady (2001b) collected 4,435 river sturgeon in the lower 850 mi (1,367 km) of the Missouri River and 100 mi (161 km) of the middle Mississippi River from November 1997 to April 2000. Field identification revealed nine wild (0.20 percent) and nine hatchery-origin pallid sturgeon.

Today, pallid sturgeon, although variable in abundance, are ubiquitous throughout most of the free-flowing Mississippi River. When the pallid sturgeon was listed as endangered they were only occasionally reported from the following areas; from the Missouri River: (1) between the Marias River and Fort Peck Reservoir in Montana; (2) between Fort Peck Dam and Lake Sakakawea (near Williston, North Dakota); (3) within the lower 70 mi (113 km) of the Yellowstone River downstream of Fallon, Montana; (4) in the headwaters of Lake Sharpe in South Dakota; (5) near the mouth of the Platte River near Plattsmouth, Nebraska; and, (6) below river mile 218 to the mouth in the State of Missouri. Areas of most recent and frequent occurrence on the Mississippi River are: (7) near

Chester, Illinois; (8) Caruthersville, Missouri; and, (9) in the Atchafalaya River in Louisiana at the ORCC (USFWS 1993). Of 872 pallid sturgeon records prior to 1998, 70 percent were reported from the Missouri River; however, most historical collection efforts for the pallid sturgeon have been focused on the middle and upper Missouri River. Approximately 10 percent of the Missouri records were from below Gavins Point Dam; while the majority of records were from intensive sampling efforts in Montana, North and South Dakota, and include recaptures. In addition, 9 percent of the total records came from the Yellowstone River, 5 percent from the Mississippi River, 14 percent from the Atchafalaya River, and less than 2 percent from the St. Francis, Platte, Ohio, Kansas, and Yazoo Big Sunflower Rivers (USFWS 2000). The range of the pallid sturgeon has been split into 6 distinctive River Recovery and Priority Management Areas (RPMA). The status of pallid sturgeon in each RPMA is discussed below.

RPMA 1 (Upper Missouri)

RPMA 1 is defined in the pallid sturgeon recovery plan as the Missouri River from the headwaters of Fort Peck Reservoir upstream to the confluence of the Marias River, Montana (USFWS 1993). The status of wild pallid sturgeon in RPMA 1 has remained relatively unchanged since listing and continues to decline. According to data obtained from the National Pallid Sturgeon Database (USFWS 2006), a total of 52 wild pallid sturgeon (individual fish) has been collected in RPMA 1 during 15 years of sampling (1990-2005). The length frequency data suggests these are all adult fish. Current population estimates suggests that as few as 45 wild pallid sturgeon still remain in RPMA 1 (Bill Gardner, Montana Fish Wildlife and Parks (MFWP), pers. comm., 2005). There is an obvious absence of smaller sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and or trot-lines) capable of collecting smaller sized hatchery-reared pallid sturgeon. The size and age of surviving fish suggest that spawning, recruitment, or both, are severely limited or absent within this reach. However, the population is being supplemented with hatchery produced fish (USFWS 2006) in efforts to prevent local extirpation. Supplementation of RPMA 1 with hatchery produced pallid sturgeon has occurred sporadically since 1997, and is required to maintain the species within this RPMA. Based on recapture data from the National Pallid Sturgeon Database (USFWS 2006), pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure.

RPMA 2 (Middle Missouri)

The Missouri River below Fort Peck Dam to the headwaters of Lake Sakakawea and the lower Yellowstone River up to the confluence of the Tongue River, Montana, is defined as RPMA 2. The wild pallid sturgeon population in RPMA 2 continues to decline. According to data compiled from the National Pallid Sturgeon Database (USFWS 2006), 527 wild pallid sturgeon captures occurred during 16 years of sampling (1990-2006). However, many of the adults were collected multiple times during those years. Removing recaptured pallid sturgeon from the query, indicates a total of 245 unique individual pallid sturgeon were collected during this timeframe. Available length frequency data indicate that these were essentially all adult fish. There is an obvious absence of smaller-sized wild pallid sturgeon despite utilization of sampling gear (gill nets, trammel nets, seines, and trot-lines) capable of collecting smaller sized pallid sturgeon. The size and associated age of

surviving fish suggest that spawning, recruitment, or both are severely limited within this reach. However, the population is being supplemented with hatchery-reared fish to prevent local extirpation (USFWS 2006). Recent population estimates suggests that approximately 136 wild adult pallid sturgeon still remain in RPMA 2 (Klungle 2004). The length frequency data indicate that, up until the time supplementation began, all collected pallid sturgeon were adults except for one small fish collected in 1993. This suggests that, like RPMA 1, spawning, recruitment, or both are limiting viability within this reach. Supplementation of RPMA 2 with hatchery produced pallid sturgeon has occurred sporadically since 1998 with various numbers being stocked depending on hatchery success for any given year (USFWS 2006). To date, pallid sturgeon from all stocking events have produced recaptures and are contributing to the current population structure.

RPMA 3 (Lower Missouri River)

RPMA 3 is the Missouri River from 20 miles (mi) (32 kilometers (km)) upstream of the mouth of the Niobrara River to Lewis and Clark Lake. There is no native wild population of pallid sturgeon known to survive in RPMA 3 and the current population consists entirely of hatchery stocked fish. According to the National Pallid Database (USFWS 2006), the last record of a wild species from this area, that was not translocated, was the collection of a single pallid sturgeon circa 1991. Prior to this (1952-1991), there was a small number of wild pallid sturgeon collected from this area. Research within RPMA 3 during 1998 and 1999 (prior to stocking hatchery-reared pallid sturgeon in this reach) did not document a single pallid sturgeon, but numerous shovelnose sturgeon were collected. A total of 102 pallid sturgeon has been collected in RPMA 3 during 2 years of sampling (2003-2005). All of these were hatchery-reared with the exception of a few translocated wild pallid sturgeon. These data suggest that prior to supplementation, pallid sturgeon were extremely rare or extirpated in RPMA 3. Supplementation of RPMA 3 with hatchery-reared pallid sturgeon has occurred sporadically with various numbers being stocked depending on hatchery success for any given year. Recent work by Shuman et al. (2005) indicates that these stocked pallid sturgeon are surviving and growing (mean growth of age-6 and older fish was <0.06 mm/day (mm/d), mean growth for ages 2-4 was 0.238 mm/d, and the youngest year class (2004) grew 1.249 mm/d) in this reach with all stocked year classes (1997-1999 and 2001 and 2002) being collected in their samples.

RPMA 4 (Missouri to Mississippi River)

The Missouri River downstream of Gavins Point Dam, South Dakota to the Missouri River/Mississippi River confluence, including major tributaries such as the Platte River, defines RPMA 4. Although pallid sturgeon captures in RPMA 4 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. In the late 1990s, the USFWS Columbia Fishery Resources Office collected larval sturgeon in the Lisbon Chute on the Missouri River. Three were confirmed as larval pallid sturgeon and seven others were identified as probable pallid sturgeon (Krentz 2000) (identification by Darrel Snyder, Colorado State University Larval Fish Laboratory). Larval sturgeon (species not confirmed) also have been documented in the Missouri River below Gavins Point Dam by Nebraska Game and Parks Commission (NGPC) (Gerald Mestl, NGPC, pers. comm., 2005) and the Missouri Department of Conservation (MDC) (Herzog et al. 2005) and in the lower Platte River (Hofpar 1997, Reade 2000). Some of these smaller fish may

have been pallid sturgeon, but accurately identifying these larval fish to species is difficult (Kuhajda et al. 2007). Recent studies also identify low numbers of unmarked pallid sturgeon (larger than fry) being collected from the lower Missouri River (Kennedy et al. 2006; Utrup et al. 2006). Augmentation with hatchery-reared pallid sturgeon has occurred sporadically since 1994 (USFWS 2006), and the collection of individuals from all stocked cohorts indicates that hatchery supplementation is contributing to the population (Barada and Steffensen 2006; Kennedy et al. 2006; Steffensen and Barada 2006; Utrup et al. 2006). Brood-stock collection for the hatchery propagation in 2009 produced 160 pallid sturgeon with 45 not known to be of hatchery origin were sent to the Blind Pony State Hatchery for evaluation; 16 of those fish were reproductively mature(Steffensen and Koch 2009). In 2010, pallid sturgeon were captured with 37 fish not suspected to be of hatchery origin were sent for evaluation, 19 were reproductively mature. Of a total 156 pallid sturgeon captured between 1999 and 2005, 51 are believed to be wild, 82 were of hatchery origin, and 24 were of unknown origin (Brannen and Wilhelm 2010). These fish were identified as wild if they did not possess a physical mark (i.e., coded wire tag or elastomere tag) indicating they were from a hatchery and were of a size class greater than what was associated with known hatchery-released fish. Fish labeled as hatchery origin had a distinguishing physical mark. Unknown individuals were consistent in length with known hatchery fish, but had no notable marks. These are considered unknown because certain marking techniques, like PIT tags, have been documented to fail. However, data within the National Pallid Sturgeon Database (USFWS 2006), for the period 1990-2005, notes 117 unique wild pallid sturgeon for RPMA 4. Available length frequency data for these fish indicates the majority to be adults. A few have been reported that are of sub-adult sizes (<600 mm), yet these sub-adult pallid sturgeon were all collected after supplementation commenced in 1994. Retrospective testing of the unmarked fish has revealed that 23 of the 24 unmarked pallid sturgeon were of hatchery origin, and the remaining unknown origin fish remained in that category because parental genetic samples were not available for all families released downstream of Gavins Point Dam and they could have originated from one of the unsampled families (DeHaan et al. 2008). The apparent lack of naturally produced or unknown origin pallid sturgeon in smaller size classes, coupled with higher relative abundances of hatchery origin pallid sturgeon and frequent captures of smaller size class shovelnose sturgeon, suggests that the sampling gear and effort being used are effective and that natural recruitment of pallid sturgeon is sporadic or limited in RPMA 4 (Barada and Steffensen 2006, Kennedy et al. 2006, Steffensen and Barada 2006, Utrup et al. 2006). These data also indicate that hatchery stocked fish are being collected and contributing to the population.

RPMA 5 (Mississippi River)

The Mississippi River from its confluence with the Missouri River to the Gulf of Mexico defines RPMA 5. While not identified in the Recovery Plan, the Mississippi River is often subdivided into two segments: the lower Mississippi River, extending 953 River miles (Rmi) (1,533.7 River kilometers (Rkm)) from the Gulf of Mexico to Cairo, Illinois; and the middle Mississippi River, extending 200 river miles (321.9 Rkm) from near Cairo, Illinois, to just above the mouth of the Missouri River confluence near St. Louis, Missouri. The availability of demographic data in RPMA 5 for pallid sturgeon has increased since the species was listed. Although pallid sturgeon captures in RPMA 5 continue to increase with fishing effort, population levels and trends, habitat use, and movement patterns remain unknown. Only 28 records of pallid sturgeon were recognized from the

Mississippi River when the species was listed in 1990 and the recovery plan was published in 1993 (USFWS 1993). During the past 6 years, over 300 pallid sturgeon (both sub-adult and adult size classes) have been collected from the Mississippi River. However, caution must be applied when looking at total catch because some of the collected pallid sturgeon reported by D. Herzog, (MDC) may also have been reported by Jack Killgore (U.S. Army Corps of Engineers (Corps) during their collaborative efforts. According to the National Pallid Sturgeon Database (USFWS 2006), 279 unique pallid sturgeon have been collected in RPMA 5 between 1990 and 2004. It is unclear what percentage of these may be hatchery origin pallid sturgeon with failed physical marks. Jack Killgore, Corps, (pers. comm., 2005) indicated that, between the winter of 2004 and the spring of 2005, 39% (7 of 18) of the pallid sturgeon sampled were hatchery stocked recaptures with a coded wire tag (CWT). Prior to 2004, pallid sturgeon were not checked for coded wire tags which were used to mark hatchery-reared pallid sturgeon stocked from Missouri's Blind Pony fish hatchery.

Middle Mississippi River

From 2002 through 2005, the Corps, Missouri Department of Conservation (MDC), and Southern Illinois University conducted a joint pallid sturgeon research project in the middle Mississippi River using trawling, gillnets, and trotlines as the primary sampling gears. A little over 64,000 hours of effort (combined for all gear types) was expended to catch a total of 148 pallid sturgeon as part of this project. Of the 148 pallid sturgeon collected, 12 individuals (8%) were hatchery origin fish determined by the presence of coded wire tags. This 8% is likely under representing the total number of hatchery origin fish in this sampling effort because scanning for coded wire tags was not a standard practice until 2004 (Jim Garvey, Southern Illinois University, pers. comm. 2006). Herzog et al. (2005) documented successful reproduction by the collection of larval pallid sturgeon in the middle Mississippi River, though the origin of these larval pallid sturgeon from within the middle Mississippi River is not known. Wild pallid sturgeon collected from this reach ranged between 500 and 1,000 mm fork length (FL; the length measured from the anterior most portion of the fish to the median caudal fin rays). Pallid sturgeon above 600 mm FL are believed to be of reproductive size, and the capture of small adult and sub-adult pallid sturgeon around and below this size may indicate that some level of recruitment is likely occurring in the middle Mississippi River or lower Missouri River, or could be a product of undetected marks in hatchery origin pallid sturgeon. Limited supplementation with hatchery reared pallid sturgeon has occurred in the middle Mississippi River (USFWS 2006).

Lower Mississippi River

ERDC sampled the lower Mississippi River (from the Chain of Rocks to south of New Orleans) from 2000 to 2006. During this time, 162 pallid sturgeon were collected from over 130 locations between Rmi 145 to 954 (Rkm 233 to 1535) (J. Killgore, Corps, pers. comm., 2005), with 3 recaptures. Sizes of pallid sturgeon collected range between 400 and 1,000 mm fork length (FL). This data set includes at least 30 "sub-adult" pallid sturgeon (i.e., <600 mm FL), showing some level of recruitment in the lower Mississippi River population. It is possible that recruitment of pallid sturgeon in RPMA 5 is higher than that reflected in sampling data. Over the past 3 years, monthly sampling in a 30 mile reach of the Lower Mississippi River (Rmi 580.9- Rmi 556.1) has resulted in

the capture of over 60 pallid sturgeon, with a single recapture, and only 2 confirmed hatchery fish (Schramm and Kuntz 2010, Hartfield pers. comm. 2010). Although morphologically distinct pallid sturgeon as small as 450 mm FL are occasionally captured, some young-of-year and sub-adult pallid sturgeon may be misidentified as shovelnose or hybrids. One recent study found that character indices do not correctly identify small upper Missouri River hatchery-reared juvenile pallid sturgeon (<250 mm standard length; the length from the tip of the upper jaw to the posterior end of the vertebral column that is most commonly used in taxonomic studies) from shovelnose or hybrid sturgeon, or reliably separate larger pallid sturgeon (up to 600 mm standard length) from hybrid sturgeon (Kuhajda and Mayden 2001). Measurements taken from 48, 10-month old hatchery-reared juvenile pallid sturgeon (309 to 413 mm FL) spawned from Atchafalaya River stock and reared at the Natchitoches NFH, incorrectly identified all but two of these hatchery-reared pallid sturgeon as hybrids, and the two exceptions were incorrectly identified as shovelnose sturgeon (Jan Dean, USFWS, pers. comm., 2005). These juvenile fish were reared from morphologically distinct pallid sturgeon confirmed by genetic analysis. Murphy et al. (2007) also have found greater morphological variation in specimens of pallid and shovelnose sturgeon from the Mississippi River than what is accounted for in current identification indices. These studies suggest that at least some young-of-year, sub-adult, or small adult pallid sturgeon can be misidentified in the field as hybrid or shovelnose sturgeon. Captures of pallid sturgeon in the Mississippi River have been associated with islands, sand bars, gravel bars, and dikes, in both the main channel and in secondary channels.

RPMA 6 (Atchafalaya River)

RPMA 6 is the Atchafalaya River from the Old River Control Complex (ORCC) to the Gulf of Mexico. Collection data from this RPMA reflects an improvement in our understanding of the pallid sturgeon population trend. Prior to listing in 1990, pallid sturgeon had not been documented from the Atchafalaya River. In 1991, seven pallid sturgeon were collected from the Atchafalaya River near the ORCC, in Concordia Parish, Louisiana (Reed and Ewing 1993). A few years later (1993-95) an additional 106 pallid sturgeon captures were reported (Constant et al. 1997). Over approximately 600 individual pallid sturgeon have been collected from the Atchafalaya River since 1991 (Dean 2007). A conservative approach to species identification was used, based upon morphometric measurements, to identify pallid versus intermediate or "hybrid" sturgeon, and thus actual number of pallid sturgeon captured from the ORCC is likely underrepresented in these data. There have been at least 37 wild adult pallid sturgeon recaptures in the ORCC area since 1991, of which 32 have been during 2004-2006 (J. Dean, USFWS, pers. comm., 2006). The length distribution of pallid sturgeon captures has remained relatively consistent over the past 7 years, although the population appears to be comprised of predominantly adult pallid sturgeon >650 mm FL (Figure 12). However, gears used to sample this area are larger mesh and may not reliably sample sturgeon smaller than 400 mm. It is currently unknown if this consistent length frequency distribution through time combined with the occasional collection of smaller pallid sturgeon, results from local reproduction and recruitment, the passage of sub-adult and/or adult pallid sturgeon from the Mississippi River through the ORCC into the Atchafalaya River, or is simply a product of gear selectivity/bias. Gill net collections at the ORCC regularly capture shovelnose sturgeon between 400 and 750 mm FL. The pallid sturgeon are larger, measuring (with occasional exceptions) above 650 mm FL. It has been noted in the discussion under

RPMA 5, above, that there are difficulties in separating juvenile *Scaphirhynchus* to species. This also is true in RPMA 6. For example, trawl sampling for 2 days below ORCC during June 2005, resulted in the capture of six young-of-year *Scaphirhynchus* (196 to 410 mm total length (the length measured from the anterior most portion of the fish to the tip of the caudal fin rays). Three of these fish were marked indicating they were hatchery-reared juvenile pallid sturgeon released during fall and winter of 2004, and the other three had no physical mark and were considered wild young-of-year sturgeon. A character index was used on all six fish and misidentified the three hatchery-reared pallid sturgeon as hybrids, and identified two of the unknown wild sturgeon as shovelnose and the other as a hybrid (Jan Dean, USFWS, pers. comm., 2005). Further investigation is required to determine if allometric growth is resulting in the misidentification of some juvenile or sub-adult pallid sturgeon as shovelnose or "hybrids/intermediates", and to document local reproduction and recruitment in RPMA 6. Based on limited catch data reported by Constant et al. (1997), the ratio of hybrid to shovelnose sturgeon in the Mississippi River is similar to that in the Atchafalaya River.

The ORCC forms a potential uni-directional barrier to fish movement between the Mississippi and Atchafalaya Rivers. The structures associated with the ORCC likely could allow movement of fish from the Mississippi River into the Atchafalaya River, but could constitute a velocity barrier for movement in the opposite direction. Data exists to indicate that passage from the Mississippi River into the Atchafalaya Rivers does occur (Reed per comm. 2006, Hartfield in litt 2006, USFWS 2007). However, passage or lack of passage in the opposite direction has not been documented but sampling to detect such passage while increasing has probably not been sufficient to disprove such passage.

Habitat Destruction/Modification

Destruction and alteration of big-river ecologic functions and habitats once provided by the Missouri and Mississippi Rivers is believed to be the primary cause of declines in reproduction, growth, and survival of pallid sturgeon (USFWS 1993). The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity, and nutrient inputs once functioned within the big-river ecosystem to provide habitat for pallid sturgeon and other native species. Human alterations such as, dams, levees, and channelization fragment the habitat and change the natural functions of the river reducing it's capacity to support the historic populations of large riverine fishes.

Construction and operation of dams on the upper Missouri River and modification of riverine habitat by channelization of the lower main stem Missouri and Mississippi Rivers has resulted in the curtailment of range and destruction or modification of habitat. On the main stem of the Missouri River (1,154 mi) (1,857 km) today, approximately 36 percent of riverine habitat within the pallid sturgeon's range has been transformed from river to lake by construction of six massive earthen dams by the Corps between 1926 and 1952 (USFWS 1993). The other 64 percent has been channelized, or altered due to dam operations (USFWS 1993). Most of the major tributaries of the Missouri and Mississippi Rivers have also been altered to various degrees by dams, water depletions, channelization, and riparian corridor modifications.

The upper ends of the reservoirs in the upper basin may be influencing the recruitment of larval

sturgeon. Both the shovelnose and pallid sturgeon larvae have a propensity to drift after hatching (Kynard et al. 1998a, b). Migration routes to spawning sites on the lower Yellowstone River have been fragmented by low-head dams used for water supply intakes. Such habitat fragmentation has forced pallid sturgeon to spawn closer to reservoir habitats and has reduced the distance larval sturgeon can drift after hatching. Reservoir habitats may also place larval sturgeon at a greater risk of predation.

The channelized reach of the Missouri River downstream of Ponca, Nebraska, once a diverse assemblage of braided channels, sandbars, and backwaters, is now confined within a narrow channel of rather uniform width and swift current. Morris et al. (1968) found that channelization of the Missouri River reduced the surface area by approximately 67 percent. Funk and Robinson (1974) calculated that, following channelization, the length of the Missouri River between Rulo, Nebraska, and its mouth (~500 river miles) (310 km) had been reduced by 8 percent, and the water surface area had been reduced by 50 percent.

Missouri River aquatic habitat between and downstream of main stem dams has been altered by reductions in sediment and organic matter transport/deposition, flow modification, hypolimnetic releases, and narrowing of the river through channel degradation. Those activities have adversely impacted the natural river dynamics by reducing the diversity of bottom contours and substrates, slowing accumulation of organic matter, reducing overbank flooding, changing seasonal patterns, severing flows to backwater areas, and reducing turbidity and water temperature (Hesse 1987).

The pattern of flow velocity, volume, and timing of the pre-development rivers provided the essential life requirements of native large-river fishes like the pallid sturgeon and paddlefish. Hesse and Mestl (1993) found a significant relationship between the density of paddlefish larvae and two indices (timing and volume) of discharge from Fort Randall Dam. They concluded that when dam operations caused discharge to fluctuate widely during spring spawning, the density of drifting larvae was lower, and when annual runoff volume was highest, paddlefish larval density was highest. Hesse and Mestl (1987) also modeled these same two indices of discharge from Fort Randall Dam with an index of year-class strength. They demonstrated significant negative relationships between artificial flow fluctuations in the spring and poor year-class development for several native and introduced fish species including river carpsucker, shorthead redhorse, channel catfish, flathead catfish, sauger, smallmouth buffalo, and bigmouth buffalo. The sample size of sturgeon was too small to model in that study; however, a clear relationship existed between poor year-class development in most native species studied and the artificial hydrograph.

Levee construction along the lower Mississippi River, from the Ohio River to the Gulf, has eliminated major natural floodways and reduced the land area of the floodplain by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also report that levee construction isolated many floodplain lakes and raised river banks. Bendway cutoffs to facilitate navigation have severed 15 meander loops between 1933 and 1942. These anthropogenic alterations (i.e., levee construction) effectively increased river stage and velocities at higher discharges by preventing overbank flows on the adjacent floodplains (Baker et al. 1991).

Free-flowing riverine conditions currently exist throughout the lower 2,000 mi (3,218 km) (60%) of the pallid sturgeon's historical range much of which is in the Mississippi River. The middle Mississippi River, from the mouth of the Missouri River to the mouth of the Ohio River, is principally channelized with few remaining secondary channels, sandbars, islands and abandoned channels and has been extensively diked. Navigation channels and flood control levees have reduced the size of the Mississippi Rivers floodplain there by 39 percent. However, recent studies and data from the Mississippi River (RPMA 5) suggests that riverine habitats are less degraded than previously believed, and that they continue to support diverse and productive aquatic communities, including pallid sturgeon. The 950 mile reach below the confluence of the Ohio River appears to be adequate for pallid sturgeon survival and recruitment and provides numerous complex secondary channel and island habitats known to be utilized by pallid sturgeon (P. Hartfield, per. comm.).

Commercial and Recreational Harvesting

Historically, pallid, shovelnose, and lake sturgeon were commercially harvested in all States on the Missouri and Mississippi Rivers (Helms 1974). The larger lake and pallid sturgeon were sought for their eggs which were sold as caviar, whereas shovelnose sturgeon were historically destroyed as bycatch. Commercial harvest of all sturgeon has declined substantially since record-keeping began in the late 1800s. Most commercial catch records for sturgeon have not differentiated between species and combined harvests as high as 430,889 lb (195,450 kg) were recorded in the Mississippi River in the early 1890s, but had declined to less than 20,061 lb (9,100 kg) by 1950 (Carlander 1954). Lower harvests reflected a decline in shovelnose sturgeon abundance since the early 1900s (Pflieger 1975).

Mortality of pallid sturgeon occurred as a result of illegal and incidental harvest from both sport and commercial fishing activities (USFWS 2000). Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits, and life history characteristics (Boreman 1997). Bettoli et al. (2008) conservatively estimated that 1.8% of the total sturgeon catch in Tennessee sturgeon caviar harvest were composed of pallid sturgeon. In addition, such illegal and incidental harvest may skew pallid sturgeon sex ratios such that hybridization with shovelnose is exacerbated. Killgore et al. (2007b) indicated that higher mortality rates for pallid sturgeon in the Middle Mississippi River could be attributed to incidental take by the commercial shovelnose fishery. In order to address incidental and illegal take of pallid sturgeon in caviar harvest, the Service has listed shovelnose as threatened, due to similarity of appearance to pallid sturgeon. The effects of this listing has effectively eliminated legal commercial harvest of sturgeon from river reaches where pallid sturgeon are known to occur.

Hybridization

Morphological variation between pallid sturgeon populations in the upper Missouri, lower Missouri, and Mississippi rivers has led to a hybridization debate. Upper Missouri River pallid sturgeon are characterized by large sizes in excess of 60 lb, and large pointed snouts, while pallid sturgeon from the lower Missouri, Mississippi, and Atchafalaya Rivers typically have shorter and rounder snouts and fish size rarely exceed 15 lb (6.8 kg) (Kuhajda and Mayden 2001, U.S. Fish and Wildlife Service 2007). Studies using mitochondrial DNA (Campton et al. 2000, Simons et al.

2001) and DNA microsatellite loci (Tranah et al. 2001, Schrey and Heist 2007, Ray et al. 2007) have demonstrated that genetic differences between shovelnose and pallid sturgeon occur throughout their sympatric range. However, several of these studies have also shown that genetic differentiation exists among pallid sturgeon from opposite ends of their range (Campton et al. 2000, Tranah et al. 2001) as well as between pallids inhabiting different geographic regions (upper Missouri, lower Missouri, Middle Mississippi, and Atchafalaya rivers) (Schrey and Heist 2007), and morphological variation within the pallid sturgeon range may be attributed to genetic structure of populations.

Bramblett (1996) found substantial differences in habitat use and movements between adult pallid and shovelnose sturgeon in less altered habitats in the Missouri River. Presumably, the loss of habitat diversity caused by human-induced environmental changes inhibits naturally occurring reproductive isolating mechanisms. Campton et al. (1995), and Sheehan et al. (1997) note that hybridization suggests that similar areas are currently being used by both species for spawning.

Carlson et al. (1985) studied morphological characteristics of 4,332 sturgeon from the Missouri and middle Mississippi Rivers. Of that group, they identified 11 pallid sturgeon and 12 pallid/shovelnose sturgeon hybrids. Suspected hybrids were observed in commercial fish catches on the lower Missouri and the middle and lower Mississippi Rivers (USFWS 2000). Bailey and Cross (1954) did not report hybrids, which may indicate that hybridization is a recent phenomenon resulting from environmental changes caused by human-induced reductions in habitat diversity and measurable changes in environmental variables such as turbidity, flow regimes, and substrate types (Carlson et al. 1985). A study by Keenlyne et al. (1994) concluded that hybridization may be occurring in half the river reaches within the range of pallid sturgeon and that hybrids may represent a high proportion of remaining sturgeon stocks. Keenlyne et al. (1994) noted few hybrids showing intermediacy in all characteristics as would be expected in a first generation cross, indicating the hybrids are fertile and reproducing. Hartfield and Kuhajda (2009) stated that hybridization rates in the Mississippi River have been overestimated, and there is no direct evidence linking the morphological or genetic variation defined as hybridization between pallid and shovelnose sturgeon in the lower Missouri, Mississippi, or Atchafalaya rivers with recent anthropogenic activities. However, if hybridization is a recent phenomenon precipitated by engineering of the Mississippi and Missouri river channels, it would present a threat to the survival of pallid sturgeon through genetic swamping if the hybrids are fertile, and through competition for limited habitat (Carlson et al. 1985).

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of the consequences of hybridization depends on hybrid viability. Hybridization can occur in fish if spawning habitat is limited, if many individuals of one potential parent species lives in proximity to a limited number of the other parent species, if spawning habitat is modified and rendered intermediate, if spawning seasons overlap, or where movement to reach suitable spawning habitat is limited (Hubbs 1955). Any of those conditions, or a combination of them, could be causing the apparent breakdown of isolating mechanisms that prevented hybridization between these species in the past (Keenlyne et al. 1994). Hartfield and Kuhajada (2009) examined three of the five original specimens used to describe the pallid sturgeon and found that the character indices currently used to distinguish the fish identify some of the type specimens as hybrids. They also noted purported hybrid reports were highest in the least altered habitats within the species range

(Lower Mississippi River), and lowest in the most severely altered areas (Upper and Lower Missouri River). In conclusion, they stated they found no evidence directly linking habitat modification and hybridization particularly in the Mississippi River and no evidence that hybridization constitutes an anthropogenic threat to the pallid sturgeon.

Microsatellite studies (Tranah et al. 2004; Heist and Schrey 2006a) have provided some genetic evidence for hybridization between pallid and shovelnose sturgeon in the Missouri, Mississippi, and Atchafalaya Rivers. However, it is currently unknown if all morphologically intermediate sturgeon are hybrids, if some hybridization is natural, or if hybridization is a result of habitat or other environmental changes. If these intermediates represent the effect of natural intercrossing between the monophyletic pallid sturgeon and shovelnose sturgeon due to anthropogenic influences, then intercrossing may indeed be perceived as a threat to the species. However, if genetically intermediate sturgeon are the result of sympatric speciation and a polyphyletic evolutionary origin of pallid sturgeon (e.g., as suggested by Campton et al. 2000 as a competing, alternative hypothesis), then intermediate fish could be considered a natural occurrence, the previously-identified mechanisms suggested for causing hybridization may not exist, intermediate sturgeon are a component of natural evolutionary processes, and hybridization does not pose a threat to the species.

Contaminants

Although more information is needed, pollution is also likely an exacerbating threat to the species over much of its range. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900s and continued to increase as populations grew and additional industries were established along the river. Due to the presence of a variety of pollutants, numerous fish-harvest and consumption advisories have been issued over the last decade or two from Kansas City, MO, to the confluence of the Mississippi River. That distance represents about 45 percent of the pallid sturgeon's total range. In 2000, the State of Mississippi formed a Fish Advisory Task Force to develop procedures regarding fish consumption advisories for organochlorine compounds and other contaminants. A review of USGS National Water Quality Assessment Program (NAWQA) data showed a persistence of elevated organochlorine levels and levels of DDT in fish tissue that are higher than other sampled parts of the Mississippi River study area. As a result, the state has issued its own preliminary advisories based on USEPA guidelines (USGS NAWQUA).

PCBs, cadmium, mercury, and selenium have been detected at elevated, but far below lethal, concentrations in tissue of three pallid sturgeon collected from the Missouri River in North Dakota and Nebraska. Detectable concentrations of chlordane, DDE, DDT, and dieldrin also were found (Ruelle and Keenlyne 1994). The prolonged egg maturation cycle of pallid sturgeon, combined with bioaccumulation of certain contaminants in eggs, could make contaminants a likely agent adversely affecting eggs and embryo, and development or survival of fry, thereby reducing reproductive success.

In examining the similarities and differences between shovelnose and pallid sturgeon, Ruelle and Keenlyne (1994) concluded that, while the shovelnose may not meet all the traits desired for a surrogate, it may be the best available for contaminant studies. Conzelmann et al. (1997) reported that trace element concentrations in Atchafalaya River shovelnose sturgeon were generally higher

than in shovelnose sturgeon from other areas. Trace elements, many of which are essential for sustaining life, can adversely affect reproduction, development, and may ultimately be lethal if concentrations are excessive. Most trace element levels were unremarkable; however, cadmium, copper, lead, and selenium concentrations were elevated in ORCC samples and may warrant concern (Conzelmann et al. 1997).

Conzelmann et al. (1997) also reported that organochlorine pesticide (OC) concentrations are the main environmental concern in Louisiana's shovelnose sturgeon, and consequently, in the pallid sturgeon. Shovelnose OC concentrations were generally greater than were observed in fishes from other areas, and ORCC shovelnose sturgeon toxaphene levels were elevated compared to the National Contaminants Biomonitoring Program. Toxaphene possesses known carcinogenic, teratogenic, xenotoxic, and mutagenic properties; can cause suppression of the immune system; and may function as an endocrine system imitator, blocker, or disrupter (Colburn and Clements 1992). Those factors make toxaphene the greatest OC concern in ORCC shovelnose sturgeon and, by extension, the ORCC pallid sturgeon (Conzelmann et al. 1997). Further investigations are needed to identify contaminant sources in the Mississippi and Atchafalaya Rivers and to assess the role, if any, of contaminants in the decline of pallid sturgeon populations.

Entrainment

Another issue that is negatively impacting pallid sturgeon throughout its range is entrainment into water intake structures. The loss of pallid sturgeon associated with water intake structures has not been accurately quantified. The U.S. Environmental Protection Agency published final regulations on Cooling Water Intake Structures for Existing Facilities per requirements of Section 316(b) of the Clean Water Act. The rule making was divided into three phases. However, only Phase I and II appear applicable to inland facilities; Phase III applies to coastal and offshore cooling intake structures associated with coastal and offshore oil and gas extraction facilities. The following rule summaries are based on information found at the website <http://www.epa.gov/waterscience/316b/>. Phase I rules, completed in 2001, require permit holders to develop and implement techniques that will minimize impingement mortality and entrainment. Phase II, completed in 2004, covers existing power generation facilities that are designed to withdraw 50 million gallons per day or more with 25% of that water used for cooling purposes only. This rule, implemented through National Pollutant Discharge Elimination System permits, is intended to minimize negative affects associated with water cooling structures.

Section 316(b) of the Clean Water Act requires the U.S. Environmental Protection Agency to insure that aquatic organisms are protected from impingement or entrainment. As part of the Phase II ruling, some power plants have begun conducting required entrainment studies. Preliminary data on the Missouri River suggests that entrainment may be a serious threat that warrants more investigation. Initial results from work conducted by Mid-America at their Neal Smith power facilities found hatchery-reared pallid sturgeon were being entrained (Jordan in litt. 2006, Ledwin in litt. 2006, Williams in litt. 2006). Over a 5-month period, four known hatchery-reared pallid sturgeon have been entrained, of which two were released alive and two were found dead. Ongoing entrainment studies required by the Clean Water Act will provide more data on the effects of entrainment. However, addressing entrainment issues may not occur immediately and continued take of hatchery-

reared or wild pallid sturgeon will limit the effectiveness of recovery efforts. In addition to cooling intake structures for power facilities, concerns have been raised regarding entrainment associated with dredge operations and irrigation diversions. Currently little data are available regarding the effects of dredge operations. However, the Corps' St. Louis District, and the Dredging Operations and Environmental Research Program have initiated work to assess dredge entrainment of fish species and the potential effects that these operations may have on larval and juvenile *Scaphirhynchus*. Data for escape speed, station-holding ability, rheotaxis and response to noise, and dredge flow fields are being used to develop a risk assessment model for entrainment of sturgeon by dredges. Entrainment has been documented in the irrigation canal supplied by Intake Dam on the Yellowstone River (Jaeger et al. 2004) (see also 2.3.1.5. Habitat or ecosystem conditions [e.g., amount, distribution, and suitability of the habitat or ecosystem]). Given that entrainment has been documented to occur in the few instances it has been studied, further evaluation of entrainment at other water withdrawal points is warranted across the pallid sturgeon's range to adequately evaluate this threat. Entrainment of pallid sturgeon stocked in the Mississippi River into the Atchafalaya River via the ORCC has been documented by the capture of a tagged stocked sturgeon that was released into the Mississippi River.

Biological Opinions which allow the take of a pallid sturgeon(s) also represent a factor that should be considered when examining factors that could have an influence on the pallid sturgeon population. The table below presents all completed Biological Opinions for the Lower Mississippi River.

OPINIONS[1] **(yr/number)**	**SPECIES**	**NUMBERS**[2]	**HABITAT**[3]	
			Critical Habitat	**Habitat**
2003 Log: 4-7-3-702	Biological Opinion on Natchitoches National Fish Hatchery's Collection of Endangered Pallid Sturgeon from Louisiana Waters for Propagation and Research	90 adults/season for 5 season (harassment) 8 adults/season for 5 seasons (death)	NA	NA
2004 Log: 4-7-04-734	Modification to revise 2003 IT estimates for BO (4-7-3-702) on Natchitoches National Fish Hatchery's Activities	120 adults/season for 5 season (harassment) 14 adults/season for 5 seasons (death)	NA	NA
2004 Log: 4-7-04-1456 (also 4-7-05-22)	Programmatic Biological Opinion Addressing Effects of the Southeast Region's Section 10(a)(1)(A) Permitting on the Pallid Sturgeon (5-	28 adults in captive propagation/year (death) 2,500 to 15,000 captive year-class 90 days old or older (one-time loss-death) 200 larval/juvenile/year sampling	NA	NA

	years)	(death) 3, 5-inch or greater fish/year netting (death or injury) 3 fish/year external tagging (death or injury) 1 fish/year transport (death) 5 fish/year radio-tracking (death or injury)		
2009 Log: 43440-2008-IE-3120,FA-43440-2009-FE-2777	Emergency Consultation for the operation of the Bonnet Carre Spillway and it's effects on entrained pallid sturgeon	14 Pallid sturgeon were captured in the spillway and incidental take occurred in the form of harassment. The Service estimated that a take of 92 pallid sturgeon occurred.	NA	NA

[1] Biological opinions within the action area.
[2] Incidental take permitted over 5-year period.
[3] No critical habitat has been designated for the pallid sturgeon.
[4] The original estimates for the 2003 BO are not included as they were revised in 2004.
[5] Incidental take of captive larval fish for NFH subsequently cover in the programmatic BO so is only counted once. NFH is no longer undertaking propagation.

Analysis of the species/critical habitat likely to be affected

The action under consideration is the construction and operation of the Small Diversion at Convent/Blind River This opening will allow Mississippi River waters to flow through the control structure and into an outfall channel leading to swamp. This will affect all life-stages of pallid sturgeon in the Mississippi River in the vicinity of the structure, because they could become entrained and it is not known if they are willing or able to move back through the structures to the river to complete essential life processes.

ENVIRONMENTAL BASELINE

Status of the species within the action area

The action under consultation occurs within the Lower Mississippi River area of RPMA 5. The range-wide status of the pallid sturgeon within the action area is discussed within the **Status and Distribution** section above. As noted in that section, Pallid sturgeon population size has not been quantitatively defined within the action area, however, collection efforts over the past decade show the species is widespread and not uncommon in the lower Mississippi River (LMR) from Rmi 954 to Rmi 100. Efforts to collect river sturgeon in the LMR have been relatively limited over the past decade, particularly considering the scope and scale of the available habitat. However, these collections have shown that pallid sturgeon occur throughout most of the 950 mile reach of the LMR

(Bettoli et al. 2008, Killgore et al. 2007a, Schramm and Mirick 2009, Hartfield, pers. obsv. 2001-2010), and the 200 mile reach of the Atchafalaya River (Constant et al. 1997, Herrala and Schramm 2010). Collections of pallid sturgeon in the LMR include over 200 individuals collected between the mouth of the Ohio River and Head of Passes (Killgore et al. 2007a; Hartfield, in litt. 2001-2010; Schramm and Kuntz 2010), ranging from 0 – 20 years of age (50 to >800 mm FL) (Killgore et al. 2007b, Hartfield pers. obsv. 2010).. Over 600 pallid sturgeon ranging from 400 to >1000 mm FL have been collected from the Atchafalaya River distributary of the LMR (U.S. Fish and Wildlife Service 2007, Dean pers. comm. 2009).

Although pallid sturgeon population size in the LMR has not been quantified, available data suggest a substantial population when compared to fishing effort and fish species composition. Killgore et al. (2007a) found that pallid sturgeon comprised 2.2% of fish captured on winter set trotlines, and ranked 5th in frequency of capture out of 22 species collected. Recaptures of pallid sturgeon are also rare in the LMR. Killgore et al. (2007a) reported only 5 pallid sturgeon recaptures over 7 years. In another study that conducted 2 years of pallid sturgeon collection and telemetry efforts in a 30-mi reach of the Mississippi River, only a single pallid recapture occurred out of >60 pallid collected, even though telemetry results indicate most pallid sturgeon have remained within the sample reach (Schramm and Kuntz 2010).

There is also evidence that the LMR pallid sturgeon population can sustain removal of substantial numbers of individuals from the population. Bettoli et al. (2008) conservatively estimated that 2% of the commercially harvested sturgeon in the Tennessee reach of the LMR were pallid sturgeon (169 females over two seasons). Commercial harvest for sturgeon caviar has occurred annually in the Tennessee and Missouri reaches of the LMR for more than two decades. While baseline data on LMR pallid populations is lacking, the persistence of the species following more than two decades of harvest pressure on mature pallid sturgeon females, suggests the population is relatively robust. Additional evidence of population robustness has recently been noted in association with evidence of persistent and periodic entrainment losses of LMR pallid sturgeon. During an emergency opening of the Bonnet Carre Spillway during 2008, the Service estimated up to 92 pallid sturgeon were injured or killed due to entrainment. Bonnet Carre has been opened three times since the species was listed (1994, 1997, 2008). Other diversion structures that have been operating for one to five decades, are known (Old River Control Complex and Bonnet Carre) or suspected (Caernarvon and Davis Pond) to entrain pallid sturgeon. While episodes of commercial harvest or entrainment constitute substantial periodic or continuous localized loss of individuals to the pallid sturgeon population within the specific stream reaches, scientific collection efforts indicate the species is persisting within the commercially harvested and diversion reaches, and is not uncommon in the LMR (e.g., Killgore et al. 2007 a,b; Schramm and Kuntz 2010).

Factors affecting species environment within the action area

Historically, the section of the Mississippi River bordering the action area would have had many sand bars and side channels that would have been usable habitat for pallid sturgeon. This section of the river has been heavily modified for the purposes of navigation and has few of these natural features left. Contaminants in water, sediments, or prey species could float down river and be in the vicinity of the action area which could affect any pallid sturgeon present.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect, and its interrelated and interdependent activities effects of the proposed action on the species in the action area.

Factors to be considered

A stage discharge relationship for the Mississippi River at the diversion site could not be located and most likely is not available. Typical discharge rates for the Mississippi River at the time of maximum diversion (3000 cubic feet per second [cfs]) are in the range of 500,000 cfs therefore, the maximum diversion flow represents approximately 0.6 percent of the flow in the river. For the range of river stages from 4 to 11 feet, the river's cross section at the diversion point (River Mile 162) varies from 110,000 to 130,000 square feet. In general the cross section of the diversion culverts (300 square feet) is less than 0.25 percent of the Mississippi River's cross section. At a stage of 11 the river at it deepest point is 130 feet.

The diversion is planned to be operated continuously between March through October each year. The actually flow rate of the diversion will depend on numerous factors including tidal variations, swamp water requirements, local rainfall events, Mississippi River stage and other environmental elements. The maximum discharge is anticipated to occur approximately 53 percent of the time. Examination of discharge data for the Caernarvon Freshwater Diversion between 2001 and 2010 indicates that it discharges below its maximum capacity from approximately 73 to 90 percent of the time.

At a distance of 30 feet from the culvert entrance the diversion's velocity is approximately 2.5 fps. The velocity, however, through the culvert at maximum flow is approximately 10 fps and would occur approximately 53 percent of the time. After the flow passes through the culverts it enters a stilling basin that is part of the transmission canal. The transmission canal is a trapezoid earthen channel with typical velocities of 1.5 to 2.0 fps. The highest velocities would occur within the culverts, however, approximately 25 percent of the time velocities within the culverts are anticipated to be at or less than 6.7 fps; a speed at which sub-adults could potentially swim against. Velocities however, within the transmission canal could be slow enough that sturgeon could fail to exhibit rheotaxis (<1.6 fps) and swim down the transmission canal. Between 2002 and 2010 velocities within the Davis Pond Diversion Outfall Canal greater than 3 fps occurred less than 1 percent of the time. Nine of 12 tagged sturgeon released in that 11,000 feet long canal eventually ended up at the end of that canal in the ponding area. However, sporadic trips by sturgeon from the ponding area back into the outfall canal have been recorded with up to 4 months passing between such trips.

The floor of the culverts will be approximately level with both the inlet and transmission canal. Shovelnose and lake sturgeons have been documented to swim through the Upper Mississippi River locks and dams (Brooks, et al. 2009). Shovelnose sturgeon have been documented to swim over the Intake Diversion Dam on the Yellowstone River; the downstream side of this dam is basically a slope. Conversely, pallid sturgeon are not known to swim upstream over this structure. White and Meddford (2002) documented only 2 of 16 shovelnose sturgeon crossing over a 21-inch vertical

baffle in velocities ranging from 0.8 to 4 fps.

Attempts to correlate spillway operation dates, duration or volumes of flow with the entrainment of lake sturgeon (*Acipenser fulvescens*) through the Little Long Generating Station Facilities were unsuccessful (Seyler et al., 1996), however, Adams et. al. (2007) utilized volumes to determine potential number of green sturgeon (*Acipenser medirostris*) entrained. Seyler et al., (1996) reported lake sturgeon undertaking post spawning downstream migrations are entrained through a spillway that diverts excess flows around the hydropower generating station. Annual recovery and relocation efforts were reported to be carried between 1990 and 1995. Recovery and relocation of green and white sturgeon has also been conducted at water diversions off the Sacramento River. Entrainment of more sturgeon was associated with higher flows; however uncertainty in the data has confounds any further data interpretation (USBRC 2008).

Analyses for effects of the action

Direct effects are those direct or immediate effects of a project on the species or its habitat. Indirect effects are those that are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Direct effects of the diversion are limited to the entrainment of all natant life stages of the pallid sturgeon. Indirect effects in the form harassment (i.e., affect breeding) would be associated with the future loss of progeny from sturgeon that could never return to the river to spawn. The diversions are not anticipated to adversely impact water quality or any habitat utilized by pallid sturgeon for spawning, nursery, or feeding in the Mississippi River. However, habitat conditions in the canals downstream of the diversions outflow canal would not be conducive (i.e., higher water temperatures, lower dissolved oxygen) to the long-term survival of larval and young-of-year (YOY) resulting in take via harm (i.e., mortality). It is not known how long sub-adult and adult sturgeon could survive in the outflow canals; tagged sturgeon within the Davis Pond Outfall Canal have survived close to 6 months. However, since no tagged sturgeon have successfully returned to the river it is anticipated that those sturgeon will remain entrained for the remained of their lives and would not contribute to the spawning population.

Effects of the action on larval, fry, and juvenile fish

No larval or YOY *Scaphirhynchus* were collected by Nichols State University (Schultz 2010) in the outfall areas of any diversion or freshwater siphon, however, the collection of larval sturgeon within any habitat typically requires considerable efforts which often only results in the capture of a few specimens (Quist 2004). Evidence of larval and YOY *Scaphirhynchus* usage of this river reach has been documented since 1985, with recent data collections indicating a greater abundance than previously thought (Constant et al. 1997, ERDC 2010; See also Age, Growth and Reproduction).

Kynard et al. (2002) and Braaten et al. (2008) reported long larval drift times. Pallid sturgeon larvae were determined to travel at approximately the mean river velocity for the first 11 days after hatching and then slightly slower for the next 6 days because of the sturgeon's transition to a benthic life stage. Distances covered during larval drift are affected by water velocity, however water temperature can affect larval/fry development rates (warmer temperatures increase development rates) which would

also affect drift distances. Higher water velocities are experienced with larger flood events (U.S. Army Corps of Engineers 2009). Water velocities in the Mississippi River south of Baton Rouge (Rmi 231) have been documented to range from 4.4 fps to 1.5 fps depending on the discharge. South of Baton Rouge the river channel is larger and the slope of the river decreases, thus velocities are slower than those above Baton Rouge (Wells 1980). Surface water velocities measured north of Baton Rouge range from 2.9 fps to 5.6 fps for discharges of 200,000 cfs to 1million cfs, respectively. The Corps has computed surface water velocities of the Mississippi River at New Orleans (Rmi 107; approximately 56 mile downstream). For the highest mean monthly river stage at New Orleans the mean river velocity would be 6.1 fps at the surface and 5.4 feet per second at 60 percent of the rivers depth. If the most southern pallid sturgeon spawning sites are the previously hypothesized gravel bars located in the vicinity of Vicksburg (Rmi 435) approximately 272 miles upstream of the structure (Hartfield personal comment) and a mean water velocity of 5.4 fps (3.7 miles per hour) is assumed to occur from Vicksburg to the diversion, larvae could travel approximately 88 miles per day if entrainment into eddies, the batture and other areas is assumed not to occur and could reach the diversion within 3 days. Sturgeon spawning further downstream would be susceptible to entrainment at an even sooner time.

The recent capture of *Scaphirhynchus* larvae and post-larvae in the Mississippi River during fall months, as well as spring, could be interpreted as an extended season or a second spawn in the lower latitudes of distribution (Paul Hartfield, USFWS, per. comm. 2006). Ongoing sampling efforts by ERDC (2010) documented young-of-year (< 56 days old) sturgeon throughout the entire summer.

It is probable that larval and juvenile fish will encounter the flows of the diversion. The lack of any of those life stages being captured within in the outfall area of any existing diversion or siphon and the still relatively few records from within the river precludes even making a reasonable assumption as to the number of such sturgeon that would be likely to be entrained. Because of the believed inability of such small sturgeon to swim against velocities likely to be encountered within the culverts it is not likely that any of those size sturgeons could return to the river. Nor is it believed that all would survive the outfall areas where higher temperatures, lower dissolved oxygen levels and slow currents exist; survival within outfall canal may be possible as evidenced by the survival of older sturgeon in the Davis Pond ponding area, but the duration of the survival is unknown. Nonetheless, failure to capture any of these size sturgeons (using appropriate gear) indicates that any entrained may have been swept downstream from the immediate outfall or left the outfall areas as velocities decreased. Considering the above factors, the Service believes that an unquantifiable number of larval could possibly be entrained and possibly a greater number of juveniles but still not a significant number of either life stage. However, almost all of those life stages that would be entrained would probably experience mortality.

Effects of the action on sub-adult and adult

The Service caught, tagged with sonic tags and released 17 *Scaphirhynchus* in the Davis Pond Outfall Canal. Six stationary receivers were positioned along the outfall canal and one in the river to detect sturgeon movement and determine their ability to navigate back into the river. Of the tagged sturgeon, four are believed to have lost their tags, three are still within the outfall canal and nine are

in the ponding area. Sturgeon have moved freely within the outfall canal and between the ponding area and canal with trips between the later two areas occurring over several months. It was anticipated that sturgeon might be able to swim back to the river at lower river stages. However, at the date of the last data collection the river stages had not decreased to levels that would have reduced the velocity through the structure sufficient to allow this to occur; monitoring is ongoing to provide additional data.

Sampling by ERDC (2010) found that the ten-mile river reach (Rmi 179 -160) where the diversion is located produced the second highest number of pallid sturgeon caught using trotlines and is equal in number to the next downstream reach with both producing the second highest number of sturgeon caught by all sampling gear combined. While sampling effort varied by 10-mile river reaches this reach had the second highest sampling effort of all gears combined. Sampling from July 2009 to June 2010 by Nicholls State University (Schultz 2010) in the Davis Pond Outfall Canal captured 3 shovelnose sturgeon and one pallid. The Davis Pond Freshwater Diversion can discharge up to 10,650 cfs, while the Convent/Blind River maximum design discharge is 3,000 cfs.

Sturgeon swimming burst speeds should allow them to swim against the velocities in the structure at lower river stages. Burst speeds, however, cannot be maintained for long distances and the length of the culvert is approximately 320 feet. Therefore, any sub-adult or adult sturgeon that are entrained may only have a very limited opportunity to swim against slower velocities and migrate back to the river, thus most sturgeon that are entrained may not be likely to return to the river.
It is believed that sturgeon located on the batture near the diversion entrance channel when it first opens or when flows are significantly increased would most likely be entrained. As additional fish move into the flooded batture while the structure is open, some of those could also be entrained. Emigration to downstream channels could occur as in-stream velocities decrease downstream of the structure.

With assistance from ERDC the Service utilized a hydrology-based method to determine the number of sturgeon entrained during the opening of the Bonnet Carre Spillway. The hydrology method is based upon a proposed relationship between the volume of water diverted and the number of sturgeon entrained. The hydrology methodology is similar to those recommended to determine entrainment by power plants (Goodyear 1997). However, methods proposed by Goodyear could not be used because insufficient information for some model parameters. While the method below is similar to that used to determine take for the Bonnet Carre opening, changes were made based more recent information and data obtained from the operating Davis Pond Freshwater Diversion. In the take determination for the Bonnet Carre the ratio of pallid to shovelnose in the river was utilized in the calculations. However, for this determination the ratio was taken from sturgeon captured in the operating diversion. While the ratios are fairly close (1.2 for the river and 1:4 for the diversion) the differences could possibly be explained by habitat usage and behavioral differences when sturgeon encounter areas of higher velocities. Use of pallid to shovelnose ratio to determine take was also previously utilized in the Final Biological Opinion for the Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study (2004). The methodology currently utilized represents the Service's best efforts to determine entrainment, however, the Service recognizes that as more information about pallid sturgeon life history, behavior, and abundance becomes available these methods may need to

be revised or totally replaced.

The Service based the effect of the action on sub-adult/adult pallid sturgeon on the following assumptions:

(1) All fish entrained will not return to the river;
(2) Adult pallid and adult shovelnose sturgeon will be entrained at the same approximate pallid to shovelnose ratio that has been found to occur in the Davis Pond Outfall Canal;
(3) With increases in the duration and volume of water diverted additional fish are entrained; entrainment is directly proportional to the duration or volume of diverted water;
(4) All tagged fish in the vicinity of sampling efforts had equal probability of being captured; and
(5) The percentage of tagged sturgeon captured of all tagged sturgeon available for capture in the Davis Pond Outfall Canal represents the effectiveness of sampling efforts (i.e., percent success) in determining the total number of sturgeon entrained.

The Service recognizes that the assumptions made may not be totally accurate for all sturgeon entrained but believes that this represents a scenario that is most likely to be the response of a majority of the sturgeon that will be entrained and therefore represents utilization of the best available information. Because the diversion is assumed to be operated at full capacity this estimate is conservative in terms of protecting the species by calculating a potential maximum number of entrained fish.

The Service calculated the maximum number of potentially entrained sub-adult/adult pallid sturgeon in the following manner: (1) From July 2009 to June 2010 there were 20 tagged sturgeon located in the Davis Pond Outfall Canal in the vicinity of sampling efforts being conducted by Nicholls State University on days that they sampled. During this time 2 tagged sturgeon were captured (i.e., 10 percent successful recapture rate) and 4 untagged sturgeon were captured with one being a pallid sturgeon (i.e., 25 percent):
(2) The ten percent successful recapture rate when applied to the 4 untagged sturgeon captured would estimate the number of entrained sturgeon to be 40 of which 25 percent are pallid sturgeon (i.e., 10 fish);
(3) The total discharge through the Davis Pond structure during the sampling period (9.472×10^{10} cubic feet [cf]) was divided by the estimated number of pallid entrained (i.e., 10) to determine the amount of volume discharged per each entrained fish (9.472×10^{9} cf);

(9.472×10^{10} cf)/10 entrained pallid sturgeon = 1 pallid sturgeon entrained per 9.472×10^{9} cf
and
(4) The proposed maximum discharge for each day was summed to determine the total volume of water diverted during one year of the structures operation (i.e., 6.32×10^{10} cf). This total volume was divided by the volume of water discharged per each entrained fish (9.472×10^{9} cf) to calculate the possible maximum number of fish entrained (see below)

3,000 second-day-feet x 244 days x 86400 seconds per day = 6.32×10^{10} cf diverted in 1 year

6.32x 10^{10} *cf/9.472x* 10^{9} *cf = 6.68 fish per year (rounded to 7)*

Over the 50 year period of analysis that the Corps must examine project impacts and benefits it is estimated that approximately 350 pallid sturgeon would be entrained.

Lacking a population model or sufficient data to develop such a model the Service previously examined age frequency information for shovelnose and pallid sturgeons (Killgore et al., 2007, Morrow et al., 1998) to determine the likelihood that the 2008 Bonnet Carre opening jeopardized the continued existence of the pallid sturgeon. The following discussion presents that analysis to inform the assessment of this proposed project on pallid sturgeon. The analysis has been modified to present information from the Bonnet Carre opening as compared to the proposed discharge from the Convent/Blind River Diversion.

Bonnet Carré Comparison

While there are behavioral and biological differences in all life stages between the two species, similarities exist that would allow inferences of population effects to be made from shovelnose sturgeon age frequency tables and extrapolated to the pallid sturgeon population with appropriate caution. Age frequency tables produced by Morrow et al., (1998) and Killgore et al., (2007) for shovelnose and pallid sturgeon, respectively, combined cohorts of the same age over several years (3 years for shovelnose and 5 years for pallid) potentially masking any minor effects of the openings. However, examination of the range of cohorts that would be impacted by past diversions may be informative even though the small number of sturgeon in those cohorts may make such speculations tenuous. Cursory examination of age frequency by Killgore et al., (2007) did not show any differences in age class strengths for pallid sturgeon.

Gear selectivity (i.e., primarily trotlines) adds an additional complication to the use of age frequency tables to determine any possible effect of Spillway openings. Shovelnose sturgeon were fully vulnerable to trotlines at age 7, while pallid sturgeon were fully vulnerable at age 11 (Morrow, et al., 1998, Killgore et al., 2007). Therefore, estimates of sturgeon abundance or cohort strength below those ages would include that bias. In addition, the data for the shovelnose study (Morrow et al, 1998) was collected in the vicinity of Rosedale, MS (Rmi 585), but data for the pallid sturgeon study (Killgore et al, 2007) was collected from approximately New Orleans, LA, (Rmi 95) to the Chain of Rocks (Rmi 954). While long distant migrations for both sturgeon species has been documented (See Movement Section) the probability that sturgeon collected from these areas were likely to have encountered the previous openings of the Spillway is unknown. Because data for the two species were collected from two different time periods that did not overlap, the effect of each previous diversion could not be compared between the species.

Examination of the shovelnose cohort range that would have been spawned during the 1994 and 1979 openings does not contain a sufficient range in cohorts to make any determination of effect but does show some recruitment did occur (Table 2; see date below figure explanation). However, examination of the cohort that would have been effected by the 1983 operations appears to show a possible loss of a cohort. Without additional data or further investigation it is not known if this represents an actual loss of a year class and if the loss is a result of the operation of the structure coupled with the effects of the flood and other factors such as commercial harvesting that was

allowed at that time or just a product of lower abundance of older age classes (Jack Killgore personal comment). The range of shovelnose cohorts that would have been approximately the same size during the 1983 operation as those entrained in the 2008 do not appear to be significantly reduced. Age classes subsequent to 1983 are well represented, including those that would include progeny of a 1983 cohort, indicating yearly recruitment occurred since 1983. Based on this limited information it appears possible that the 1983 opening could have effected the 1983 year class but overall any effect does not appear to have impacted future cohort abundance.

Table 2.

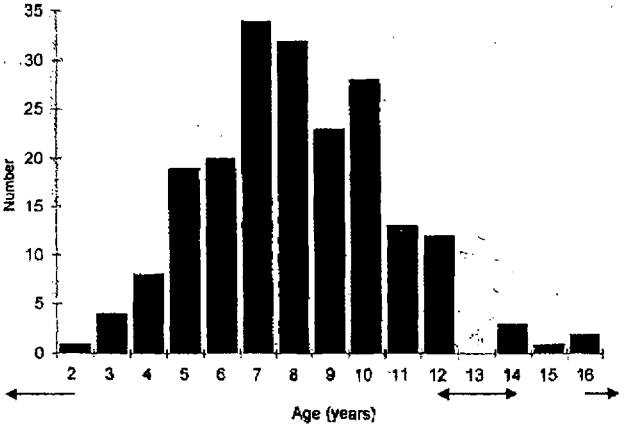


FIGURE 2.—Age frequency of 200 lower Mississippi River shovelnose sturgeon captured between 15 October 1995 and 12 March 1997.

Year of Opening	1994	1983	1979

The pallid sturgeon age distribution table (Table 3) has sufficient cohort ranges to examine the possible effects of the 1997, 1994, and 1983 openings. However, the examination was complicated by the longer sampling period which lengthens the number of years that cohorts could have been present during the diversion. Examination of years when spawned fish would have been present during the diversion does not present any discernable impact. As with the shovelnose data, the 1983 cohort range also includes a year that had no individuals captured, however, other cohorts in the same range do not show any discernable effect. Also like the shovelnose data, without additional data or further investigation it is not known if this represents an actual loss of a year class and if the loss is a result of the operation of the structure coupled with the effects of the flood and other factors or just a product of lower abundance of older age classes (Jack Killgore personal comment). Examination of cohorts that would have been of the size range of pallid sturgeon entrained in the 2008 (24 to 34 inches) opening did not show any discernable negative effect from the 1994 and 1997 openings. No

sturgeon large enough to be present in the 1983 opening were captured; in addition, the slower growth rates of older sturgeon could complicate the use of that size fish for this type of analysis. Comparison of the 1997, 1994 and 1983 days of operation suggest that the 1983 operation could have extended into the shovelnose and pallid sturgeon spring spawning season which means that the river discharge and the operation of the Bonnet Carre could have impacted that cohort size. Because the 2008 opening was of a shorter duration and diverted less water (Table 4) than the 1997, 1994, and 1983 openings the Service believed that any impact from the opening would be similar but less than that of the 1997 operation. Examination of age distribution table does not show any discernable impact to the strength of any pallid sturgeon cohort from the 1997 opening. Furthermore, the age distribution of both species (Tables 5 and 6) indicates ongoing recruitment of juveniles and greater abundance (possibly survivorship) of all age classes but especially of spawning age individuals within the Lower Mississippi River (Table 3). While the cumulative discharge from the Convent/Blind River may exceed the Spillways discharge the Convent/Blind River discharge is based upon diverting the maximum flow every day. In addition, the small localized area of potential entrainment associated the diversions inlet canal (160 feet wide) when compared to the Bonnet Carre's approximately 7,700 wide opening could result in a much smaller chance of sturgeon encountering entraining flows. This coupled with the relatively few recaptures of tagged pallid sturgeon (indicative of a relatively large population) and the increased number of larval and juveniles being captured in the Lower Mississippi River leads the Service to believe that the proposed operation of the small diversion at Convent/Blind River is not likely to significantly affect the pallid sturgeon population.

Table 3.

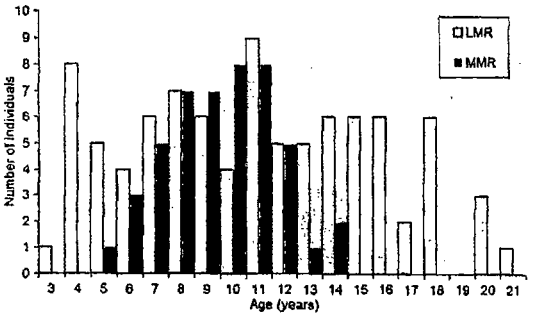


Fig. 1. Age distribution of pallid sturgeon in the lower Mississippi River (LMR) and middle Mississippi River (MMR)

Year of Opening	1997	1994	1983

Table 4. BONNET CARRE SPILLWAY DISCHARGE COMPARED TO CONVENT/BLIND RIVER DIVERSION				
YEAR	OPENED	CLOSED	DAYS OPERATED	TOTAL VOLUME CFS
1979	17 APR	31 MAY	45	5.2099×10^8
1983	20 MAY	23 JUN	35	5.927×10^8
1994	16 MAY	27 MAY	12	
1997	17 MAR	17 APR	31	4.1221×10^8
2008	11 APR	8 MAY	28	2.6368×10^8
CONVENT/BLIND RIVER	MARCH	OCT	244	6.32×10^{10}

642

Ongoing studies have demonstrated the greater abundance of pallid sturgeon within the southern portion of the Lower Mississippi River than in the more northern portions of its range. The ratio of pallid to shovelnose sturgeon from Rmi 179 to 80 ranges from 1:1 to 1:3 while a ratio of 1:22 has been tentatively calculated for Rmi 319 to 300 (ERDC 2010). Pallid sturgeon were the fifth most abundant fish based on sampling from the middle and lower Mississippi River (Killgore et. al, 2007). Recent data collected from the Lower Mississippi River indicates that they rank sixteenth in relative abundance (ERDC 2010).

Species' response to a proposed action

The Pallid Sturgeon Lower Basin Recovery Workgroup has identified information gaps essential to the consultation and recovery processes in the Lower Mississippi River Basin. These include: relative abundance of pallid sturgeon, demographics, feeding habits, habitat use, hybridization ratios, presence of fish diseases in the wild, population anomalies, and reliable separation and identification of pallid sturgeon, shovelnose sturgeon, and hybrids. A more recent information gap identified by the Lower Basin Work Group is the entrainment of adult and juvenile pallid sturgeon through the ORCC and potential entrainment through the existing coastal wetland restoration diversions. While recent publications have contributed to filling some of the former data gaps (e.g., Killgore et al., 2007, Hoover et al., 2007) incomplete knowledge of those areas remains. Therefore, the sturgeons' response to encountering the diversion flows (e.g., avoidance, actively sought) is unknown, which can affect the number of sturgeon believed to be adversely affected by the structures operation. There are several hypotheses on possible sturgeon reactions to entrainment that must be considered to determine project impacts: (1) only sturgeon located near the structure during its opening are subject to the possibility of entrainment(i.e., no increase in sturgeon entrained because of active avoidance); (2) sturgeon may actively swam into the structure seeking velocity refuge from main-channel flows and/or seeking food sources on the batture and/or in a perceived secondary channel (i.e., diversion); or (3) sturgeon are passively or actively entrained during down-river migration. It is likely that the reaction to a diversion would vary with the life stage of the sturgeon, and entrainment may be due to a combination of any of the above hypotheses.

As discussed previously, it is anticipated that approximately 7 pallid sturgeon per year will be lost from the population via entrainment through the diversion structure. In the context of larval, fry and juvenile fish, it is anticipated that an unspecified number of pallid sturgeon will be entrained and also lost from the population.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

No additional State, local, and private actions have been identified in addition to the ongoing threats previously described in the Status and Distribution sub-section of STATUS OF THE SPECIES/CRITICAL HABITAT. These human-caused threats include industrial development

and associated intakes and discharges, electrical generating facility construction and associated intakes and outfalls, dredging for sand, incidental harvesting, and poaching. The indirect effects of those actions include loss of habitat and water quality degradation. Such activities are likely to continue throughout the action area.

Future major construction activities in the Missouri and Mississippi River basins, along with new point-sources of pollution discharge would presumably have a Federal nexus (for example, they require Federal funding or permitting) and their potential adverse effects to pallid sturgeon would require section 7 consultation under the Act. Major construction activities in the Lower Mississippi River could include several other proposed coastal restoration freshwater diversions south of Baton Rouge and the continued operation of the Bonnet Carre Spillway and the ORCC; however, because they would all have a Federal nexus they would also not be considered as cumulative effects as described in the previous paragraphs.

CONCLUSION

After reviewing the current status of the pallid sturgeon, the effects of the diversion and its cumulative effects, it is the Service's biological opinion that operation of that structure is not likely to jeopardize the continued existence of the species. No critical habitat has been designated for the pallid sturgeon; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Endangered Species Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The following is a summary of the estimated incidental take previously discussed in the **Analysis for effects of the action** section. The Service believes incidental take in the form of harm (mortality associated with entrainment behind the structure) and harassment (loss of potential spawning adults) will result from the operation of the small diversion at Convent/Blind River. It includes.

The Service estimated incidental loss (by death or serious injury) associated with entrainment behind the structure of 7 pallid sturgeon (sub-adults and adults) per year with a total of 350 fish entrained over the life of the project. The Service anticipates the incidental take (direct death) of an unknown number of larval/juvenile pallid sturgeon due to entrainment but that number cannot be quantified. Indirect effects in the form harassment (i.e., affect breeding) would be associated with the future loss of progeny from sturgeon that could never return to the river to spawn. The diversions are not anticipated to adversely impact water quality or any habitat utilized by pallid sturgeon for spawning, nursery, or feeding in the Mississippi River. However, habitat conditions in the canals downstream of the diversions outflow canal would not be conducive (i.e., higher water temperatures, lower dissolved oxygen) to the long-term survival of larval and YOY resulting in take via harm (i.e., mortality) and it is anticipated that sub-adult and adult sturgeon will remain entrained for the remained of their lives and would not contribute to the spawning population.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of expected take is not likely to result in jeopardy to the pallid sturgeon.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of pallid sturgeon by entrainment through the small diversion at Convent/Blind River.

1. Gate operations should minimize velocity through the structure by maximizing the open cross-section, especially at Mississippi River stages of 6 feet Mean Sea level or less (equates to velocities at the culvert face of 7.2 fps or less).
2. Any gate operation that would significantly increase or decrease the velocity (change greater than 500 cfs) should be implemented over several hours to allow fish sufficient time to migrate back to the river or swim away from the structure.
3. Once the end of the annual discharge period is reached minimal gate openings should be maintained for several days to allow passage of any sturgeon that may have emigrated downstream.
4. The downstream edge of the culverts should have a slope to act as a ramp and/or sufficient erosion protection that would prevent scour from forming a vertical ledge greater than 6 inches at the downstream end of the culvert.
5. In channel refuge consisting of several submerged wing dikes (or similar structures) on both banks should be constructed no further downstream than 75 feet from the structure. Minimal spacing between the structures should be 10 feet but can be moved to account for scour. The maximum suggested height is 24 inches, but the length extending into the channel is not yet determined.
6. The downstream side walls should be angled towards the culverts so they will guide fish back into the culverts at lower velocities.
7. The two outer most culverts should have fish passage baffles constructed on the floor of the culverts.

8. Monitoring to determine take and to reduce potential take by returning pallid sturgeon to the river should be undertaken

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Corps shall execute the following terms and conditions, which implement the RPMs described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Manuals (or other similar documents) written to guide the daily operations and maintenance activities of the diversion should be written in cooperation with the Service. Any proposed changes to such document would require re-initiation of consultation under Section 7 of the ESA.
2. Detailed design of wing dikes and the scour protection to prevent development of a vertical ledge should be coordinated with the Service. After construction annual inspection (i.e., measurements) should be taken at the downstream edge of the culvert to determine need to for maintenance. If maintenance is required funding should be immediately requested.
3. Design of downstream side walls and detailed design of the fish passage baffles should be coordinated with the Service.
4. Three days of sampling effort will be made each quarter. Sampling will consist of at minimum utilizing otter trawls, gillnets (i.e., 27.4 meter by 1.8 meter, six mesh panel ranging from 23 to 76 centimeters), and trotlines (61 meters long with 60 dropper lines at 0.9 meter intervals using 2/0 hooks baited with worms). Up to eight trotlines will be fished on the bottom overnight and two gillnets will also be fish overnight. All procedures and protocols for handling sturgeon should be followed and are available at: www.fws.gov/mountain-praire/endspp/protocols/PallidSturgeonHandlingProtocol2008B.pdf

All pallid sturgeon captures should be measured and tagged according to the protocol; if permitted and when feasible, ageing and endoscopy to determine sex and reproductive stage should also be conducted. All pallid sturgeon captured should be returned to the Mississippi River as soon as practicable. The number and size of each pallid sturgeon caught by date and gear type should be provided to the Service. Unsuccessful sampling efforts should also be reported by date and gear type.

Upon locating a dead or injured pallid sturgeon that may have been harmed or destroyed as a direct or indirect result of the proposed project, the Corps and/or contractor shall be responsible for notifying the Service's Lafayette, Louisiana, Field Office (337/291-3100) and the LDWF's Natural Heritage Program (225/765-2821). Care shall be taken in handling an injured sturgeon to ensure effective treatment or disposition and in handling dead specimens to preserve biological materials in the best possible state for later analysis. Disposition of dead sturgeon is also addressed in the protocols.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and

threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service has developed the following conservation recommendations to help minimize adverse effects and to development information that may further reduce adverse actions to the endangered pallid sturgeon.

1. Ongoing population studies for the Lower Mississippi River should be continued to aid the determination of future diversion impacts to the pallid sturgeon population.
2. A comprehensive review of fish passage literature should be undertaken to aid in the possible future design of additional fish passage features on other diversion projects.

REINITIATION NOTICE

This concludes formal consultation on the proposed action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take (i.e., the habitat acreage amount described herein) is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take shall cease pending reinitiation.

The above findings and recommendations constitute the report of the Department of the Interior. If you have any questions about this biological opinion, please contact Ms. Jennifer Hogue of this office at 337/291-3144.

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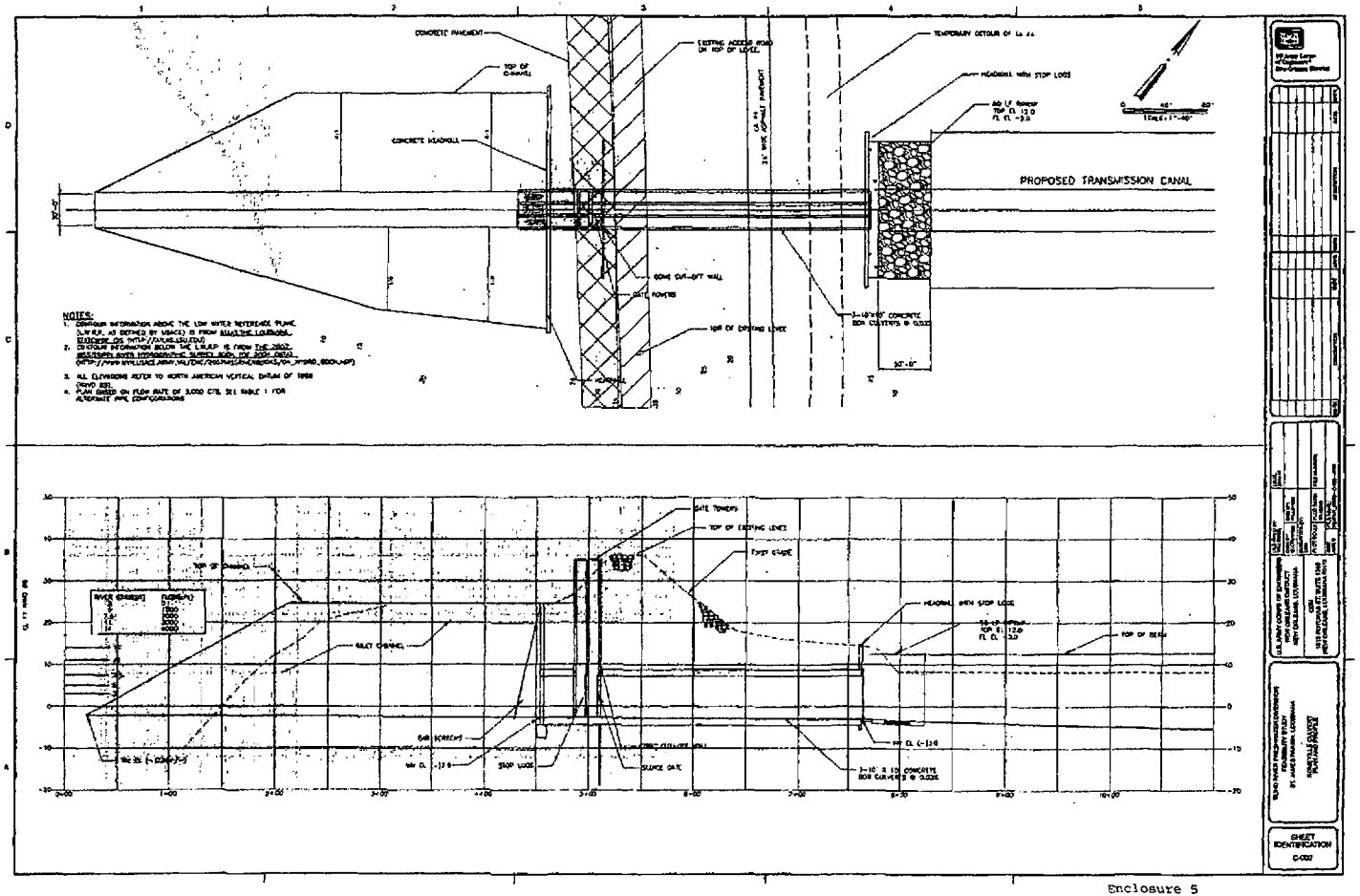
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APPENDIX


CONCRETE PAVEMENT
TOP OF LEVEE
EXISTING ACCESS ROAD ON TOP OF LEVEE
TEMPORARY DETOUR OF LA 44
HEADWALL WITH STOP LOGS
CONCRETE HEADWALL
PROPOSED TRANSMISSION CANAL
GATE TOWERS
TOP OF EXISTING LEVEE
SILT CHANNEL
FENCE
SLUICE GATE
STOP LOGS
NOTES:
1. ELEVATIONS REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
4. PLAN BASED ON FLOW RATE OF 3,000 CFS. SEE TABLE 1 FOR ALTERNATE PIPE CONFIGURATIONS

Enclosure 5

Volume IV

APPENDIX B:

U.S. Fish and Wildlife Service Coordination Letter and Report

→ Brian Haase

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
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Lafayette, Louisiana 70506

January 21, 2010

RECEIVED
2010 FEB -3 AM 9:20
Office of the LA-Coastal

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee

The U.S. Fish and Wildlife Service (Service) is collaborating with the U.S. Army Corps of Engineers (Corps) and the State of Louisiana's Office of Coastal Protection and Restoration (LOCPR) on the formulation and evaluation of six Louisiana Coastal Area (LCA) projects. LCA is a coastal ecosystem restoration authority that was authorized by the Water Resources Development Act of 2007 and includes both specific projects and general authorizations to aid in the restoration of Louisiana's coastal wetlands. Those wetlands, which support nationally important fish and wildlife resources, are being lost at an average rate of approximately 24 square miles per year due to a variety of causes. The purpose of this Planning-aid Report is to provide the Service's plan formulation-related comments and recommendations regarding four of the restoration projects and identify planning constraints that may influence the selection of project features and the ability of the Service to fulfill our reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The 4 projects that are being addressed in this report are:

Multi-purpose Operation of Houma Navigation Lock
Convey Atchafalaya River Water to Northern Terrebonne Marshes
Terrebonne Basin Barrier Shoreline Restoration
Small Diversion at Convent/Blind River

The Service will be providing project specific reports for the other 2 LCA projects in the planning phase. This Planning-Aid Report was prepared under the authority the FWCA; however it does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of that Act. The Service has provided copies of this report to the National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries (LDWF); if any comments are received on this report they will be forwarded under a separate cover. Comments in this report are also provided under the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.) as a cooperating agency for the Small Diversion at Convent/Blind River study.

TAKE PRIDE IN AMERICA

The Service previously submitted draft FWCA Reports (i.e., September 26, 2003 [comprehensive plan], May 28, 2004 [draft near-term plan], and October 6, 2004 [final near term plan] during the development of the LCA near-term plan. Habitat values and fish and wildlife resources (but not habitat acreage) described in those previous reports remain relatively unchanged and are therefore incorporated herein by reference.

We recognize that the legislatively mandated study schedule (i.e., study completion within three years from authorization) was developed to respond to the significant and ongoing rapid loss of coastal wetlands. Considering the scope and complexity of the some of these LCA projects, that schedule, because of a one year delay in getting cost-sharing documents signed, should be acknowledged as a key planning constraint, and risks and uncertainties associated with meeting such an abbreviated study schedule (i.e., reduced to two years) should also be thoroughly considered in any planning and NEPA documents. We also recognize that relatively new policies requirements (i.e., model certification and analysis of sea-level rise) implemented by the Corps have also contributed to some delays in essential data analysis. Additionally, the Service recognizes that some of our comments provided below regarding the analyses and findings of the LCA projects may be of an interim nature as planning efforts proceed. General comments that apply to the overall-planning process are presented below and are followed by general project-type comments and then by project specific comments, recommendations, and data needs.

The expedited schedule of the impact (i.e., benefit) analyses has curtailed time available for hydrological modeling work, precluding the correction of known model limitations and errors and also required utilizing assumptions and data interpolations in the impacts analysis that would have normally been more refined. Currently, coastal fisheries impact assessments may be conducted without the use of models that would have otherwise provided an overall indication of the cumulative effect of multiple restoration (planned and operating) and flood protection projects on fishery resources within a coastal basin. The Corps has verbally indicated that use of those type models will be incorporated in future planning efforts. Future Service comments regarding cumulative impacts (that should be thoroughly examined in NEPA documents) may be contingent upon completion of such modeling efforts. During a more typical project planning study, when sufficient time to conduct detailed impact analyses is available, the Service would usually rely upon more robust data and assumptions than is currently available.

The shortened time frame of the planning process has also reduced the amount of time used to fully develop and refine alternatives and alternative features. While many good alternatives for each LCA project were developed, the reiterative process of alternative refinement and selection was reduced which could preclude the development of alternatives or alternative features which could increase restoration benefits. Therefore, while selection of a Tentatively Selected Plan (TSP) has occurred or is scheduled to soon occur, changes to the TSP may be warranted based on further planning efforts and review of existing assumptions and modeling (i.e., quality control).

All diversion projects should include monitoring that would not only measure the success of the project but, also facilitate the recognition of existing and future maintenance needs as sedimentation occurs within the project area. Failure to include such monitoring may result in decreased benefits as areas experience sedimentation, vegetative response, and debris collection

which could isolate areas from the influence of the diversion. Implementation of an adaptive management/maintenance program throughout the project area and over the life of the project would also ensure such conditions would not prevail over the project life, significantly impacting the diversion's success. Varying the discharge of diversions during Mississippi River high water periods could increase their land building capabilities; however, the shortened study schedule has limited the examination of such adaptive management operations. The Service should be included in the development and implementation of both the monitoring and adaptive management/maintenance programs.

Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multi-purpose Operation of Houma Navigation Lock

Both of the subject LCA projects involve water management within a very large and hydrologically complex area and because these projects have substantial interaction they have been combined into one project. Given those factors, intensive hydrologic modeling is needed to evaluate the effects of the combined projects. Time needed to obtain adequate computer capabilities delayed the initiation of necessary hydrologic modeling. Therefore, to meet the project schedule, the array of project alternatives will be limited such that additional model runs to optimize channel sizes will not be done. If initial modeling suggests that there are other potentially viable project alternatives, there will not be sufficient time to assess those. More detailed comments regarding these studies are presented below:

1. Because of the shortened planning period and reduced amount of time allowed for hydrologic modeling runs, there was no time to consider the many Grand Bayou channel size and configuration alternatives. The LCA study intended to select the channel alternative selected under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Central and East Terrebonne Freshwater Delivery Project, which examined a number of channel size and configuration alternatives. In that CWPPRA effort, a 7,500 square foot (sq ft) east branch channel alternative (i.e., single channel) was selected as the preferred alternative. However, because the hydrologic model used in the CWPPRA effort failed to adequately simulate flows in the Cutoff Canal, those model results are flawed and inadequate to support a decision on a preferred alternative. Although intending to use that CWPPRA preferred alternative, the model mesh was set up for the 7,500 sq ft branched channel alternative (i.e., bifurcated channel).

2. The following structures were not included in the computer models, thus efforts to assess their impacts (especially when effects of the proposed Houma Navigation Channel Lock are considered) may be flawed.

   The 2 structures through the Morganza to the Gulf levee through the southbank of Falgout Canal.

   The Penchant Plan's Superior Canal water control structure is not in the future without project (FWOP) model projections.

3. The WD2 channel flows in Alternative 2 are predicted to exceed that of the predicted upstream source channel. The WD2 channel is also assumed to be functioning under FWOP conditions.

4. Time did not allow for the assessment of benefits for individual measures or groups of measures to improve the efficiency of measure combinations and the resulting alternatives. For example, in the Grand Bayou area, the proposed St. Louis Canal enlargement provides little additional freshwater input when combined with the proposed Grand Bayou enlargements. However, both features are combined in several alternatives, resulting in more costly alternatives.

5. Insufficient opportunity was provided to evaluate the effectiveness and benefits/value provided by individual outfall management features.

6. Because the diversion model allows only three loss rate changes, it is a less robust means of predicting future acreage trends than use of standard spreadsheet methods which can incorporate numerous loss rate changes over time. Because there was not sufficient time to upgrade this modeling tool, the more robust spreadsheet-predicted FWOP acreages are compared with the diversion model generated future with project (FWP) acreage. This may result in up to a 200-acre error by target year (TY) 100.

7. Because of the schedule, salinity outputs were not available to determine project and/or diversion influence areas from those model outputs. Instead, best professional judgment was used to determine the influence areas.

8. In some cases, salinity prediction models may not have been run long enough to fully illustrate project effects.

9. Polygons from which wetland loss rates were determined included fastlands.

10. Measured impacts did not remove spoil bank acreage – thus marsh impacts are overestimated.

14. Due to time constraints, diversion influence areas were assessed in the Wetland Value Assessments (WVA) as a single habitat type; separate WVAs on each habitat type are therefore needed.

15. To model project benefits, many assumptions have been made regarding the size and location of Morganza to the Gulf Project features. Those assumptions could later be found to be incorrect as that feasibility study work progresses.

Terrebonne Basin Barrier Shoreline Restoration

Project area acreages - Barrier island project boundaries encompass all emergent and subtidal habitat (i.e., 0.0 to -1.5 NAVD88) associated with the island, while deep ocean water habitat

around the island is omitted. Subtidal habitat extends bayward to the -1.5 ft NAVD88 contour or a maximum distance of 1,000 feet from the island. In many instances, a barrier island project area changes throughout the evaluation period (i.e., 50 years) as the island erodes, migrates, and/or shrinks in size. As the island erodes, areas converting to deep ocean water (>-1.5 NAVD88) are removed from the project area and the boundary shrinks as the island shrinks. This information needs to be determined for all alternatives.

Barrier Island Wetland Value Assessment V1, V2, and V3 values - Recent changes to the Final Array of Alternatives resulted in the deletion of some and the addition of new alternatives to that array. The acreage of each of the habitat components (i.e., dune supratidal, and intertidal) should be provided as soon as possible for all new alternatives added to the revised Final Array (distributed to the Project Delivery Team on January 11, 2010).

Impacts to the threatened piping plover (*Charadrius melodus*) and/or its critical habitat via dredged material placement on the islands should be addressed in planning studies. Should the proposed project directly or indirectly affect the plover or its critical habitat, further consultation with this office will be necessary. If the effect would adversely affect piping plovers or would affect its critical habitat, formal consultation with the Service would be necessary. Formal consultation has specific timelines that the Service must adhere to and must be completed prior to completion of any NEPA document.

Small Diversion at Convent/Blind River

The TSP for Convent/Blind River Freshwater Diversion includes constructing a gated culvert system and transfer canal along the Romeville alignment to divert as much as 3,000 cubic feet per second of freshwater from the Mississippi River into the Maurepas swamps. In-swamp management measures (e.g. gapping spoil banks, installing additional culverts under U.S. Highway 61 and installing water control structures in existing canals) are proposed to facilitate and maximize freshwater throughput within the swamp. The LCPR has requested that a new alternative be formulated and evaluated in the final array of alternatives. That alternative would include all of the features of the TSP with the exception of water control structures within existing canals due to concern that water control structures will be difficult to operate and maintain.

To fully evaluate the benefits of the Convent/Blind River Freshwater Diversion TSP and compare alternatives, the following additional information and actions will be required:

1. Additional results of hydrologic modeling efforts that identify/quantify influence areas at a more detailed level indicating how water, sediment, and nutrients move through the system and within each hydrologic unit.

2. Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.

3. Salinity predictions need to be re-evaluated and changes in future-with and future-without assumptions, if necessary, be undertaken.

4. Diversion operations need to be developed for each alternative and incorporated into the hydrologic modeling.

5. Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease).

Furthermore, in conjunction with the development of an operational plan, plan formulation should also include the development of a long-term monitoring plan. That monitoring plan should include measures to monitor project success, facilitate adaptive management, and support operation and maintenance of project features to ensure that the project is fully successful and capitalize on the availability of freshwater.

Impacts to the endangered pallid sturgeon (*Scaphirhynchus albus*) via entrainment through the diversion structure should be addressed in planning studies. Should the proposed project directly or indirectly affect the pallid sturgeon or its habitat, further consultation with this office would be necessary. If the project would adversely affect (i.e., take) the pallid sturgeon, formal consultation with the Service would be necessary. Formal consultation has specific timelines that the Service must adhere to and must be completed prior to completion of any NEPA document.

For all the above projects, much of the recommendations, information and data needs identified above will be needed to complete our evaluation of alternatives and of the individual TSP effects on fish and wildlife resources, so that we can fulfill our reporting responsibilities under Section 2(b) of the FWCA. Therefore, extensive additional Service involvement during ongoing detailed planning, engineering, and design of specific project measures and associated maintenance, along with more-definitive project information that will be available during those planning phases, will be required so that we can fulfill our responsibilities under that Act.

The Service has actively participated throughout plan formulation and evaluation of the LCA projects. Each of those LCA projects would, to varying degrees, reduce coastal wetland loss. Hence, implementing any of the proposed projects would be preferable to the continued loss and degradation of coastal wetlands and Louisiana's nationally significant fish and wildlife resources. We remain committed to working closely with all agencies involved in LCA planning effort to further explore alternatives and alternative features and refine models and model assumptions in order to reduce the current degree of risk and uncertainty associated with their outputs and to ensure optimum fish and wildlife resource benefits are achieved. The Service recognizes the formidable challenge that the Corps has been tasked with (i.e., balancing sufficient planning with meeting abbreviated Congressionally mandated deadlines) and we look

forward to continuing the ongoing LCA planning efforts to restore Louisiana's nationally significant coastal wetlands and resources.

Sincerely,



James F. Boggs
Supervisor
Louisiana Field Office

cc: EPA, Dallas, TX
CEMVN-PM-R
National Marine Fisheries Service, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Dept. of Natural Resources (CMD), Baton Rouge, LA
LOCPR, Baton Rouge, LA
Natural Resource Conservation Service, Alexandria, LA

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
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April 7, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The U.S. Fish and Wildlife Service (Service) has reviewed the March 8, 2010, draft Louisiana Coastal Area (LCA) Program: LCA Small Diversion at Convent/Blind River Monitoring and Adaptive Management Plan developed by the LCA Adaptive Management Planning Team in collaboration with the U.S. Army Corps of Engineers (Corps), the Louisiana Office of Coastal Protection and Restoration (LOCPR), and the LCA Science and Technology Program. That feasibility level monitoring and adaptive management plan was developed in accordance with Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) and implementation guidance for Section 2039 of WRDA 2007 provided by the Corps Headquarters Civil Works Policy and Planning, and Programs Divisions (CECW-PB) Memo dated August 21, 2009. The Service submits the following comments in accordance with the National Environmental Policy Act of 1969 (83 Stat. 852, as amended; 42 U.S.C. 4321 et seq.), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Service has coordinated with NOAA's National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries (LDWF), and their comments have been incorporated.

General

The Service recognizes that the monitoring and adaptive management plan has been developed to reflect a level of detail consistent with the project feasibility study, and that a detailed monitoring and adaptive management plan will be drafted as a component of the design document during planning, engineering and design phase. Project delivery team and natural resource agency involvement should continue throughout this iterative plan development process.

Specific

4.2. Monitoring Plan ... Convent/Blind River Project, Objective 1, Monitoring Design, page 9 –

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The term "ecological success" appears to be a misnomer in the cited quotation. It is recommended that this term be replaced in the subsequent sections with "project objectives" or "environmental restoration."

4.2. Monitoring Plan ... Convent/Blind River Project, Objectives, pages 9-11 – The organization of the monitoring plan is difficult to follow. We recommend for each objective that the "Desired Outcomes" be bulleted and followed by "Performance Measures", "Supporting Information Needs" and "Monitoring Design." It would also be beneficial to see the adaptive management measures outlined in this section once those measures have been more fully developed.

4.2. Monitoring Plan ... Convent/Blind River Project, Objective 1, Monitoring Design, page 9 – To measure freshwater distribution during operational events, we recommend also including conductivity, turbidity, and pH parameters as tracers.

4.2. Monitoring Plan ... Convent/Blind River Project, Objective 2, Desired Outcome, page 9 – Five years seems arbitrary for determining successful sediment accretion rates. An explanation of the target year for the desired outcome would be beneficial to the reader and future decision makers. Further, it is uncertain how long the project area may take to begin functioning as a healthy and sustainable swamp providing adequate biomass and sediment to achieve and sustain suitable elevations. As noted in Section 6.0, assessments will continue through the life of the project or until it is decided that the project is successful. As the project plans become more formalized we foresee more defined adaptive management measures and expanded monitoring target years should desired outcomes not be achieved.

4.2. Monitoring Plan ... Convent/Blind River Project, Objective 2, Performance Measure B, Desired Outcome, page 10 - As we are aware Southeastern Louisiana University monitoring stations are not located within the project area, but are located within other areas of the Maurepas Swamp. Pre-construction measurements have also been obtained by LOCPR's contractor, CDM. We recommend that the Adaptive Management Team coordinate with LOCPR and CDM to obtain that data.

4.2. Monitoring Plan, Performance Measure C, Monitoring Design, page 10 – Hourly turbidity recorders within the outfall canal seem adequate to measure sediment discharge, and additional turbidity recorders at hydrologic sites may not be necessary if rod surface elevation tables are installed. The use of turbidity recorders at hydrologic sites should be reconsidered.

4.2. Monitoring Plan ... Convent/Blind River Project, Objective 3, Performance Measure A, Desired Outcome, page 10 – Under "Desired Outcomes" it states that "Operations will determine dry periods." This should be clarified to state that the project will be operated to facilitate dry periods. We expect that dry periods will be dependent on the design and location of the outfall management measures, and adaptively managing those features will be necessary to achieve project goals.

Section 4.2., Objective 3, Performance Measure B, Desired Outcome, page 10 – Both cypress and tupelo are shade intolerant. The desired outcome should be revised to accurately depict the

limits of this performance measure. Performance of this measure is dependent on achieving historic hydrologic patterns (extended dry periods) in the swamp and would be more probable in areas that allow sufficient light (i.e., deteriorated swamp habitats that are converting to marsh/open water).

Section 4.2., Objective 3, Performance Measure B, Monitoring Design, Page 10 – Changes in cover classes is not reflected in the Performance Measure. Documenting the increase or decrease in the number of cypress and tupelo should be adequate. If those species decline project success would not be obtained. If it is a goal to document cover class changes, that should be included as a performance measure.

Section 4.2., Objective 4, Page 10 – Hydrologic and water quality parameters are a significant portion of the monitoring procedures and should provide performance measures for improving aquatic habitat within the project area. We recommend revising Objective 4 to include performance measures, desired outcomes, and design relative to improving aquatic habitat based on water quality parameters (i.e., increased dissolved oxygen conditions).

Furthermore, improved fish and wildlife habitat could be also measured indirectly through fish surveys or wildlife surveys, and the Conceptual Ecological Model (page 15) indicates that fish sampling will be performed. The LDWF have historical data on Blind River and is still currently surveying it twice a year in their biological sampling program. We recommend coordinating with the LDWF to incorporate and expand their baseline data to develop performance measures and desired outcomes for this objective; please contact Robert Bourgeois and Heather Finley with LDWF at (225) 765-0765, and (225) 765-2956, respectively.

Section 4.2., Objective 4, Risk Endpoint, page 10 – It is unclear as to the implication of the monitoring decision point titled "Risk Endpoint," and it is only listed as an item under Objective 4. It may be beneficial to the reader to define this and other adaptive management terms in the plan.

Section 4.2.1. Monitoring Procedures, Vegetation, page 11 – This section states that diameter-at-breast height (DBH) of all tagged trees will be measured at regular fixed intervals. These intervals should be identified whether it is annually, biannually, or by using another protocol.

Section 4.2.1. Monitoring Procedures, Vegetation, page 11, and Sediment Accretion and Elevation, page 12 – Reference locations should be designated within the monitoring and adaptive management plan and should be coordinated with LOCPR and CDM who may have already implemented reference locations.

Section 4.2.1. Monitoring Procedures, Hydrology, page 11 – We recommend including conductivity and acidity (pH) in the hydrologic parameters of the interior swamp. We also recommend extending the sampling area and parameters of the open water habitats (i.e., Blind River and Mississippi River Outfall locations) to include the project area drainage channels which support local aquatic habitat. Collecting baseline conditions are important to understand changes to a system relative to an action; therefore, including pre-project sampling should be

included.

In regards to tracking the distribution of freshwater and sediments, we recommend considering using satellite photography as an adaptive management tool. Yvonne Allen with the Corps' Engineer Research and Development Center and Eric Glisch with the Corps' New Orleans District have used satellite signatures and gauge data to identify flow paths (and flooding regimes) at different river discharges into the Atchafalaya and Breton basins, respectively. We suggest including this method to supplement the analysis and help identify areas not receiving flow (frequency/duration) and use that information to guide outfall management.

Section 4.2.1. Monitoring Procedures. Water Quality, page 12 – Higher salinity waters within the project area are a result of tropical storm events and possibly severe drought conditions. Hourly measurements seem unnecessary.

Section 6.0, Assessment, page 14 – We recommend development of a table that identifies each performance measure; anticipated completion dates for each phase of the planned assessment action, and expected dates for report dissemination to the Adaptive Management Team and the Program Management Team. We understand that assessment completion and report delivery dates will be tentative and subject to change; however, assurance should be provided that reasonable time frames will be established, and necessary modifications will be identified and brought to the attention of the program managers in a timely manner. In the absence of a schedule for action, data analysis and reporting and identification of needed modifications could be unacceptably delayed or not completed.

Annex 1, Conceptual Ecological Model, Section 2.2, Project Background, page 5 – The last sentence should be revised to state, "These factors combined with increasing occurrences of episodic high salinities ...will result in a highly degraded swamp system which is at risk of conversion to open water."

Annex 1, Conceptual Ecological Model, Section 2.2, Project Background, page 6 – The project description should be revised to state that the proposed diversion project could introduce up to 3,000 cubic feet per second.

Annex 1, Conceptual Ecological Model, Section 3.1.2, Altered Hydrology, page 10 – While cypress and tupelo tress are able to grow in flooded conditions, prolonged flooding could result in decreased growth rates and eventually tree mortality. Increasing dry periods from existing conditions could be very beneficial to the existing forest stand. We recommend revising this section accordingly.

Annex 1, Conceptual Ecological Model, Section 3.4.2., Fish and Wildlife, pages 14-15 – The bald eagle was removed from the Federal list of threatened and endangered species on August 8, 2007. Further, the endangered West Indian manatee (*Trichechus manatus*) and pallid sturgeon (*Scaphirhynchus albus*) are likely to occur in the project area. This section should be revised accordingly.

We appreciate the opportunity to review and comment on the draft monitoring and adaptive management plan, and look forward to continued coordination with the LCA Adaptive Management Framework Team. Should you have any questions regarding our comments, please contact Angela Trahan (337/291-3137) of this office.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: EPA, Dallas, TX
NMFS, Baton Rouge, LA
Corps, New Orleans, LA (Attention: Dr. William Klein, CEMVN-PM-RS)
LDWF, Region 7 Office, Baton Rouge, LA
LDWF, Baton Rouge, LA (Attn.: Kyle Balkum)
LDWF, Baton Rouge, LA (Attn.: Heater Finley)
LOCPR, Baton Rouge, LA

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

April 30, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. Enclosed is our Draft Fish and Wildlife Coordination Act Report for the LCA - Small Diversion at Convent/Blind River project. This report does not constitute the 2(b) report of the Fish and Wildlife Service (Service). This draft report has not been reviewed by the Louisiana Department of Wildlife and Fisheries (LDWF) or the National Marine Fisheries Service (NMFS); however, their comments will be incorporated into the final report.

Should your staff have any questions regarding the enclosed draft report, please have them contact Angela Trahan of this office at 337/291-3137.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosures

TAKE PRIDE IN AMERICA

cc: FWS, Atlanta, GA (ES/HC)
EPA, Dallas, TX
NMFS, Baton Rouge, LA
Corps, New Orleans, LA (Attention: Dr. William Klein, CEMVN-PM-RS)
LDWF, Region 7 Office, Baton Rouge, LA
LDWF, Baton Rouge, LA (Attn.: Kyle Balkum)
LDWF, Natural Heritage Program, Baton Rouge, LA
LDWF, Scenic Rivers Program, Baton Rouge, LA
LOCPR, Baton Rouge, LA

DRAFT
FISH AND WILDLIFE COORDINATION ACT REPORT

ON

LOUISIANA COASTAL AREA –
SMALL DIVERSION AT CONVENT/BLIND RIVER

Submitted To
New Orleans District
U.S. Army Corps of Engineers

And

Louisiana Office of Coastal Protection and Restoration

Prepared by
Angela Trahan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Ecological Services
Lafayette, Louisiana

April 2010

TABLE OF CONTENTS

INTRODUCTION 1

DESCRIPTION OF THE STUDY AREA 2

FISH AND WILDLIFE RESOURCES 5
Major Habitat Types 6
Cypress/Tupelo Swamps 6
Bottomland Hardwoods 6
Fresh Marsh 7
Open Water 7
Developed Areas 8
Fishery Resources 8
Wildlife Resources 9
Invasive Species 10
Threatened and Endangered Species 10
Species of Special Interest 11
Refuges and Wildlife Management Areas 13

ALTERNATIVE EVALUATION 13

FINAL ARRAY OF ALTERNATIVES 14

EVALUATION METHODOLOGY 15

FUTURE WITHOUT PROJECT FISH AND WILDLIFE RESOURCES 18

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN 19

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN 20

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES 21

SERVICE POSITION AND RECOMMENDATIONS 22

LITERATURE CITED 25

APPENDIX A A-1

INTRODUCTION

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration (OCPR), under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. This authorization was recommended by the Chief of Engineer's Report, dated January 31, 2005. That report recommended projects and features in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related water resources purposes.

The Small Diversion at Convent/Blind River project was identified in the Louisiana Coastal Area Ecosystem Restoration Study, dated November 2004 (2004 LCA Plan), as a near term critical restoration feature. WRDA 2007 directed that a feasibility report for the Small Diversion at Convent/Blind River project be submitted to Congress by December 31, 2008. The WRDA also directed that a Report of the Chief of Engineers be completed by December 31, 2010. Specifically, Section 7006(e)(3) requires the Secretary of the Army to submit feasibility reports to Congress on six projects by December 31, 2008 and a Chief's Report by December 31, 2010. Due to delays in executing a Feasibility Cost Sharing Agreement for the projects the requested feasibility reports were not submitted to the Congress by the December 31, 2008 deadline. The contingent authorization provided in Section 7006(e)(3)(B) for the six projects however remains subject to the December 31, 2010 deadline for a Chief's report.

The LCA - Small Diversion at Convent/Blind River project includes the construction of a small diversion (i.e., less than 5,000 cubic feet per second) from the Mississippi River into Blind River through a new control structure to introduce sediments and nutrients along with freshwater into the southeast portion of Maurepas Swamp. Diverting Mississippi River water into the Maurepas Swamp will assist in improving biological productivity and restoring the natural hydrologic regime within that degraded swamp habitat. This diversion project in concert with two other LCA near-term critical features, the Small Diversion at Hope Canal project and the Amite River Diversion Channel Modification project, will help to restore Mississippi River water, sediment, and nutrient flows into the Maurepas Swamp ecosystem.

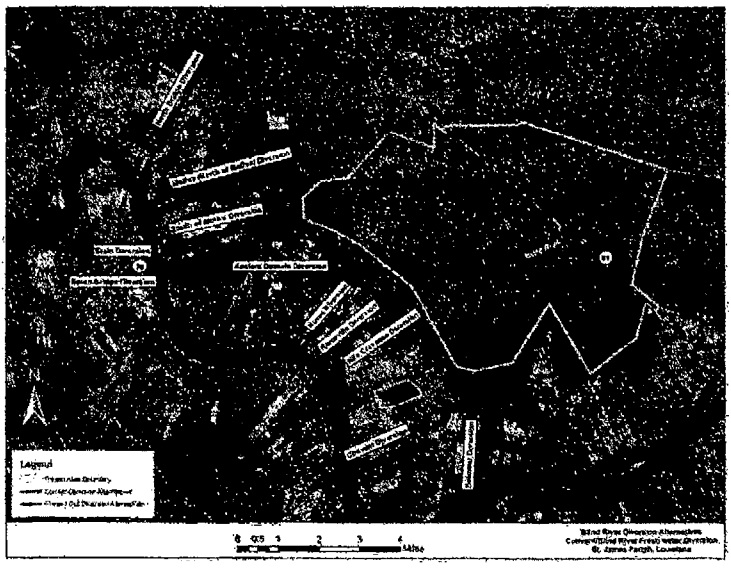
Previous U.S. Fish and Wildlife Service (Service) involvement includes a Final Programmatic Fish and Wildlife Coordination Act (FWCA) Report for the Near Term Plan for the LCA Study (Grouchy and Paille 2004); this draft report supplements that 2004 Programmatic Report. The Service has also submitted comments dated October 20, 2008, on the State of Louisiana, OCPR's Draft Interim Feasibility Study; comments dated January 30, 2009, were provided in regards to the Corps' Notice of Intent to prepare a Supplemental Environmental Impact Statement; and the Service provided a programmatic planning-aid Report dated January 21, 2010. Furthermore, Service comments were provided on the Draft Monitoring and Adaptive Management Plan dated April 7, 2010. When finalized, this report will be submitted in fulfillment of the requirements of the Fish and Wildlife Coordination Act (FWCA; 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and will constitute the report of the Secretary of the Interior as required by Section 2(b) of

that Act. This draft FWCA Report is being provided to the Louisiana Department of Wildlife and Fisheries (LDWF) and the National Marine Fisheries Service (NMFS); their comments will be incorporated into the final report.

DESCRIPTION OF THE STUDY AREA

The project area is located within the Maurepas Swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1, Figure 1). The U.S. Interstate 10 (I-10) corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the distribution area (i.e., diversion influence area). The Maurepas Swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the LDWF, Maurepas Wildlife Management Area.

Figure 1. LCA- Small Diversion at Convent/Blind River Study Area and Alternative Diversion Locations.



Alternative locations for the proposed control structure have been investigated in the vicinity of Convent, Louisiana, located at Mississippi River mile 159. Prior to extensive human modification, overbank flow of the Mississippi River during spring floods and tidal inflow,

through Pass Manchac, into Lake Maurepas, and southwest to the study area, significantly influenced the hydrologic conditions. Overbank flows from the Mississippi river brought nutrients, sediment, and freshwater that promoted productivity and sustained the health of the swamp ecosystem. As floodwaters receded, surface flows traveled eastward as sheet flow into existing channels and subsequently Lake Maurepas.

Some uncertainty surrounds the historic frequency of flooding events in the study area due to the natural variability of these events and limited historic record. Lopez (2003) estimated that flooding of the Mississippi River historically occurred once every 3.5 years in the Lake Pontchartrain Basin. Between 1799 and 1931, the frequency of major flood events for the Mississippi River was approximately every 2.8 years (Gagliano and van Beek, 1970), with twenty-three flood years recorded below Baton Rouge from 1849 to 1927 (Vogel 1930).

For an evaluation of potential sediment loading at Bayou Lafourche, Mashriqui and Kemp (1996) reported the mean sediment load of the Mississippi River at Tarbert's Landing to be 226 mg/l, of which about 26% was sand, with silts and clays each contributing between 30% and 40%. Shaffer et al. (2001a) concludes even if only clays are conveyed by the channel to the swamps north of I-10, about 30% of the river load could be expected to reach the swamps. If only 30% of that potential sediment load is delivered to the primary swamp receiving areas, and an exceedingly low capture efficiency by the swamp of only one-third is assumed, it will represent a loading per area of about 1098 g/m2/yr, or about twice the quantity needed as estimated by Templet and Meyer-Arendt (1988). It is, therefore, anticipated that sediments introduced with diverted water will increase accretion rates, likely holding or increasing existing swamp elevations against subsidence, at least for those areas within the high influence areas of the diversion. Thos sediments will also increase soil bulk densities, and with increased elevations contribute to increased tree health, survival, and productivity, and the potential for tree regeneration (Shaffer et al. 2001a).

Study evaluations conducted for the Small Diversion at Hope Canal project determined that the volume of water that would be delivered by a 1,500 cfs diversion running most of the year would be the equivalent of two complete replacements of lake volume per year. In addition, the diversion design would be capable of, on the average, operating at full flow even during the late summer and fall low-flow period, when high salinities and saltwater intrusion are the biggest threat. Thus, it is expected that Lake Maurepas would experience significant freshening as a benefit beyond direct benefits to the swamps. Such freshening could have a positive impact on fisheries as well as other ecosystem components (Shaffer et al. 2001a).

The MRSNFR study concluded that there were no issues of water or sediment quality that would preclude consideration of diversion of river water (and sediment) for restoration purposes. Only a few compounds, mainly mercury and some organochlorine pesticides that have been banned from use for well over a decade, were found to occasionally exceed water or sediment standards. However, the absence of significant observed bioaccumulation of these compounds was taken as evidence for no overall problems (Corps 2000). Furthermore, studies conducted for the Small Diversion at Hope Canal project determined that nutrients added with diverted river water would be essentially completely taken up within the swamp (Shaffer et al. 2001a).

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10 and Airline Highway corridor. Development along the I-10 and Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of cypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

Since the construction of the Mississippi River flood control levees, the Maurepas Swamps have been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands; and preliminary evaluations suggest that productivity in the stressed Maurepas Swamp may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas Swamp and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas Swamp study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas Swamp will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined (LCWCRTF 1999). Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. Subsidence may be caused by compaction, oxidation, and consolidation of sediments, faulting, groundwater depletion, or decreased organic deposition as a result of decreased vegetation biomass production; while land elevations increase as a result of sediment accretion from direct sediment input from riverine sources or from organic vegetation deposition. The soil characteristics of the western Maurepas Swamp indicate a lack of riverine influence as evidenced by high soil organic matter content and low bulk density values (DeLaune et al. 1979, Hatton 1983, Messina and Conner 1998). Consequently, soil building within the Maurepas Swamp is almost exclusively a

result of organic productivity (Shaffer et al. 2001, 2003, 2006, Rybczyk et al. 2002, Roberts 1985). With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, doubling flood frequency over the last four decades (Thompson 2000), so that the swamps are now persistently flooded.

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA Maurepas (Hope Canal) Diversion project, has revealed in some areas of Maurepas Swamp floor elevations are often lower than Lake Maurepas. This results in Lake Maurepas stage exerting a significant influence (backflow) on water levels within Blind River and adjoining channels rendering swamp water levels and dry-out periods dependent on the water levels in Lake Maurepas. Flooding is essentially semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and hydrologic impoundments caused by major transportation corridors as well as parish canal embankments. These adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., I-10, U.S. Highway 61, and Kansas City Southern Railroad (KCS RR)]; flood waters within the project area are the last to recede from the basin.

Saltwater intrusion has increased in this general area, partly due to net subsidence and the lack of riverine freshwater inputs. Salinities as low as three parts per thousand (ppt) can reduce growth of both bald cypress and water tupelo saplings (Pezeshki et al. 1990). Salinity, combined with flooding stress, can substantially reduce bald cypress growth. Consequently, salinity significantly contributes to swamp deterioration, particularly combined with stressors such as flooding and herbivory. Storm surges from Lake Maurepas caused by tropical cyclones also exert a stochastic but severe stress on the swamp habitat through salinity spikes in swamp surface waters. Embankments along the parish canals and associated with the railroad and highways prevent higher salinity water from being flushed out of the system. Storm surge waters remain in the impounded swamps cumulatively increasing salinities in impounded waters and soils.

FISH AND WILDLIFE RESOURCES

The Service has provided a Final FWCA Programmatic Report for the Near Term Plan for the LCA Study (Grouchy and Paille 2004). That report contains a through discussion of the significant fish and wildlife resources (including those habitats) that occur within the study area as well as fish and wildlife concerns that occurs within coastal Louisiana and future without project conditions. That discussion is incorporated by reference herein, but the following information is provided to update to that report and provide project specific information and recommendations.

Major Habitat Types

Cypress/Tupelo Swamps

The study influence area (distribution area) contains approximately 21,844 acres the majority of which is dominated by bald cypress/tupelo swamp habitat and is semi-permanently or permanently flooded. Persistent flooding has resulted in the impairment of cypress/tupelo seedling establishment/regeneration (CWPPRA Task Force 2002). Cypress/tupelo regenerates well when the seedbed is moist but not flooded during the time period of seed germination and seedling establishment. Cypress/tupelo seeds cannot germinate in standing water, and seedlings must grow tall enough during dry periods for their crowns to extend above the water surface to survive flooding during the growing season. Excessive flooding will reduce regeneration even though overstory trees may still be thriving. Ultimately, the lack of regeneration due to prolonged inundation will eliminate forest cover, resulting in the conversion of swamp habitat to open water over time (CWPPRA Task Force 2002). In addition, saltwater intrusion from storm events has stressed the swamp habitat along the Blind River.

Cypress swamps in the project area provide substantial fish and wildlife values. Wildlife species typical of cypress swamps include green tree frog, bullfrog, mud and musk turtles, American alligator, various species of water snakes, anhinga, barred owl, northern parula, great blue heron, great egret, white ibis, and mink. Often surrounding backwater lakes, these areas also provide essential habitat for aquatic species when inundated.

While bald cypress is the canopy dominant in a few locations within the study area, water tupelo was the predominant species across sites. In addition to bald cypress and water tupelo, Drummond red maple, green ash, and various oak species are also found in the cypress/tupelo swamp habitat within the study area, with Drummond red maple and green ash comprising sub-dominant midstory species (Conner and Day 1976; Hoeppner 2008; Shaffer et al. 2003). Scrub species, including black willow, wax myrtle, and common buttonbush are sporadically present, particularly in areas with diminished canopy cover caused by impaired health or mortality of overstory species. Shrub-scrub swamps provide important nesting habitat for colonial wading birds as well as various species of aquatic wildlife.

Bottomland Hardwoods

Bottomland hardwood forests are generally intolerant of inundation during the growing season (Putnam et al. 1960; Hodges 1997). Fluctuations in water level are more prevalent in the bottomland hardwood forest than bald cypress-tupelo swamp, with characteristic alternating wet and dry periods. Where bottomland hardwood forests experience increased flooding regimes the forest stand begins to transition into a more flood tolerant community composition and becomes more characteristic of a swamp habitat. Bottomland hardwoods are present within the distribution area as elevations increase near the natural levee of the Mississippi River and along several ridge remnants and spoil banks that traverse the study area. Also the alternative transmission canal alignments traverses bottomland hardwood forests along the natural levee and within the Mississippi River batture. Dominant tree species in the higher elevated area include

Drummond red maple, black willow, green ash, laurel oak, water oak, sweet gum, sugarberry, American elm, and Chinese tallow. The areas between the ridges and the swamp show a transition in species and are dominated by green ash and Drummond red maple. Wax myrtle, rough-leaf dogwood, black willow, Chinese tallow, Chinese privet, yaupon, and deciduous holly typically are common shrub species. Vines such as poison ivy, greenbriars, pepper vine, and trumpet creeper are present.

Bottomland hardwood forests typically provide high wildlife habitat values to a variety of species, including amphibians such as the Gulf coast toad and Cope's gray tree frog; reptiles such as the copperhead and green anole; many species of birds, including wood duck, barred owl, pileated woodpecker, red-shouldered hawk, Acadian flycatcher, Swainson's warbler and northern parula; and mammals including white-tailed deer, swamp rabbit, gray fox, bobcat, raccoon, opossum, and squirrels. In addition to terrestrial wildlife, many species of fish utilize flooded bottomland hardwoods as well; some species are specifically adapted for spawning in these backwater flood plains.

Fresh Marsh

Within the study area fresh marsh habitat mainly consists of pipeline and powerline easements. While some of these easements have ditches, many of the easements are slightly elevated above the adjacent swamp and are thickly vegetated with grasses and forbs. These areas are usually saturated to the surface, and flooded only during higher water periods. Therefore, it is unlikely that fresh marshes within the Study Area currently provide nursery habitat for estuarine species. However, these fresh marshes would provide habitat for other wildlife species such as reptiles and amphibians.

Open Water

The Blind River is the major waterway influencing the project area wetlands and is designated as a state water bottom along with the Mississippi River and Lake Maurepas also within the study area. Several parish canals, transmission line and pipeline canals, and borrow canals transect the study area swamp habitat. Because of the stagnant conditions, the loss of sediment inputs, reduced primary productivity, and limited consolidation, net phosphorus and organic matter export from the swamp is likely low. Therefore, support for dependent systems downstream (e.g., Lake Maurepas) is likely limited and substantially reduced from historic levels.

In their *2006 Water Quality Integrated Report*, the Louisiana Department of Environmental Quality (LDEQ) indicated that water within the study area (i.e., LDEQ sub-segment 040403) supports the designated standards for primary and secondary contact recreation, but does not support those standards for fish and wildlife propagation. Suspected sources of impairment include were mercury, nitrate/nitrite, non-native aquatic plants, total phosphorus (TP), and turbidity. The suspected sources for mercury were listed as atmospheric deposition and unknown sources. Site clearance (land development or redevelopment) and flow alterations from water diversions were listed as the suspected sources for nitrate/nitrite, dissolved oxygen, and TP. The suspected causes of impairment for the outstanding natural resource waters designation were sedimentation/siltation and turbidity, which are believed to be caused by site clearance.

Developed Areas

Developed areas within the study area occur along the Mississippi River levee and are dominated by industry facilitated by Mississippi River commerce and associated business and residential development. Historically, agriculture has been a major industry within both parishes and is still relevant today primarily in the form of sugarcane farming. Two railways run through the study area. The KCS RR transects the distribution area and parallels U.S. Highway 61 to the south. The Canadian National Railway extends to the south of the distribution area and would be transected by the Romeville and South Bridge transmission canals. U.S. Interstate 10 and U.S. Highway 61 pass through the distribution area. Where U.S. Highway 61 and Blind River intersect the St. James Boat Club, a boat launch facility, provides boat access to the upper Blind River. Also a second boat launch is located at the north terminus of Louisiana Highway 642 with access to Grand Point Canal. Numerous transmission and pipeline rights-of-way also intersect the study area.

Fishery Resources

Lower Mississippi River

Baker et al. (1991) noted at least 91 species of freshwater fishes occupy the Lower Mississippi River as their primary population center; 30 or more species may be present sporadically. From what is known of its physical attributes, few species could regularly inhabit the upper and middle water column in this habitat. 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 moving among other habitats (Baker et al. 1991).

Blind River /Swamp

Freshwater sport fishes likely present include white crappie, bluegill, warmouth, channel catfish, and blue catfish. Other fishes likely present include yellow bullhead, freshwater drum, bowfin, carp, buffaloes, and gars. In addition, aquatic and wetland habitats within the study area provide nursery and foraging habitats supportive of a variety of fishery species including economically important estuarine-dependent fishery species (e.g., the blue crab, striped mullet, and Gulf menhaden), some of which may serve as prey for other fish species.

During a survey conducted from January 1976 to August 1977, Watson et al. (1981) sampled fisheries species at six locations along Blind River from south of Highway 61 to Lake Maurepas. In doing so, 57 species of finfish were collected and included 12 estuarine, 43 freshwater, and two diadromous species. Freshwater species were dominant both spatially and temporally. Finfish diversity appeared to be higher at the lower stretches of Blind River, below the Amite River Diversion Canal and nearer Lake Maurepas. The lower Blind River had the greatest species diversity, primarily due to the presence of estuarine species.

A survey conducted by Davis et al. (1970) between 1967 and 1969 in the Lake Maurepas revealed forty species of finfishes and shell fishes. Some of the fishes included Gulf menhaden,

gizzard shad, striped and bay anchovy, blue and channel catfish, sand and spotted seatrout, Atlantic croaker, striped mullet, southern flounder, largemouth bass, bluegill, several species of gar as well as shrimp. In a later fisheries survey of Lake Maurepas, Hastings et al. (1987) reported an equal proportion of freshwater (55 percent) and marine (40 percent) fish species with four-percent of individuals being diadromous. A correlation was observed between the fisheries species present in the lake and mouth of Blind River and salinity levels in Lake Maurepas: marine species exhibited a higher contribution to the fisheries of Lake Maurepas and had a greater likelihood of presence in Blind River with increasing salinity levels, with the opposite trend apparent for freshwater species.

Wildlife Resources

The coastal marshes and forested wetlands of the Lake Pontchartrain Basin have been identified by the North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCLV): Mississippi River Coastal Wetlands Initiative as a key waterfowl wintering area. The Gulf Coast is the terminus of the Central and Mississippi Flyways and is therefore one of the most important waterfowl areas in North America, providing both wintering and migration habitat for significant numbers of the continental duck and goose populations that use both flyways. The Mississippi River Coastal Wetlands Initiative area is dominated by coastal marsh, forested swamps, and seasonally flooded bottomland hardwoods that provide habitat for several species of wintering waterfowl. Wood ducks are the primary waterfowl species in forested wetlands, while other ducks (e.g., mallard, American widgeon, gadwall, blue- and green-winged teal, Northern shovelers, ring-necked ducks, and lesser scaup) use those forested habitats to a lesser degree.

Strategies to achieve the goals and objectives of the GCJV include but are not limited to: 1) maintaining the existing functions and values of those habitats and preventing additional losses and degradation of those wetlands and 2) modifying existing spoil banks and canals to restore hydrology (Wilson et al. 2002). Numerous other game birds are present in or adjacent to the study area, including American coot, rails, gallinules, common snipe, and American woodcock. Non-game bird species also utilize the study area marshes, including least bittern, pied-billed grebe, black-necked stilt, American avocet, killdeer, black-bellied plover, willet, and various species of sandpipers, gulls, and terns. The study area supports many resident and transient hawks and owls including red-shouldered hawk, barn owl, common screech owl, great horned owl, and barred owl. Winter residents include red-tailed hawk, northern harrier, and American kestrel, while the Mississippi kite, swallow-tailed kite and broad-winged hawk are common summer residents. In addition, the project area supports many species of resident and migratory passerine birds. Some neo-tropical migrants that are currently experiencing a population decline (e.g., white-eyed vireo, northern parula) are dependent on large forested acreage to successfully reproduce. Also, present are cuckoos, swifts, hummingbirds, nighthawks, woodpeckers, and the belted kingfisher.

Invasive Species

Within the study area invasive mammal species present include nutria and feral hogs. Invasive plant species present within that area include: water hyacinth, alligator weed, hydrilla, common salvinia, giant salvinia, variable-leaf milfoil, Chinese tallow, and Chinese privet. Those species displace native aquatics and degrade water and/or habitat quality. In addition, Chinese tallow is tolerant to flooding and salt stress and can establish self-replacing monocultures that provide less foraging value to migrating birds and interrupt the natural succession of woody species (Louisiana Coastal Protection and Restoration 2008).

Threatened and Endangered Species

West Indian Manatee

Federally listed as an endangered species, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals.

All contract personnel associated with the project should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel are responsible for observing water-related activities for the presence of manatee(s). Temporary signs should be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign should be placed where it is visible to the vessel operator. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels should operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, should be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed. Any manatee sighting should be immediately reported to the Service's Lafayette, Louisiana Field Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf

sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project, however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

The Corps is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the Service's concurrence with that determination. If the Corps determines, and the Service concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the ESA should be submitted to the Service. That request should also include the Corps' rationale supporting their determination.

Pallid Sturgeon

The pallid sturgeon (*Scaphirhynchus albus*) is an endangered fish found in Louisiana, in both the Mississippi and Atchafalaya Rivers (with known concentrations in the vicinity of the Old River Control Structure Complex); it is possibly found in the Red River as well. The pallid sturgeon is adapted to large, free-flowing, turbid rivers with a diverse assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. Habitat loss through river channelization and dams has adversely affected this species throughout its range. Entrainment issues associated with dredging operations in the Mississippi and Atchafalaya Rivers and through diversion structures off the Mississippi River are two potential effects that should be addressed in future planning studies and/or in analyzing current project effects.

Impacts to the pallid sturgeon via entrainment through the diversion structure should be addressed in planning studies. Should the proposed project directly or indirectly affect the pallid sturgeon or its habitat, further consultation with this office will be necessary. If the affect would result in a take of a pallid sturgeon, formal consultation with the Service would be necessary. Formal consultation has specific timelines that the Service must adhere to and must be completed prior to completion of any National Environmental Policy Act document.

Species of Special Interest

Bald Eagle

The project-area forested wetlands provide nesting habitat for the bald eagle (*Haliaeetus*

leucocephalus), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. Several active and inactive bald eagle nests are documented within and adjacent to the study area. Other nests may also be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. Eagles typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. 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.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at:
http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf.
Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at:
http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

Colonial Nesting Birds

The proposed project would be located in an area where colonial nesting waterbirds may be present. Colonies may be present that are not currently listed in the database maintained by the

Louisiana Department of Wildlife and Fisheries. That database is updated primarily by monitoring the colony sites that were previously surveyed during the 1980s. Until a new, comprehensive coast-wide survey is conducted to determine the location of newly-established nesting colonies, we recommend that a qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. To minimize disturbance to colonial nesting birds, the following restriction on activity should be observed:

1) For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present).

2) On-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

Refuges and Wildlife Management Areas

There are no U.S. Fish and Wildlife Service National Wildlife Refuges located within the study area. A majority of the study area is located within the state-operated Maurepas Swamp Wildlife Management Area. Please contact the LDWF, Region 7 Office in Baton Rouge, Louisiana, (225/765-2360) for their comments regarding potential project impacts to this area.

Blind River is designated as a Louisiana Natural and Scenic River. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

ALTERNATIVE EVALUATION

Based on a review and analysis of prior studies, initial site visits, and input received through the scoping process, an initial list of management measures (i.e., restoration features that are elements of an alternative) was developed. Examples of management measures includes water management modifications within Maurepas Swamp (e.g., weirs, flow control gates, and control valves); alternate measures and approaches to distributing freshwater throughout the distribution area (e.g., pumps and control structures); alternative transfer systems to transfer the freshwater from the diversion point to the swamp (e.g., trapezoidal earthen or concrete-lined channel, underground conduits, or existing natural and man-made drainage systems); and alternative diversion system features including alternative diversion locations and levee crossing measures (siphon vs. culverts). An example of nonstructural management measures includes alternative diversion operation plans to achieve certain restoration goals and planting cypress seedlings in targeted areas.

After management measures were screened and evaluated, the management measures were then grouped into an array of preliminary alternatives for further evaluation to achieve the overall project goals and objectives. The alternatives in the initial array underwent a screening and

evaluation process to develop the final array of alternatives. The screening process analyzed the specific components or features that were included in the alternatives including diversion location, diversion flow rates, and diversion methods.

FINAL ARRAY OF ALTERNATIVES

The evaluation determined that the Romeville and Sunshine Bridge locations are hydraulically efficient locations from which to provide freshwater, nutrients, and sediments to an effective portion of the benefit area. It was determined that 3,000 cubic feet per second (cfs) of flow is needed to provide both prevention of saline backflow and inundation from Lake Maurepas and also achieve the overall goal of reversing the trend of degradation in the swamp. Further, an analysis of construction costs indicates that siphons are more cost effective for flow rates below 1,000 cfs and gated culvert systems are more cost effective for flow rates greater than 1,000 cfs. Considering the preliminary results of initial screen and evaluations efforts, the following five alternatives were identified for further consideration and inclusion in the final array:

No Action Alternative (Future without Project Conditions)
Alternative - 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
Alternative - 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
Alternative - 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
Alternative - 6 – Two 1,500 cfs (3,000 cfs combined) Diversions at Romeville and South Bridge (Siphons)

Alternative 2 – 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4 – 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4B – 3,000 Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds 3 new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

Alternative 6 – 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

EVALUATION METHODOLOGY

Evaluation of project-related impacts on fish and wildlife resources was conducted using the Wetland Value Assessment (WVA) methodology developed for the evaluation of proposed CWPPRA projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 2006). The WVA methodology is similar to the Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project (FWOP) and future with-project (FWP) conditions. Instead of the species-based approach of HEP, each model utilizes an assemblage of variables considered important to the suitability of a given habitat type for supporting a diversity of fish and wildlife species. As with HEP, these models allow a numeric comparison of each future condition and provide a combined quantitative and qualitative estimate of project-related impacts to fish and wildlife resources.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each habitat type. Each model consists of: 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability Indices) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

The WVA methodology was first developed in 1991 by the CWPPRA Environmental Work Group (LCWCRTF 2006). Initially, emergent marsh habitat models were developed for fresh, intermediate, brackish and saline marsh types. Subsequently, models were also developed for swamps, barrier islands, barrier headlands, and coastal forested ridges. The habitat variable-habitat suitability relationships within the WVA models have not been verified by field experiments or validated through a rigorous scientific process. However, the variables were originally derived from HEP suitability indices taken from species models for species found in that habitat type. It should also be noted that some aspects of the WVA have been defined by policy and/or functional considerations of CWPPRA. However, habitat variable-habitat suitability relationships are, in most cases, supported by scientific literature and research findings. In other cases, best professional judgment by a team of fisheries biologists, wildlife biologists, ecologists, and university scientists may have been used to determine certain habitat variable-habitat suitability relationships. In addition, the WVA models have undergone a

refinement process and habitat variable-habitat suitability relationships, HSIs, and other model aspects are periodically modified as more information becomes available regarding coastal fish and wildlife habitat suitability, coastal processes, and the efficacy of restoration projects being evaluated.

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The CWPPRA swamp WVA model used consists of four variables: 1) stand structure; 2) stand maturity; 3) water regime; and 4) mean high salinity during the growing season.

Using the WVA methodology, impact assessments were conducted by the Habitat Evaluation Team (HET), which included representatives from the Service, the Corps, Office of Coastal Protection and Restoration, LDWF, NMFS, Southeast Louisiana University (SLU), and CDM, Incorporated. To assess impacts the HET used habitat information collected during four separate field trips from March through September of 2009, surveys, expert opinions, knowledge of the area, experience with similar projects, Digital Ortho-quarter Quadrangle aerial photographs (DOQQ), and preliminary hydraulics and hydrology modeling information.

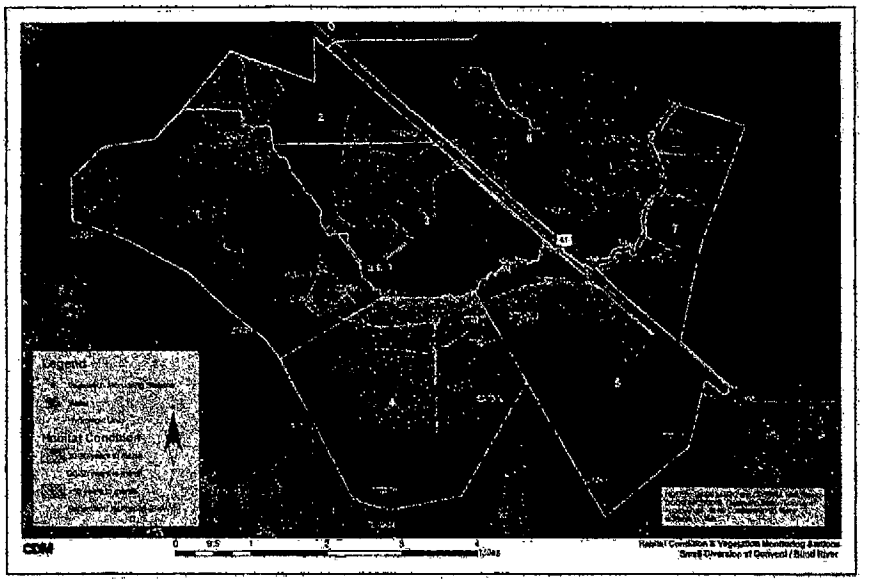
For the LCA - Small Diversion at Convent/Blind River project those elements above were used in conjunction with the WVA models to compute an HSI value for each target year (TY). Selection of target years is based on anticipated changes in the area being evaluated. Three levels of habitat condition class were defined within the project area (i.e., 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh) based on the degree of degradation and according to classifications used by Dr. Gary Shaffer (SLU) at other areas within the Maurepas swamp (Figure 2). Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level of degradation and not necessarily the target years that the habitats will convert to marsh. Alternatives were analyzed using target years reflective of those habitat condition classes. The target years used for this project were TY0, TY1, TY20, TY30, and TY 50. The standard period of analysis for Corps projects is 50 years.

The product of an HSI and the acreage of available habitat for a given target year is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

Prior to running the WVA analysis, the hydrologic units (i.e., benefit areas) associated with each alternative were designated based on the location of the hydrologic unit within the watershed in relation to the diversion outfall. It was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). For purposes of the WVA, the Service assumed that the high influence areas would receive the most benefits from sediments, nutrients, and freshwater flow (i.e., freshwater throughput); moderate influence areas would receive benefits from nutrients and freshwater flows; and low influence areas would

experience benefits as a result of freshwater flow. However, assuming the diversion would be operated to maximize dry-out frequency, all hydrologic units see increased benefits in the form of dry-out frequency as a result of the berm cuts.

Figure 2. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Subsequent to the mapping of influence areas for each alternative, WVAs were run for each habitat condition class (i.e., 20-30 years to marsh, 30-50 years to marsh, and greater than 50 years to marsh) present within those areas. Once benefits were calculated, adverse temporary and permanent impacts to swamp and bottomland hardwood habitats associated with construction of the transmission channels were calculated. The change in AAHUs for each FWP scenario, compared to FWOP project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type.

The WVA initial analysis was completed on the benefit areas for all alternatives under the intermediate sea level rise (SLR) scenario. As requested by the Corps, additional WVAs were later run to quantify impacts under the low and high SLR scenarios for the Tentatively Selected Plan (TSP) and the National Ecosystem Restoration (NER) Plan. A combined total of 96 WVA evaluations have been completed.

The Project Information Sheet (including assumptions used by the HET) for the project are presented in Appendix A. The complete WVA analysis can be obtained from the Service's

Lafayette, Louisiana Ecological Services Office upon request.

FUTURE WITHOUT-PROJECT FISH AND WILDLIFE RESOURCES

According to the Coast 2050 Report (LCWCRTF 1999), in 1990, this unit contained approximately 138,930 acres of swamp and 3,440 acres of marsh. Under future without-project conditions continued impoundment, flooding, subsidence, and herbivory are expected to increasingly stress area swamps in the future. The current problems associated with altered hydrology are expected to continue. The lack of overbank flooding from the Mississippi River into the swamp and hydrologic connectivity within the swamp would result in the continued impoundment of the project-area swamp, with an associated reduction in canopy cover, degradation of water quality, and transition of swamp habitat to marsh, with the eventual conversion to open-water habitat similar to areas further east. Storm surges from tropical cyclone events would increase salinity levels and the frequency of saltwater inundation is expected to increase with relative sea level rise (RSLR). Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

The lack of freshwater, sediments, and nutrients would continue to reduce tree vigor and growth, increase tree mortality, increase the presence of invasive species, and reduce ecological functions. In addition, the assumed RSLR, would exacerbate swamp degradation in the future. The anticipated conversion of swamp habitats to marsh and open water would result in the loss of wetland values and functions. While the Service recognizes the ecological importance of freshwater marshes, in this case, the anticipated conversion of swamp to marsh habitat is a transitional phase resulting from habitat deterioration and conversion and is not indicative of a healthy sustainable ecosystem. Keddy et al. (2007) reports that the vast majority of the Maurepas Swamp is typical of swamps identified as either nutrient poor and stagnant or near-continuously flooded. Flood durations in the Maurepas Swamp have doubled, on average, over the past half-century (Thomson et al. 2002). The flooding and impoundment within the study area prevents seed germination and recruitment and, as a result, swamps are converting to marsh and open water.

Keddy et al. (2007) identified priority actions for habitat restoration within the Maurepas Swamp. Two of the primary recommendations addressed include diverting several freshwater diversions into the area and re-establishing sheet flow via removal or gapping of spoil banks and road and railroad beds. That report noted that pulsing of water flow from the river was a historical occurrence and that a sufficient volume to carry sediment and nutrients at least as far as the Manchac land bridge is necessary. That report further explains that sheet flow (or shallow water flow over the surface of the soil) was, most likely, the principle way in which water and nutrients moved through this system. Now, however, the presence of man-made hydrologic barriers impedes sheet flow. Canals decrease overbank flooding and accelerate the flow of water, sediment, and nutrients out of the area, while spoil banks and other such man-made features block sheet flow. Implementation of the proposed project would restore an historic ecosystem and increase the fish and wildlife habitat values of the project area.

This project would work in concert with other recently constructed and proposed projects to

restore the Lake Pontchartrain Basin ecosystem including the de-authorization and closure of the Mississippi River Gulf Outlet (MRGO) channel at Bayou La Loutre authorized under WRDA 2007; and three Near-Term LCA projects, the MRGO Ecosystem Restoration Project, the Amite River Diversion Channel Modification project, and Small Diversion at Hope Canal (Maurepas Swamp) Project.

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN

After comparing the four alternative plans carried forward for detailed analysis and the No Action Alternative, the NER Plan, Alternative 2, a 3,000 cfs diversion at Romeville was selected, as the TSP. Alternative 2 best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Corps' Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the southeast part of the Maurepas Swamp. Alternative 2 would improve a total of 21,369 acres of baldcypress-tupelo swamp that are in various stages of deterioration.

Alternative 2 has the following six major components:

1. **Diversion structure** – three, 10 x 10-foot concrete box culverts with sluice gates are proposed under the Mississippi River's east bank levee and Louisiana Highway 44. The sluice gates would include motor operators on the culvert inlets. The diversion structure would also include trash racks, an inlet canal across the batture, and other ancillary structures.

2. **Transmission canal** - the transmission canal will be designed for 3,750 cfs and will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The canal will be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2-foot freeboard. The top width will be approximately 250 feet. A railroad and highway crossing will require eight, 12 x 8-foot concrete box culverts.

3. **Control structures** - Control structures will be installed at key locations in the existing channels to distribute the diverted flow throughout and into the swamp. The control structure locations and designs will be determined during more detailed planning and engineering.

4. **Berm gaps (spoil bank gaps)** - new 500-foot wide berm gaps will be excavated in the spoil banks at an approximate spacing of 2,500 feet on center. The gaps will be excavated to the elevation of the adjacent swamp natural ground elevations, and the spoil will be disposed behind the existing spoil banks. As proposed, the spoil will be placed up to Elevation +6 North American Vertical Datum of 1988 (NAVD 88) to provide additional refuge areas for wildlife during flood events in the swamp.

5. **Cross culverts** - at four locations along U.S. Highway 61 and KSC RR. Each installation will consist of three, 3 x 4-foot concrete box culverts. There may be sufficient cross drainage openings at the KCS RR, and additional culverts may not be required. Earthen channels (large ditches) will be excavated across the 500-foot space between the KCS RR and U.S. Highway 61 to interconnect the drainage capacity at the railroad with the new culverts at U.S. Highway 61.

6. **Water level and flow rate instrumentation** – instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp will be installed. Additional instrumentation may be required as part of monitoring and adaptive management.

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN

Alternative 2 is one of three cost-effective and best-buy alternatives. Alternative 2 provides over 90 percent of the benefits for about 67% of the cost of Alternative 6, the cost per AAHU is much lower for Alternative 2 than that for the other two alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Current habitat analysis indicates that the highest net benefits would be achieved through implementation of Alternative 6 (7,114 AAHUs). However, due to the high incremental cost per habitat unit going from Alternative 2 to Alternative 4B or 6, those alternatives were not considered to be justified. Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the NER Plan and the TSP.

Based on preliminary hydrologic modeling results, which at this stage of the study have focused on transfer of flow between benefit areas, Alternative 2 directly influences a larger area (i.e., hydrologic units 1 and 4) providing 8,088 acres with sediments, nutrients, and freshwater. Approximately 3,415 acres of swamp would benefit through the addition of freshwater and nutrients, and an additional 4,535 acres would experience freshwater benefits. Aside from the benefits achieved from diverting freshwater into the system, the project area will experience increased throughput, hydrologic connectivity, and dryout periods as a result of in swamp management measures. The WVA analysis indicates that the NER and TSP for the project would result in net gains of 6,741; 6,421; and 5,459 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

Swamp habitat for fish and wildlife species would be restored, mimicking as closely as possible, conditions which occurred historically in the area. Restored hydrologic connections would: 1) increase the nutrient and sediment input, 2) increase acreage of high-quality swamp habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements, and 3) increase vegetative growth and productivity. In addition, when compared to the future without project scenario, implementation of this alternative would significantly reduce the likelihood of existing swamp habitat converting to marsh and eventual open water habitat over the life of the project.

Because of the expedited schedule many specific details regarding the design, operation, and associated effects of the TSP are not yet available at the current level of planning, we cannot, therefore, complete our evaluation of project feature effects on fish and wildlife resources, and thus we cannot entirely fulfill our reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act. Therefore, extensive additional Service involvement during subsequent detailed planning, engineering, design, and construction of specific project measures, along with more-definitive project information that will be available during those planning design and analysis phases will be required so that we can fulfill our responsibilities under that Act.

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES

Swamp habitats are considered by the Service to be aquatic resources of national importance due to their increasing scarcity and high habitat value for fish and wildlife within Federal trusteeship (i.e., migratory waterfowl, wading birds, other migratory birds, threatened and endangered species, and interjurisdictional fisheries). Restoring coastal swamp habitat through implementation of the proposed project would be preferable to the continued loss and degradation of coastal wetlands and Louisiana's nationally significant fish and wildlife resources.

A critical design challenge for the Maurepas Swamp will be the distribution of flow into and throughout the swamp habitat. Modifications to drainage patterns, distribution channels, and installation of control structures will be necessary to distribute water, sediment, and nutrients throughout the swamp and avoid adverse impacts to existing drainage features. To accommodate changing goals and restoration needs for the region, the diversion structure, as well as the outfall management system, should be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

We recognize that the legislatively mandated study schedule (i.e., study completion within three years from authorization) was developed to respond to the significant and ongoing loss of coastal wetlands. Considering the scope and complexity of the some of the projects, that schedule, because of a one year delay in getting cost-sharing documents signed, should be acknowledged as a key potential planning constraint and risks and uncertainties associated with meeting such an abbreviated study schedule (i.e., reduced to two years) should also be thoroughly considered in any planning and NEPA documents.

The expedited schedule of the impact (i.e., benefit) analyses has curtailed time available for hydrological modeling work, precluding the correction of known model limitations and errors and also required utilizing assumptions and data interpolations in the impacts analysis that would have normally been more refined. During a more typical project planning study, when sufficient time to conduct detailed impact analyses is available, the Service would usually rely upon more robust data and assumptions than is currently available.

The shortened time frame of the planning process has also reduced the amount of time used to fully develop and refine alternatives and alternative features. While many good alternatives for

the LCA - Small Diversion at Convent/ Blind River project were developed, the reiterative process of alternative refinement and selection was reduced which could preclude the development of alternatives or alternative features which could increase restoration benefits. Therefore, while selection of a TSP has occurred changes to the TSP and/or the TSP features may be warranted based on further planning efforts and review of existing assumptions and modeling (i.e., quality control).

The intent of the habitat assessment is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit under the operational plan identified.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.
- Due to time constraints, impacts associated with the transmission canal were assessed in the habitat assessment as a single habitat type; separate WVAs on each habitat type are therefore needed.

SERVICE POSITION AND RECOMMENDATIONS

The TSP will benefit the fish and wildlife resources that depend on the Maurepas Swamp by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increase organic production, increase biological productivity, and reduce conversion of swamp habitat to open water. Approximately 21,369 acres would benefit from the proposed project resulting in 6,421 AAHUs of swamp habitat at the end of the project life. The Service supports implementation of Alternative 2, a 3,000 cfs diversion at Romeville, provided the following fish and wildlife recommendations are implemented concurrently with project implementation:

1. Because of the expedited schedule, we recommend that the Corps continue to coordinate with the agencies during the remaining Feasibility phase and the Preconstruction, Engineering, and Design (PED) phase to ensure any new project features, development of the operational plan, and/or changes in the design fully incorporate adequate fish and wildlife conservation measures and that those features can be adequately evaluated with regards to impacts to fish and wildlife resources.

2. We recommend that hydrologic modeling efforts better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within

each hydrologic unit under the proposed operational plan. Those hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and conduct detailed impacts analysis. Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

3. To accommodate changing goals and restoration needs for the region, we recommend that the diversion structure, as well as the outfall management system, be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

4. We recommend that water levels and swamp floor elevations be determined on a refined scale and incorporated into the hydrologic modeling.

5. Salinity predictions should be included in the hydrologic modeling efforts and re-evaluated, and, if necessary, changes be undertaken.

6. Due to time constraints, impacts associated with the transmission canal were assessed in the habitat assessment as a single habitat type; separate WVAs on each habitat type are recommended.

7. If a proposed project feature is changed significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

8. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

9. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

10. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at:

http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

11. Please coordinate with the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on the Maurepas Swamp Wildlife Management Area (WMA).

12. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

13. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

14. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) and any adaptive management and monitoring plans should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

15. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

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APPENDIX A

PROJECT INFORMATION SHEET WITH ASSUMPTIONS
FOR
LCA- SMALL DIVERSION AT CONVENT/ BLIND RIVER

Draft

Wetland Value Assessment Project Information Sheet

Comparing Final Array of Alternatives

April 29, 2010

Prepared for:
U.S. Army Corps of Engineers
and
Louisiana Department of Natural Resources

Prepared by
U.S. Fish and Wildlife Service

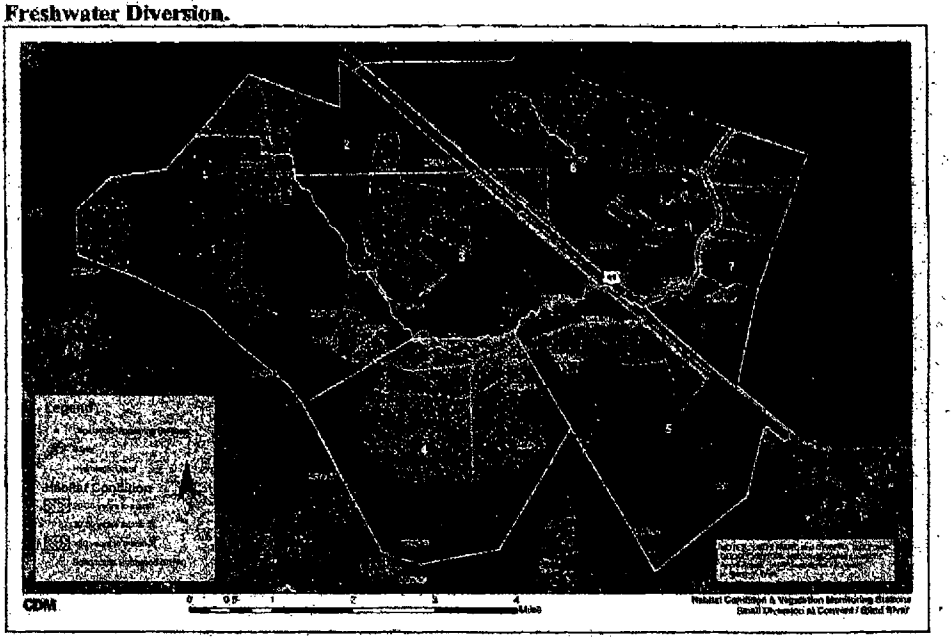
Project Name: Louisiana Coastal Area – Small Freshwater Diversion at Convent/Blind River

Project Type(s): Freshwater diversion and hydrologic restoration within swamp habitat

Project Area: The project area is within the Maurepas swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1). The U.S. Interstate 10 corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the project area. The Maurepas swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the Louisiana Department of Wildlife and Fisheries, Maurepas Wildlife Management Area.

For planning and hydrologic modeling purposes, the project area was divided into three benefit areas (i.e., benefit area 1, 2, and 3) and within those benefit areas are several sub-basins. Benefit areas and sub-basins are defined by topographic high areas (e.g., spoil banks, relict railroad grade, road embankments) or channels, natural or artificial (e.g., rivers, canals, channels, intermittent tributaries) that would serve to impede or intercept hydrologic flows. The area south and southwest of Blind River is defined as benefit area 1 (i.e., 100 sub-basin series). The area north of Blind River and west of U.S. Highway 61 is benefit area 2 (i.e., 200 sub-basin series), and the area north of Blind River and east of U.S. Highway 61 is benefit area 3 (i.e., 300 sub-basin series). For the purposes of the Wetland Value Assessment (WVA) the sub-basins are grouped into hydrologic units (Figure 1), or units that are considered to be under the same hydrological influences.

Figure 1. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Problem: Since the construction of the Mississippi River flood control levees, the Maurepas swamps have been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands; and preliminary evaluations suggest that productivity in the stressed Maurepas swamps may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas swamps and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas swamps will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

U.S. Army Corps of Engineers guidance requires project performance to be assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. Using the rate of 9.20 mm/yr, a starting year of 2011, and a 50-year project life, a sea-level rise of 1.5 feet is projected for the year 2061 (Table 1). A historic rate considered to be representative of the project area is calculated using the West End at Lake Pontchartrain gage (85625). The rate of 9.20 mm/yr is considered to include both the eustatic and local subsidence contributions to the estimated total sea-level rise.

In order to estimate the local subsidence rate for the project area, the global eustatic rate (1.7 mm/yr) is subtracted from the local sea level rate or:

Local subsidence rate = 9.20 mm/yr – 1.7 mm/yr = 7.50 mm/yr.

Table 1. Summary of total sea level rise (i.e., considers subsidence) for each scenario.

Project year	Scenario 1, Low Rate (feet)	Scenario 2, Intermediate Rate (feet)	Scenario 3, High Rate (feet)
2011	0.0	0.0	0.0
2016	0.2	0.2	0.2
2021	0.3	0.3	0.5
2026	0.5	0.5	0.8
2031	0.6	0.7	1.1
2036	0.8	0.9	1.4
2041	0.9	1.1	1.7
2046	1.1	1.3	2.0
2051	1.2	1.5	2.4
2056	1.4	1.7	2.8
2061	1.5	1.9	3.2

The estimate for the local subsidence rate is used in conjunction with estimates for the eustatic rates using NRC curves I and III to determine the intermediate and high projections of sea level rise for the project area. The following formula is used to estimate the total rise in eustatic sea level for the project life for the intermediate and high rate scenarios of sea level rise:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,
t_1 is the time in years between the project's construction date and 1986,
and
t_2 is the time between a future date at which one wants an estimate for sea-level rise and 1986.

These eustatic estimates are added to the local subsidence estimate to get the total sea-level rise for the intermediate and high rate scenarios. For the purposes of hydrologic modeling for this project the intermediate rate was used.

Project Goal: Reverse the trend of degradation in the southeast portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

Objectives:

1. Promote water distribution in the swamp which, in turn, will increase freshwater throughput and nutrient input thereby increasing swamp productivity and wetland assimilation.
2. Facilitate swamp building: by increasing swamp productivity and sediment input by up to 1000 g/sq meter per year to decrease the annual subsidence rate (or accretion deficit).
3. Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and seed germination and survival. This is proposed by decreasing flood duration for high flood events within the swamp, increasing the length of dry periods in the swamp, and increasing the number of cypress and tupelo saplings per acre from existing conditions.
4. Improve fish and wildlife habitat in the swamp and in Blind River by increasing sediment and nutrient input, freshwater flow, and dry periods which will contribute to an increase in swamp productivity. This will result in a diversity of stand structure components (tree species composition and a combination of herbaceous, midstory and overstory vegetation), thus improving fish and wildlife habitat needs. Direct project related benefits fish and wildlife resources (i.e., swamp habitat) are quantified by acreage and habitat quality using the Wetland Value Assessment, and are defined by average annual habitat units or AAHUs.

Alternatives:

Alternative 2 – Diversion at Romeville, 3,000 cfs

This proposed alternative includes constructing a gated culvert system and transfer canal along the Romeville alignment. In-swamp management measures include restoring and improving 160 existing canal spoil bank (berm) gaps that have silted in to an appropriate width (TBD), adding 30 new 500-foot wide berm gaps, building 7 water control structures at strategic locations in the swamp along man-made drainage canals to force river diversion water through the swamp, and adding 3 new culverts under U.S. Highway 61.

Alternative 4a – Diversion South of the HWY 70 Bridge, 3,000 cfs

This proposed alternative includes constructing a gated culvert system and transfer canal along the Cox alignment south of the Louisiana Hwy 70 Bridge and constructing in-swamp

management measures as noted above.

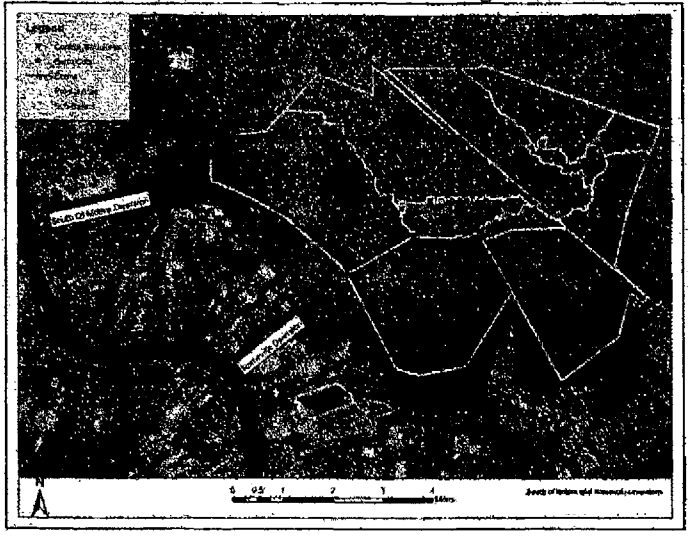
Alternative 4b – Diversions South of the HWY 70 Bridge, 3,000 cfs

This proposed alternative includes constructing a gated culvert system and transfer canal along the Cox alignment south of the Louisiana Hwy 70 Bridge and constructing in-swamp management measures as noted above. Additionally, in order to achieve a similar distribution as in the dual diversion alternative (Alternative 6) the distribution of the single diversion would be modified by diverting 1,500 cfs to the south at the junction of the St. James Parish Canal.

Alternative 6 – Dual Diversions at Romeville and South of the HWY 70 Bridge, 3,000 cfs (1,500 cfs for each diversion)

This proposed alternative includes constructing a gated culvert system and transfer canal along both the Romeville and Cox alignments and constructing in-swamp management measures as noted above.

Figure 2. Alternative Diversion Locations and Water Management Measures.



HEC-RAS and HEC-HMS Modeling

The Hydrologic Engineering Centers - River Analysis System (HEC-RAS) is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels to determine hydrologic flow simulation, sediment transport, and water quality analysis. The HEC - Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems including large river basin

water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, flood damage reduction, floodplain regulation, and systems operation.

Preliminary HEC-RAS and HMS modeling has been conducted by the contractor, CDM. The HEC-RAS was simulated over an average year, 2003 being the representative average water year. HEC-HMS used a 15-year simulation period from 1989-2004. One of the major constraints with directing freshwater into the study area is the efficiency of the Blind River to remove water from the system greatly reducing the exchange and widespread distribution of water throughout the system. A diversion directed to the southern portion of the project area and within benefit area 1 has limited influence on the other benefit areas because Blind River acts as a hydrologic barrier, and vice versa.

Modeling for this project, as well as the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Maurepas ("Hope Canal") Diversion project, has revealed that the Maurepas swamps are often lower in elevation than Lake Maurepas. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput (EPA 2001).

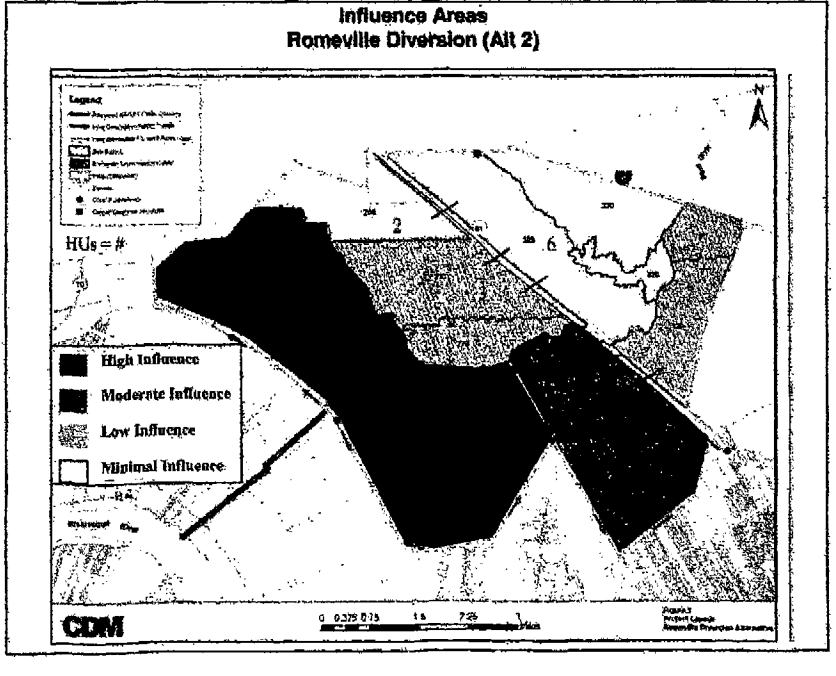
Investigations into diversion capacity determined that changes related to swamp productivity within the system require a minimum diversion flow of 1,000 cubic feet per second (cfs), and 1,500 cfs is required to prevent backflow from Lake Maurepas into the Blind River and swamps. Modeling results also indicate that hydrologic benefits within the system (described by modeling reports as average water depth, water depth exceedence, frequency above Lake Maurepas, and average annual freshwater inflow) either stabilize or do not see incremental benefits as a diversion flow magnitude exceeds 3,000 cfs. Another constraint affecting diversion operations is the availability of water from the Mississippi River. To meet design flow rates Mississippi River water elevations need to be at a minimum of 11 feet; the Mississippi River is at or above that elevation 60 % of the year. It was determined that a 3,000 cfs diversion would be required to provide enough water when available to offset unavailability during low flow periods in the Mississippi River.

Table 2. Diversion Influence for Each Alternative by Habitat Condition Class (construction impacts considered).

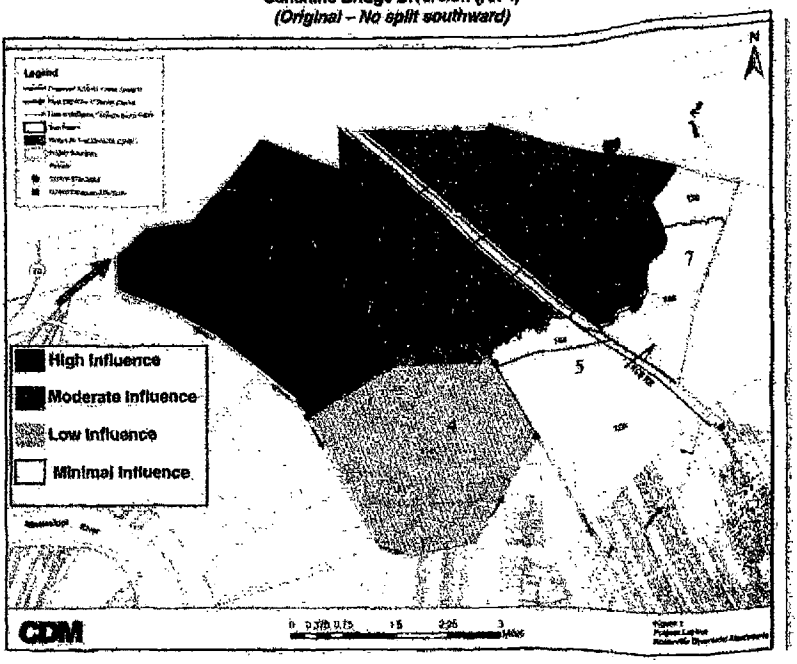
	Degree of Diversion Influence	20-30 Years to Marsh[1]		30-50 Years to Marsh		>50 Years to Marsh	
		HUs[2]	acres	HUs	acres	HUs	acres
Alternative 2 (Romeville)	High	1,4	169	1,4	3364	1,4	4555
	Moderate	5	204	5	604	5	2607
	Low	3,7	2397	3,7	1669	3	469
	No /Minimal	2,6	525	2,6	2297	2,6	2509
Alternative 4 (Hwy 70 Bridge)	High	1,2	169	1,2	1827	1,2	3550
	Moderate	6,3	1837	6,3	2972	6,3	2070
	Low	4	0	4	2013	4	1799
	No/Minimal	5,7	1289	5,7	1073	5	2607
Alternative 6 (Total Div)	High	1,2,4	169	1,2,4	3848	1,2,4	5361
	Moderate	3,5,6	2041	3,5,6	3579	3,5,6	4691
	Low	7	1085	7	469	--	0
	No /Minimal	--	0	--	0	--	0

[1]Habitat Classes as defined under Habitat Assessment Method [2]Hydrologic Units (see Figure 1)

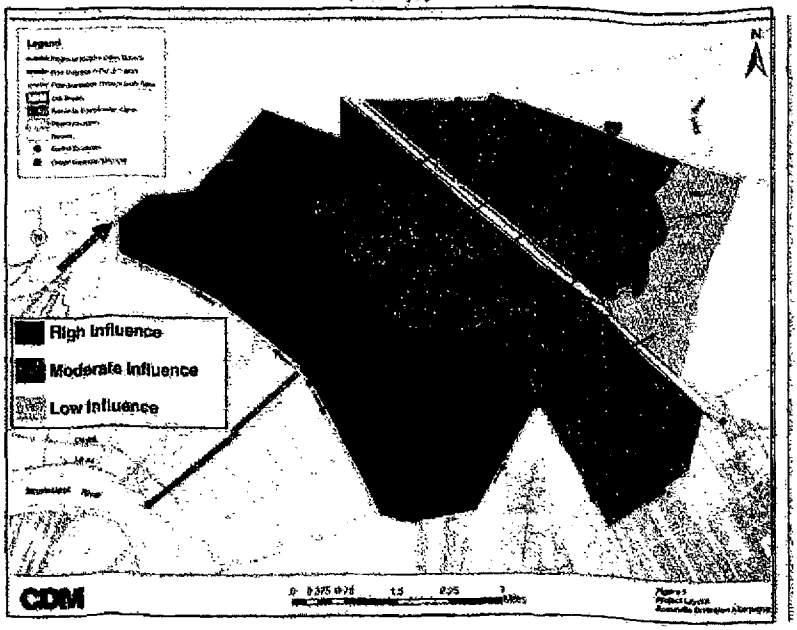
Figure 3. Diversion Influence Areas for Each Alternative.



Influence Areas
Sunshine Bridge Diversion (Alt 4)
(Original – No split southward)



Influence Areas
2 Diversions (or entry points)
(Alts 4b, 6)



Habitat Assessment Method

The procedure for evaluating project benefits on swamp habitats, the WVA swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed diversion project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the swamp for the given time period. The habitat suitability index (HSI) is combined with the acres of swamp to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

Existing and Future without Project Conditions

To characterize existing conditions CDM established 28 vegetation monitoring stations throughout and adjacent to the project area during four separate field trips from March through September of 2009. A trend apparent to Shaffer et al. (2003) in the Maurepas swamp was increasing habitat degradation with proximity to Lake Maurepas. Therefore, two vegetation stations were positioned outside of the project area, closer to Lake Maurepas, to reference and track the progression of more degraded habitat conditions and to suggest potential future conditions for the project area under the no-action alternative. Data was collected on hydrology, wildlife, vegetation, community structure, composition, and health (per WVA methodology) at all vegetation monitoring stations. Soils data were also recorded at most monitoring stations.

On October 7, 2009, the team met with Dr. Gary Shaffer (Southeastern Louisiana University) and Bernard Wood (Research Assistant, SELU) to inspect the project area and compare habitat quality and swamp degradation to other areas of the Maurepas swamp that they are currently studying. Based on observations made during that field trip, data collected during previous field trips, knowledge of the habitat condition of the entire Maurepas swamp by Dr. Shaffer and Mr. Wood, and aerial photography, a habitat condition class map was then developed to categorize the different areas of swamp habitat (levels of degradation) according to classifications used by Dr. Shaffer at other areas within the Maurepas swamp (Figure 1). The intersection of diversion influence and habitat condition class defines the different areas that would require a separate WVA for each alternative (32 WVAs, not including WVAs for construction related impacts).

Three levels of habitat condition class were defined within the project area: 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh. Data obtain from representative vegetation monitoring stations were then summarized according to each habitat class to get a representative value for each habitat class for the WVA. Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level of degradation and not necessarily the target years that the habitats will be removed from the habitat assessment.

Variable V_1 - Stand Structure (Table 3)

Most swamp tree species do not produce hard mast; consequently, wildlife foods predominantly consist of soft mast, other edible seeds, invertebrates, and vegetation. Because most swamp tree species produce some soft mast or other edible seeds, the actual tree species composition is not usually a limiting factor. More limiting is the presence of stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy and preferably as a combination of all three. This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.

Conversion of forested wetlands to open water or marsh within the project area has not been observed during field investigations. Minimal windthrow of canopy trees was observed; however, light to moderate crown damage and windthrow of midstory trees was evident and likely occurred from recent hurricanes and tropical storm events. Similar damage was observed throughout Maurepas swamp, with data suggesting that midstory windthrow was inversely related to canopy density (Effler et al. 2007, Shaffer personal communication per DEIS). Decreasing canopy is also indicative of stress due to prolonged inundation and/or stagnant water conditions. Decreased vigor may increase susceptibility of trees to tropical storm damage.

Plant diversity in baldcypress-tupelo swamps is typically low due to low light penetration into the understory and the extended hydroperiod, which limit the establishment and survival of understory vegetation. Baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) are common codominant canopy species in this habitat, with swamp red maple (*Acer rubrum var. drummondii*) predominant and green ash (*Fraxinus pennsylvanica*) codominant, in the midstory and understory strata. Common herbaceous species include arrow arum (*Peltandra virginica*), pennywort (*Hydrocotyle* spp.), smartweed (*Polygonum punctatum*), and lizard's tail (*Saururus cernuus*). Salvinia (*Salvinia* spp.), a non-native invasive aquatic fern, is prolific in many areas. Savanna panicum (*Phanopyrum gymnocarpon*), thought to be an indicator of flow and nutrients, was also observed in the higher quality swamps. A complete list of species and existing habitat conditions at each vegetation monitoring station is provided in CDM's October 2, 2009, "Existing Environmental Condition of Project Area" Memorandum.

Stand Structure for 20-30 Years-to-Marsh

Existing –The 20-30 years-to-marsh habitat class is characterized by having 23 percent canopy cover, 33 percent midstory cover, and 80 percent herbaceous or ground cover (Class 1). Of the overstory canopy cover, 81 percent is tupelo and other species, and the remaining 18 percent is cypress, with some monitoring sites being comprised of 100 percent tupelo. While basal area averages 113.85 ft^2/ac (moderately dense), one monitoring site has a basal area of 34.52 ft^2/ac which is considered open, and one site is 64.43 ft^2/ac which is considered to be moderately open. One aspect of stand structure that is not reflected in the data is crown damage or loss of tree tops. While this is localized within the project area it is expected to be a common characteristic in the

future as conditions deteriorate which is evident in other areas of Maurepas swamp. Crown damage also contributes to the low canopy cover phenomenon in an area were basal area is moderately dense, which consequently results in a high herbaceous cover. Water tolerance by tupelo has allowed the swamp stand structure to be dominated by tupelo in those areas experiencing prolonged flooding. Coupled with occasional salinity spikes, some tupelo dominated areas are experiencing either canopy top-off or complete canopy die off.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover will persist below 33 percent (Table 3).

Table 3. Future-with and Future-without Project Stand Structure Conditions.

FWOP

Habitat Condition Class	TY0					TY1	TY20				TY30				TY50			
		%O	%M	%H	Class		%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh		23	33	80			<33				<33				<33			
30-50 yrs. to marsh		38	39	51			33<50	<33	<33		33<50	<33	<33		<33			
>50 yrs. to marsh		64	46	22			50<75	>33	<33		50<75	>33	<33		33<50	<33	<33	

FWP

Habitat Condition Class	Level of Influence	TY0				TY1				TY20				TY30				TY50			
		%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh	High Influence	23	33	80		23	33	80		33<50	>33	>33		33<50	>33	>33		50<75	>33	<33	
	Moderate Influence	23	33	80		23	33	80		33<50	>33	>33		33<50	>33	>33		50<75	>33	<33	
	Low Influence	23	33	80		23	33	80		33<50	>33	>33		33<50	>33	>33		33<50	>33	<33	
	No Influence**	23	33	80		23	33	80		33<50	>33	>33		<33				<33			
30-50 yrs. to marsh	High Influence	38	39	51		38	39	51		33<50	>33	>33		≥50	>33	>33		≥50	>33	<33	
	Moderate Influence	38	39	51		38	39	51		33<50	>33	>33		≥50	>33	>33		≥50	>33	<33	
	Low Influence	38	39	51		38	39	51		33<50	>33	>33		33<50	>33	>33		33<50	>33	<33	
	No Influence**	38	39	51		38	39	51		33<50	>33	>33		33<50	>33	>33		33<50	>33	<33	
>50 yrs. to marsh	High Influence	64	46	22		64	46	>33		≥50	>33	>33		50<75	>33	<33		50<75	>33	<33	
	Moderate Influence	64	46	22		64	46	>33		≥50	>33	>33		50<75	>33	<33		50<75	>33	<33	
	Low Influence	64	46	22		64	46	>33		≥50	>33	>33		50<75	>33	<33		50<75	>33	<33	
	No Influence**	64	46	22		64	46	>33		≥50	>33	>33		50<75	>33	<33		50<75	>33	<33	

FWP – Depending on the location of this habitat class within the influence of the diversion, the 20-30 years to marsh is expected to see some benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. According to FWP modeling of "existing conditions with berm cuts", the project area is expected to be constantly inundated with an average annual water depth throughout the project area of 1.01 feet by target year 20 and 1.75 feet by target year 50. Additional flows from a 3,000 cfs diversion would only increase flood duration. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest possible dry out period in some years. With the diversion average annual water depths are predicted to be in some areas as high as 3.71 feet (Alternative 6, hydrologic sub-basin series 200) and 5.82 feet (Alternative 4, hydrologic sub-basin series 200) during operation of the diversion. Therefore, the stand structure class was reduced at target year 50 (Table 3) to reflect prolonged inundation and a reduced herbaceous and midstory component.

Areas not affected by the diversion should see some benefits of increased hydrologic flow/throughput as a result of the in-swamp management measures. However, these benefits are short term as total sea level rise contributes to these areas returning to a persistent flooding regime by target year 20. It is projected that those areas of 20-30 years-to-marsh habitat class within areas not influenced by the diversion will not have enough time and benefits to regenerate and maintain a healthy forested stand, and, therefore, returns to a Class 1 by target year 30.

Stand Structure for 30-50 Years-to-Marsh

Existing – The 30-50 years-to-marsh habitat class is characterized by having 38 percent canopy cover, 39 percent midstory cover, and 51 percent herbaceous or ground cover (Class 5). Of the overstory canopy cover, 85 percent is tupelo and other species and the remaining 15 percent is cypress. Similar to the 20-30 years-to-marsh habitat class, several of the monitoring vegetation sites were 100 percent tupelo. Basal area varied from 133.42 ft^2/ac to 320.79 ft^2/ac, or moderately dense to dense; however, light penetration appears to be suitable enough to support a midstory and herbaceous cover component.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, especially to tupelo, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover is predicted to drop below 33 percent by target year 50.

FWP – High to moderate influenced areas are predicted to see benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. As noted above, flood duration is expected to increase as total sea level rise increases, resulting in an eventual decrease in herbaceous cover by target year 50.

Areas that are not affected (no influence areas) or are minimally affected (low influence areas) by the diversion see no increase in stand structure, but rather maintain the existing stand structure until target year 50. Consistent with the previously mentioned hydrologic conditions, stand structure is reduced at target year 50 as a result of a reduced herbaceous component.

Stand Structure for Greater than 50 Years-to-Marsh

Existing – The greater than 50 years-to-marsh habitat class is characterized by having 64 percent canopy cover, 46 percent midstory, and 22 percent herbaceous or ground cover. Of the overstory canopy cover, 44 percent is tupelo and other species and 56 percent is cypress. While the percentage indicates an even distribution, the individual monitoring vegetation sites were dominated by either one or the other species. Basal area and percent canopy cover is considered optimal, or dense, with an average basal area of 256.09 ft^2/ac. The midstory is also considered suitable; however, herbaceous cover is less than optimal likely due to lack of light penetration and nutrients.

FWOP – In comparison to other areas of the Maurepas swamp, this habitat class is considerably healthier and is expected to maintain a Class 4 stand structure through much of the FWOP life. By target year 50 conditions will begin to deteriorate and the canopy begins to thin.

FWP – This habitat class is expected to see benefits as a result of increased sediments, nutrients, and freshwater from the diversion, and due to increased throughput as a result of in-swamp management measures. Consequently, an increase in herbaceous cover is expected within the short term for all areas of influence. However, as canopy closure becomes even more prevalent and as flood duration is expected to increase as total sea level rise increases, a decrease in herbaceous cover by target year 30 is predicted.

Variable V_2 - Stand Maturity (Table 8)

The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important component of this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, but only average DBH, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically an adequate number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Existing Conditions

Seven vegetation monitoring stations were identified that were representative of the 20-30 years-to-marsh class. Basal area averaged 113.85 ft^2/acre. The average DBH measured 11.21 inches

for cypress and 13.08 inches for tupelo and other canopy co-dominant species. Even though this is the most degraded habitat, class basal area is still considered to be moderate.

Six vegetation monitoring stations were identified that were representative of the 30-50 years-to-marsh class. Basal area averaged 222.73 ft²/acre. The average DBH measured 14.71 inches for cypress and 14.20 inches for tupelo and other canopy co-dominant species.

Nine vegetation monitoring stations were identified that were representative of the greater-than 50 years-to-marsh class. Basal area averaged 256.09 ft²/acre. The average DBH measured 15.76 inches for cypress and 13.97 inches for tupelo and other canopy co-dominant species.

FWOP

Numerous bald cypress and tupelo growth rates have been documented in deep water swamp habitats and are summarized by Visser and Sasser (1995). For FWOP conditions we assumed mean annual growth rates documented by Dr. Shaffer (unpublished) (Table 4) for target years 1-20. These assumptions are similar to what was used for the LCA, Amite River Diversion Channel Modification project. Since subsidence, total sea level rise and associated stresses are expected to continue mean annual growth rates were reduced for target years 20-50.

Table 4. Cypress and Tupelo Annual Growth Rates FWOP

	Cypress (inches)	Tupelo et al (inches)
TY 0-20		
20-30 yrs to marsh	0.11	0.08
30-50 yrs to marsh	0.15	0.1
>50 yrs to marsh	0.15	0.1
TY 20-50		
20-30 yrs to marsh	*0.064	**0.073
30-50 yrs to marsh	*0.064	0.08
>50 yrs to marsh	*0.064	0.08

*Visser and Sasser (1995) ** Day (1985) from Visser and Sasser (1995)

Increase in basal area was estimated by species and habitat condition class by calculating and projecting the increase in basal area using the predicted growth rates and tree mortality. Percent composition of canopy trees in the FWOP was estimated based on best professional judgment of expected mortality of tupelo among the habitat condition classes taking into consideration assumptions made for the CWPPRA Maurepas ("Hope Canal") Diversion Project. The CWPPRA (Hope Canal) Diversion Project estimated that 50% of tupelo would die over the 20 year FWOP life, but that actual mortality of cypress would be minimal. Because habitat conditions within the Convent/Blind River project area are more favorable and are not at the same stage of degradation we assumed a reduced tupelo mortality rate for the first 20 years and for higher quality habitat condition classes (Table 5). Because tupelo is more flood tolerant highly degraded areas have become dominated by tupelo. Those areas have also experienced continued degradation as a result of seasonal salinity spikes and are seeing increased tupelo mortality and reduced vigor. In order to be conservative only tupelo mortality was assumed when determining FWOP mortality and projected project benefits because lower quality habitats were dominated by tupelo.

Table 5. Tupelo Mortality FWOP

	TY 20	*TY 50
20-30 yrs to marsh	50%	50%
30-50 yrs to marsh	25%	50%
>50 yrs to marsh	25%	25%

*percent mortality is of the TY 0 (existing) stand

Table 6. Tupelo Mortality FWP

	TY 1	TY 20	TY 50	Total Mortality
High Influence				
20-30 yrs to marsh	0%	0%	5%*	5%
30-50 yrs to marsh	0%	0%	5%*	5%
> 50 yrs to marsh	0%	0%	0%	0%
Moderate Influence				
20-30 yrs to marsh	0%	0%	10%*	10%
30-50 yrs to marsh	0%	0%	10%*	10%
> 50 yrs to marsh	0%	0%	0%	0%
Low Influence				
20-30 yrs to marsh	0%	0%	20%*	20%
30-50 yrs to marsh	0%	0%	20%*	20%
> 50 yrs to marsh	0%	0%	10%*	10%
No Direct Influence				
20-30 yrs to marsh	0%	40%*	40%*	80%
30-50 yrs to marsh	0%	10%*	40%*	50%
> 50 yrs to marsh	0%	10%*	20%*	30%

*% of existing stand @ TY0

Table 8. Future-with and Future-without Project Stand Maturity Conditions.

Future Without Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft²/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	FWOP	baldcypress	11.87	13.96	14.60	15.88	10.42	18.87	18.87	100.00	122.35	82.98	90.81	18.42
		tupelo et al.	13.56	15.08	15.81	0.00	89.58	81.13	81.13	0.00				
30-50 yrs. to marsh	FWOP	baldcypress	15.61	18.46	19.10	20.38	17.57	22.13	22.13	46.02	241.96	247.88	269.12	157.24
		tupelo et al.	14.80	16.70	17.50	19.10	82.43	77.87	77.87	53.98				
>50 years to marsh	FWOP	baldcypress	16.66	19.51	20.15	21.43	41.51	48.62	48.62	58.67	280.03	320.24	345.15	338.32
		tupelo et al.	14.57	16.47	16.47	18.87	58.49	51.38	51.38	41.33				

Future With Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft²/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	High Influence	baldcypress	11.98	16.16	17.25	18.91	10.42	10.42	10.42	10.91	123.80	185.60	213.14	247.37
		tupelo et al.	13.64	16.68	17.92	19.82	89.58	89.58	89.58	89.09				
	Moderate Influence	baldcypress	11.95	15.50	16.33	17.61	10.42	10.42	10.42	11.44	123.37	174.97	195.25	208.04
		tupelo et al.	13.62	16.20	17.15	18.61	89.58	89.58	89.58	88.56				
	Low Influence	baldcypress	11.91	14.62	15.26	16.54	10.42	10.42	10.42	12.69	122.79	161.30	176.18	170.34
		tupelo et al.	13.59	15.56	16.29	17.75	89.58	89.58	89.58	87.31				
	No Influence**	baldcypress	11.87	13.96	14.60	15.88	10.42	16.23	16.23	36.76	122.35	96.67	105.81	54.07
		tupelo et al.	13.56	15.08	15.81	17.27	89.58	83.77	83.77	63.24				
30-50 yrs. to marsh	High Influence	baldcypress	15.56	21.26	22.35	24.01	17.57	17.57	17.57	18.32	241.69	383.85	435.66	500.91
		tupelo et al.	14.80	18.60	19.96	22.04	82.43	82.43	82.43	81.68				
	Moderate Influence	baldcypress	15.52	20.36	21.19	22.47	17.57	17.57	17.57	19.15	240.70	359.05	397.06	423.01
		tupelo et al.	14.77	18.00	19.04	20.64	82.43	82.43	82.43	80.85				
	Low Influence	baldcypress	15.46	19.16	19.80	21.08	17.57	17.57	17.57	21.04	239.40	327.36	355.08	348.08
		tupelo et al.	14.71	17.20	18.00	19.60	82.43	82.43	82.43	78.96				
	No Influence**	baldcypress	15.41	18.26	18.90	20.18	17.57	19.15	19.15	29.89	238.42	280.58	305.05	232.82
		tupelo et al.	14.70	16.60	17.40	19.00	82.43	80.85	80.85	70.11				
>50 yrs. to marsh.	High Influence	baldcypress	16.81	22.51	23.60	25.27	41.51	41.51	41.51	41.51	275.69	454.73	510.25	601.75
		tupelo et al.	14.67	18.47	19.83	21.91	58.49	58.49	58.49	58.49				
	Moderate Influence	baldcypress	16.77	21.51	22.45	23.73	41.51	41.51	41.51	41.51	274.46	423.36	464.05	530.56
		tupelo et al.	14.64	17.87	18.93	20.51	58.49	58.49	58.49	58.49				
	Low Influence	baldcypress	16.71	20.41	21.05	22.33	41.51	41.51	41.51	44.09	272.83	383.33	412.97	450.44
		tupelo et al.	14.60	17.07	17.87	19.47	58.49	58.49	58.49	55.91				
	No Influence**	baldcypress	16.66	19.51	20.15	21.43	41.51	44.09	44.09	50.34	271.61	336.31	363.08	372.21
		tupelo et al.	14.57	16.47	17.27	18.87	58.49	55.91	55.91	49.66				

**NO INFLUENCE GROWTH RATES SET AS FWOP.

FWP

The proposed diversion is expected to substantially stimulate productivity, and so stimulate growth of the cypress and tupelo (as well as other species). The amount of stimulation is assumed to be related to level of influence of the diversion. Depending on the alternative diversion location certain hydrologic units will receive different levels of influence. Those areas within the high influence area will receive freshwater, nutrients, and sediments; so it is assumed those hydrologic units will see the greatest increase in growth. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (EPA 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing levels of productivity in Maurepas are ½ to ¼ of average values (EPA 2001). Southeast Louisiana University study sites within the Maurepas swamp that receive non-point source runoff (i.e., containing nutrients and sediment) have documented an average 1 centimeter of diameter increase per year. When sewage effluent is involved some study sites average 1.5 cm of growth per year close to such a source (Bernard Wood, personal communication). As a very conservative projection, a 2-fold increase in growth rate (i.e., 200% of growth rates listed in Table 4) was applied to the high influence areas for the first 19 years to capture the anticipated stimulation of growth from the diversion. Reduced growth rates were assumed as the level of influence decreased and as the area returned to a more semi-permanent flooding regime (Table 7). DBH and basal area in the FWP were estimated as for FWOP, by applying the increased growth rates and mortality rates.

Table 7. Percent Increase in DBH growth rate based on Level of Diversion Influence (50 yr project life) FWP

	TY 1	TY 20	TY 30
High Influence Area	200%	170%	130%
Moderate Influence Area	170%	130%	100%
Low-Direct Influence Area	130%	100%	100%

Areas not affected by the diversion may still experience benefits as a result of the berm cuts and in-swamp management modifications. Tupelo mortality was assumed based on flood duration and existing stand health. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest possible dry out period in some years.

Variable V_3 - Water Regime (Table 9)

The optimal water regime is assumed to be seasonally flooded with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. In addition, abundant and consistent input and water flow-through is optimal, because under that regime the full functions and values of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable. Habitat

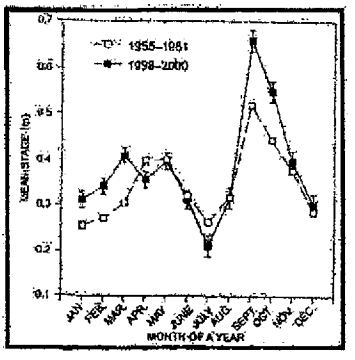
suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be the least desirable (SI=0.1). Those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production (WVA Procedure Manual).

Existing

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA Maurepas (Hope Canal) Diversion project, has revealed that the Maurepas swamp floor elevations (i.e., 1.12 feet NAVD per CRMS station 5167) are often lower than Lake Maurepas bottom elevations. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and the hydrologic impoundments caused by major transportation corridors. Adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., U.S. Interstate 10, U.S. Highway 61, and Kansas City Southern Railroad (KCSRR)]; flood waters within the project area are the last to recede from the basin. It is appears that within hydrologic unit 3 interior elevations are low enough to allow ponding of water for longer periods of time, and is, therefore, considered permanently flooded with low water exchange.

Lunar tidal fluxes in Maurepas swamp average 30 cm but are typically overwhelmed by meteorological tidal fluxes. Wind is also a significant forcing agent for water level in Maurepas swamp and may exhibit daily and seasonal variability. During the summer and early fall, storms and prevailing winds from the southeast raise water levels in the swamp as they push Gulf water into the system. Conversely, during the winter months, continental fronts with prevailing winds from the northeast often lower water levels in the swamp as they push water out of the system and towards the Gulf. Fluctuations in water level are generally expected to be similar throughout Maurepas swamp, acknowledging slight variability associated with landscape position and elevation. Within any given year, water stage is characterized by a bimodal hydrograph (Figure 4). Water level rises in the spring, then falls to its lowest level during the summer, rises to its highest level in the fall, and again falls to low levels in the winter (Thomson 2000, Keddy et al. 2007). The intensity of peaks and troughs is typically associated with those meteorological events.

Figure 4. Intra-annual variability of monthly mean stage comparing the periods 1955-1981 (historical) and 1998-2000 (drought period). The duration of flooding (percentage of the year that the marshes by Schleider's Ditch flood) more than doubled over the period of record for the USACE tide gage (from Thomson 2000, referenced in Keddy 2007)



Water exchange between the project area swamps and adjacent swamps is reduced to what the Blind River and other small tributaries can exchange across the embankments of the three transportation corridors (i.e., U.S. Interstate 10, U.S. Highway 61, and KCSRR). These embankments act as hydrologic barriers and reduce flow-through across the project area swamp. Within the project area interior drainage and hydrologic exchange has been altered by the construction of drainage canals and associated berms, pipeline and transmission line rights-of-way, and remnant logging infrastructure (i.e., roads, pull boat ditches, and temporary railroad track embankments). Historically, seasonal overbank flooding over the natural Mississippi River levees facilitated hydrologic exchange and freshwater input on average every three to five years. Today the only additional freshwater input is through rainwater runoff, and even those contributions can by-pass the wetland system through the many storm water drainage canals that direct floodwaters directly into Blind River and Lake Maurepas. The project area swamp habitat has been altered and disrupted to a point that adequate water exchange does not exist, and is considered to have low water exchange.

FWOP

Future without project conditions flood durations are expected to worsen as sea level rise and subsidence continues and storm water control projects continue to force storm water into an already flooded system. It is assumed that the entire project area swamp habitat will become permanently flooded and continue to have low flow exchange.

Table 9. Summary for Average Annual Water Depth (ft)

No Sea Level Rise (existing conditions)

Alternatives	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.90	1.73	1.83	2.09	1.34	1.53	1.61	1.72
	Existing Conditions; With Berm Cuts	0.78	0.74	0.69	0.82	0.55	0.58	0.65	0.69
2	Romeville Diversion	2.13	0.74	1.30	2.18	0.55	0.59	0.66	1.16
4	South of Highway 70 Bridge Diversion	1.79	3.40	1.62	0.85	0.54	0.59	0.65	1.35
6	Total Diversion	1.82	2.08	1.47	1.54	0.55	0.59	0.65	1.24

20-year Sea Level Rise

	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.92	1.76	1.84	2.11	1.37	1.56	1.65	1.75
	Existing Conditions; With Berm Cuts	1.10	1.08	0.99	1.20	0.81	0.89	1.02	1.01
2	Romeville Diversion	2.75	1.08	2.03	2.93	0.82	0.90	1.02	1.65
4	South of Highway 70 Bridge	2.42	4.66	2.46	1.27	0.81	0.89	1.02	1.93
6	Total Diversion	2.44	2.84	2.30	2.13	0.81	0.90	1.02	1.78

30-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions	1.95	1.82	1.87	2.14	1.42	1.61	1.71	1.79
	Existing Conditions; With Berm Cuts	1.29	1.30	1.17	1.42	0.98	1.08	1.26	1.21
2	Romeville Diversion	2.99	1.30	2.38	3.21	0.99	1.12	1.27	1.89
4	South of Highway 70 Bridge	2.77	5.13	2.91	1.54	0.98	1.09	1.26	2.24
6	Total Diversion	2.76	3.16	2.70	2.45	0.99	1.10	1.27	2.06

50-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions;	2.15	2.07	2.04	2.33	1.64	1.83	2.02	2.01
	Existing Conditions; With Berm Cuts	1.83	1.88	1.68	1.96	1.48	1.58	1.86	1.75
2	Romeville Diversion	3.49	1.88	3.06	3.73	1.51	1.68	1.88	2.46
4	South of Highway 70 Bridge	3.52	5.82	3.83	2.16	1.48	1.60	1.85	2.90
6	Total Diversion	3.42	3.71	3.47	3.16	1.51	1.69	1.88	2.69

FWP

Depending on the location of the hydrologic unit within the watershed in relation to the diversion outfall it was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). However, all HUs see increased benefits in the form of dry-out frequency as a result of the berm cuts assuming the diversion would be operated to maximize dry-out frequency. At this time an operational plan has not been developed. In target year 1 (defined as "existing conditions with berm cuts" in Table 9), without a diversion water depths are lower than existing conditions throughout all hydrologic units for all alternatives, and below swamp floor elevations in most hydrologic units (Table 9).

Hydrologic data indicates that by TY 20 water levels within all areas are at or above swamp floor elevations. Within areas of high influence sediment accretion is expected and should keep up with total sea level rise. Nutrient input into areas moderately influenced would facilitate increased growth rates contributing to above ground biomass. While this has been taken into

consideration, accretions rates have not been predicted or analyzed at this time. As displayed in Table 10, FWP water regime was evaluated by each hydrologic unit for each alternative and grouped according to level of influence by the diversion.

Table 10. Future With Project Water Regime Conditions.

	TY0		TY1		TY20		TY30		TY50	
	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	semiperm/-low	0.45	seasonal-moderate	0.85	semiperm-moderate	0.65	semiperm-moderate	0.65	semiperm-moderate	0.65
no influence	perm-low	0.30	seasonal-low	0.70	semiperm-low	0.45	perm-low	0.30	perm-low	0.30
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	permanent-low	0.30	semiperm-moderate	0.65	semiperm-moderate	0.65	permanent-moderate	0.45	permanent-moderate	0.45
no influence	-	-	-	-	-	-	-	-	-	-

Variable V_4 - Mean high salinity during the growing season.

Swamps can tolerate increased salinities; however increased salinity spikes coupled with prolonged flooding has been shown to be detrimental to those forested swamps. Baldcypress is able to tolerate higher salinities compared to other swamp species such as tupelogum and many herbaceous species which are salinity-sensitive. Salinity recorded at Pass Manchac during the 1999-2000 drought spiked at 8 parts-per-thousand (ppt) and averaged around 5 ppt until heavy rains in July 2000 ended the drought (Keddy et al. 2007). For the Swamp WVA optimal conditions for salinity are assumed when mean high salinities during the growing season are equal to or less than 1.0 ppt. Habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

For the CWPPRA Maurepas (Hope Canal) Freshwater Diversion project the lowest existing salinities documented were 1.53 ppt for the "Hope" station group (EPA 2001). The Convent/Blind River Diversion project area is located further inland from the "Hope" station group and is landward of several hydrologic barriers (i.e., I-10, US 61, KCSRR), thereby being protecting from the higher salinity waters coming from the Gulf. Because of these barriers it is likely salinity levels remain relatively consistent throughout the project area and do not fluctuate

within the project area. While salinity spikes still affect the project area through the hydrologic connectivity of Blind River and other small tributaries, those salinity spikes are not representative of typical salinities and are not represented in this variable. For 2008, average salinities during the growing season recorded at CRMS stations (0065 and 5167) located west of U.S. Hwy 61 were measured at 0.25 ppt. The highest salinity measured during the growing season was 0.33 ppt. Salinities have been collected periodically in Blind River at US Hwy 61 by LDEQ (LA040403), and average annual salinities taken from 1981 to 1998 were 0.95 ppt. Average salinities recorded during the growing season at that station range from 0.15 ppt in 1996 to 0.70 ppt in 1995. However, those values were only obtained from the months of April, June, August, and October. For two CRMS stations located west of U.S. Hwy 61 and in the project area average salinities in the growing season were measured at 0.35 ppt (CRMS0039) and 0.53 ppt (CRMS5167), slightly higher than the interior sites.

According to the data available for the entire project area it appears that mean high salinity during the growing season is less than 1.0 ppt. Should restoration projects proposed for the Lake Pontchartrain Basin not be implemented, it is highly likely that the project area will continue to see slight increases in average salinities and a greater frequency in salinity spikes. This is evident from the salinity trends observed in the forested swamps to the east and closer to Lake Maurepas. However, average high salinities during the growing season are not expected to exceed 1.0 ppt over the project life. The suitability index for salinities 1.0 ppt or less is 1.0.

It is assumed that the project area can be subdivided into two salinity regions. Areas east of U.S. Hwy 61 and south of Interstate 10 experience slightly higher salinity levels as a result of being closer to the lake. Areas further inland and west of U.S. Hwy 61 are slightly fresher due to the hydrologic barriers impeding the salinity gradient and the contribution of freshwater run-off from the adjacent upland areas.

Existing conditions for areas east of U.S. Hwy 61 are estimated based on the CRMS data for 0065 and 5167. Salinities were consistent throughout the 2008 growing season so mean high salinities were not calculated. Because of freshwater runoff and the hydrologic barriers, average mean high salinities are not expected to increase; however, salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes. Average high salinities during the growing season are not expected to exceed 1.0 ppt over the 50-year future without project life.

Existing conditions for areas west of U.S. Hwy 61 are estimated using data from the two CRMS stations (0039 and 5167) within the area. It is likely that in the 50-year future without project life the area will experience a slight increase in salinities, but will still be within the optimal range. Project area salinities are greatly influenced by adjacent storm water and agricultural freshwater runoff, and hydrologic barriers prevent high saline waters from entering the swamps. Salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes.

Modeling conducted for the closure of the MRGO at Bayou La Loutre showed that salinities would decrease within the adjacent marshes and associated waterways on the order of 1.0 to 3.0 ppt as a result of that closure (Draft IER 11 Tier 2 Pontchartrain 2009). Higher saline waters that

commonly entered through the MRGO into the southern end of Lake Pontchartrain have been cut off as a result of that closure and the Lake Borgne surge barrier currently being constructed.

Summary/Results

According to initial results from the hydrologic modeling, benefits are achieved through gapping spoil banks and modifying other hydrologic barriers to allow the redistribution of hydrologic flow throughout the swamp system. Because in-swamp management is a feature of all three alternatives, all three alternatives see considerable WVA benefits in the first 20 years as a result of those features; therefore, the difference in AAHUs between alternatives is minimized. The analysis then becomes a comparison of diversion influence areas. Based on preliminary hydrologic modeling results which at this stage of the study has focused on transfer of flow between benefit areas, the Romeville diversion alternative (Alternative 2) directly influences a larger area (i.e., HUs 1 and 4) compared to Alternative 4, the South of Hwy 70 Bridge diversion alternative (i.e., HUs 1 and 2). The "Total diversion" alternative (i.e., Alternative 6 and 4b) consequently has the highest benefits because sediments, nutrients, and freshwater are influencing a larger receiving area. Another observation in the analysis is that basal area throughout most of the project area is considered to be within the optimal range (i.e., >161 sq. ft./ac) to support wildlife habitat. The WVA, therefore, does not show a distinction (or change in suitability indices) between habitat classes and between FWP and FWOP for this variable. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The project area is semi-permanently flooded and future-with-project modeling projections indicates that the flooding regime within most of the project area will return to pre-project conditions by target year 20 as a result of total sea level rise. However, hydrologic flow will be improved and will provide additional benefits by increasing forest stand vigor, accretion, water quality and back flow prevention.

Data Gaps and Additional Information Needs for Analyzing Benefits of the Tentatively Selected Plan (TSP)

Because of the expedited schedule, limited data was available at the time of this analysis. Therefore, the intent of this habitat analysis is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Diversion operations need to be developed by alternative and incorporated into the hydrologic modeling.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

IMPACTS

For each alternative, impacts to swamp habitat are associated with the transmission channel from the Mississippi River to the outfall area (benefit area) and with transmission canal construction and modification within the outfall area (Tables 11 & 12). For FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed alternative.

Table 11. Forested Wetland Impacts (Acres)

	Alternative 2 Romeville 3000cfs	Alternative 4 Southbridge 3000cfs	Alternative 4B Southbridge 3000 cfs split flows	Alternative 6 Romeville 1500 cfs Southbridge 1500 cfs
Diversion Channel	53	107	107	160
Northern Transmission Canal	-	163	126	126
Widening of St James Canal	-	-	72	-
Total	**53**	**270**	**305**	**286**

Impacts associated with the transmission channel were quantified using the highest quality habitat (i.e., greater than 50 years-to-marsh) variable assumptions from the WVA assessing benefits. Field data was not obtained along the proposed transmission channels due to limited time associated with the expedited schedule; therefore, variable assumptions were made to give advantage to the forested resources being impacted (e.g., stand structure and maturity were assumed to have the highest suitability index value). Forested areas closer to, and associated with, the natural levee of the Mississippi River are at higher elevations, and prolonged inundation is not expected. Therefore, for areas where water regime is currently classified as seasonal or temporary, stand structure class is expected to increase through the 50-year project life. Water regime was determined using classifications by National Wetlands Inventory 1988. Forested habitat at higher elevations along the natural levee of the Mississippi River is not expected to experience marked salinity influences through the project life. See WVA worksheets for the discrete variable assumptions.

The proposed northern transmission canal (i.e., Alternatives 4A, 4B, and 6) traverses through the "benefit area" and the associated acreage was previously included in the habitat analyses evaluating benefits. Those analyses were revised, and the associated acres impacted were subtracted from the respective analysis by habitat condition class. The associated impacts were then evaluated using the same variable assumptions from those previous habitat analyses assessing benefits for FWOP. Again, for FWP, all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Alternative 4B would include expanding the St. James Parish Canal and constructing channel berms to achieve a head differential sufficient to move diverted water to the southern portion of the project area. While additional indirect impacts would be associated with impounding areas of swamp by constructing these berms, only direct impacts to wetlands were evaluated. Much of this area was already classified in the habitat condition class and the same variable assumptions for FWOP were used. Again, for FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Figure 5. Forested Impacts Associated with the Romeville Diversion Channel (Alts. 2 & 6)



Figure 6. Forested Impacts Associated with the South Bridge Transmission Channel (Alternative 4A and 6)

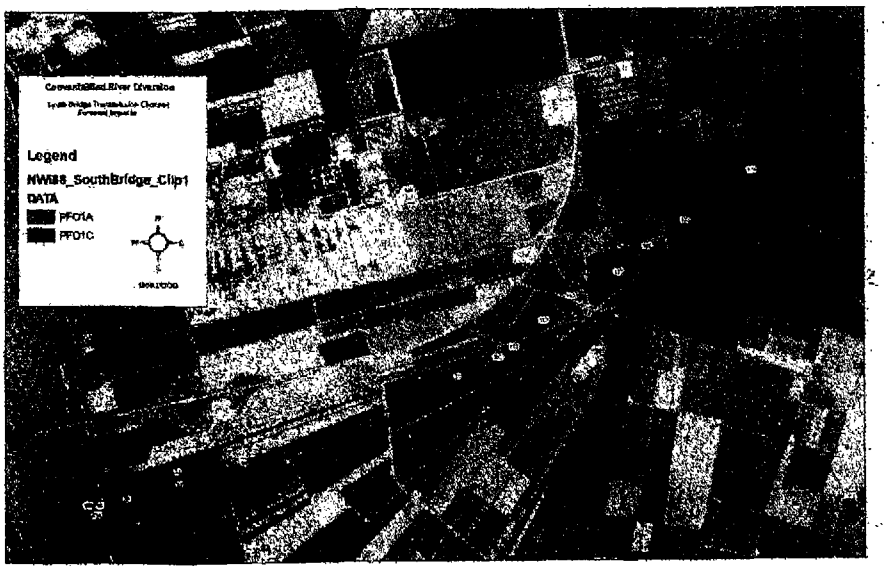


Figure 7. Forested Impacts Associated with the Outfall Canal (Alternatives 4A, 4B, & 6).

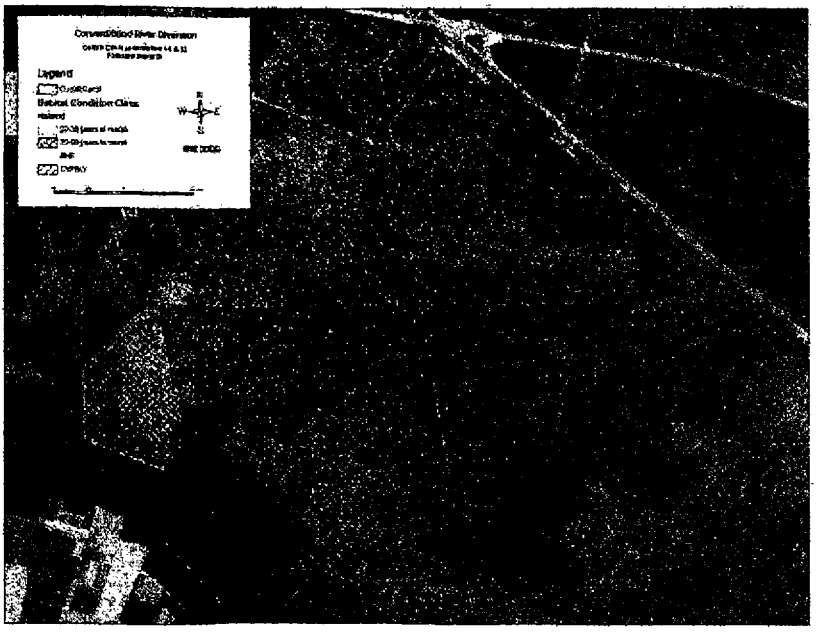


Figure 8. Forested Impacts Associated with Widening St. James Parish Canal (Alt. 4B)

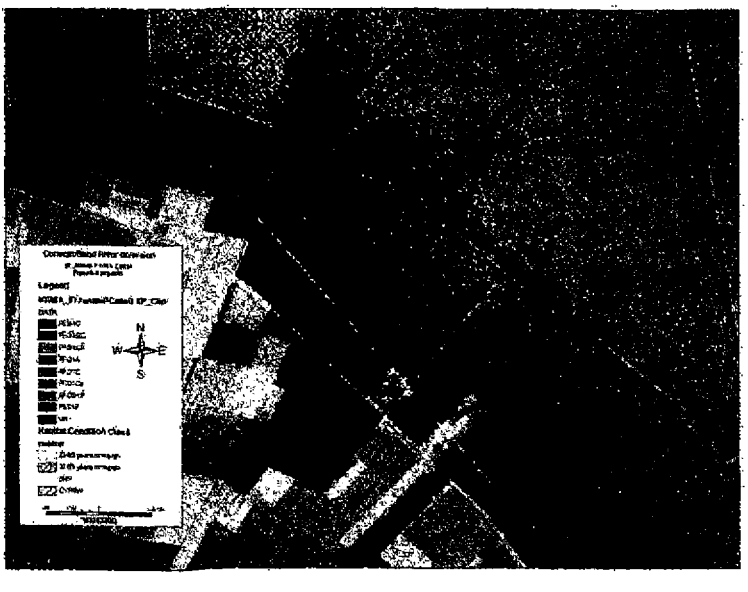


Table 12. Summary of Total Acres Benefited and Impacted.

	Acres			
Benefits	Alternative 2	Alternative 4A	Alternative 6	4B
High IA, 20-30 years to marsh	169	169	169	169
High IA, 30-50 years to marsh	3364	1827	3848	3848
High IA, >50 years to marsh	4555	3550	5361	5361
Moderate IA, 20-30 years to marsh	204	1837	2041	2041
Moderate IA, 30-50 years to marsh	604	2972	3579	3579
Moderate IA, >50 years to marsh	2607	2070	4691	4691
Low IA, 20-30 years to marsh	2397	0	1085	1085
Low IA, 30-50 years to marsh	1669	2013	469	469
Low IA, >50 years to marsh	469	1799	0	0
No IA, 20-30 years to marsh	525	1289	0	0
No IA, 30-50 years to marsh	2297	1073	0	0
No IA, >50 years to marsh	2509	2607	0	0
Benefits Total	21,369	21,206	21,243	21,243
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	36	28	28
High IA, >50 years to marsh	0	52	40	40
Moderate IA, 30-50 years to marsh	0	13	10	10
Moderate IA, >50 years to marsh	0	62	48	48
Transmission Channel				
FWetlands, Seasonally Flooded	31	39	70	39
FWetlands, Temporarily Flooded	2	69	71	69
FWetlands, Semipermanent Flooded	20	0	20	0
St. James Parish Canal Modifications				
FWetlands, Seasonally Flooded	0	0	0	22
FWetlands, Semipermanent Flooded	0	0	0	50
Impacts Total	53	271	287	306
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 13. Summary of Total AAHUs.

	Average Annual Habitat Units (AAHUs)			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	77	77	77	77
High IA, 30-50 years to marsh	1350	733	1545	1545
High IA, >50 years to marsh	1293	1014	1532	1532
Moderate IA, 20-30 years to marsh	93	828	919	919
Moderate IA, 30-50 years to marsh	243	1182	1423	1423
Moderate IA, >50 years to marsh	745	585	1325	1325
Low IA, 20-30 years to marsh	935	0	354	354
Low IA, 30-50 years to marsh	527	663	137	137
Low IA, >50 years to marsh	110	447	0	0
No IA, 20-30 years to marsh	72	163	0	0
No IA, 30-50 years to marsh	585	237	0	0
No IA, >50 years to marsh	431	373	0	0
Benefits Total	**6,462**	**6,302**	**7,313**	**7,313**
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	-17.07	-13.28	-13.28
High IA, >50 years to marsh	0	-30.19	-23.22	-23.22
Moderate IA, 30-50 years to marsh	0	-6.09	-4.69	-4.69
Moderate IA, >50 years to marsh	0	-35.69	-27.63	-27.63
Transmission Channel				
FWetlands, Seasonally Flooded	-25.87	-32.55	-58.43	-32.55
FWetlands, Temporarily Flooded	-1.67	-56.33	-57.96	-56.33
FWetlands, Semipermanent Flooded	-13.5	0	-13.5	0
St. James Parish Canal Modificaitons				
FWetlands, Seasonally Flooded	0	0	0	-18.36
FWetlands, Semipermanent Flooded	0	0	0	-33.76
Impacts Total	-41.04	-177.92	-198.71	-209.82

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Appendix A

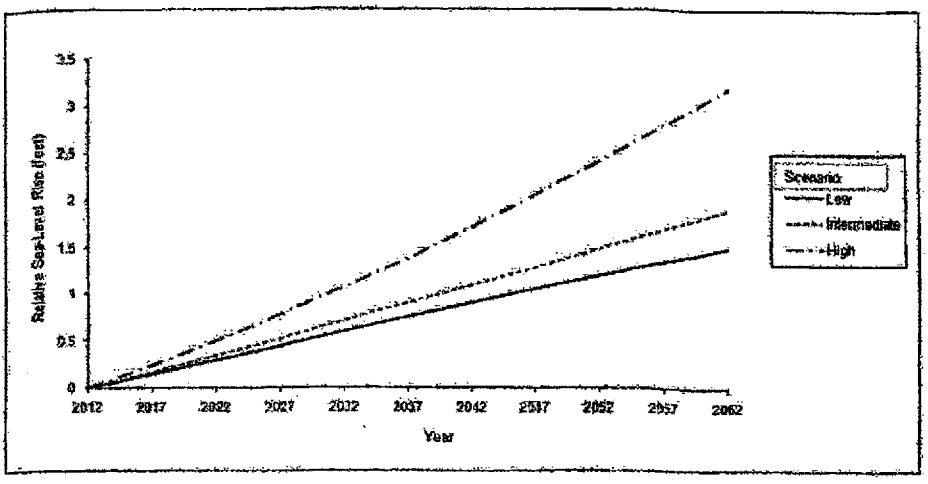
The direct impact of the diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp.

Based on hydrologic and hydrodynamic modeling, CDM has projected that for the low relative sea level rise scenario the project area will experience average annual water depths of 1.46, 1.67, and 2.11 feet in target years 20, 30, and 50, respectively. For the high sea level rise scenario the project area will experience average annual water depths of 1.79, 2.26, and 3.46 feet in target years 20, 30, and 50, respectively. Finally, for the intermediate sea level rise scenario the project area will experience average annual water depths of 1.54, 1.80, and 2.42 feet in target years 20, 30, and 50, respectively (Figure 1).

Table 1. Projected relative sea-level rise (feet) over the project life (2012-2062) in 5-year increments for low, intermediate, and high scenarios in the project area based on West End at Lake Pontchartrain tide gage daily stage data from 1959-2009 and USACE Circular No. 1165-2-211 (2009).

	Relative Sea Level Rise (feet)		
YEAR	LOW	INTERMEDIATE	HIGH
2012	0	0	0
2017	0.15	0.17	0.24
2022	0.30	0.35	0.51
2027	0.45	0.53	0.78
2032	0.60	0.72	1.08
2037	0.75	0.90	1.39
2042	0.91	1.10	1.72
2047	1.06	1.29	2.06
2052	1.21	1.49	2.42
2057	1.36	1.70	2.80
2062	1.51	1.90	3.19

Figure 1. Projected relative sea-level Rise (Ft) over the project life (2011-2061) for low, intermediate and high scenarios.



Based on the available hydrologic hydrodynamic modeling the following assumptions were made (Table 2). The direct impact of the diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp.

Table 2: Alternative 2, Water Regime Relative to Sea Level Rise

	TY0	TY1	TY20	TY30	TY50

RSLR*	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI
EWOP	semiperm-low	0.45	perm-low	0.45	perm-low	0.30	perm-low	0.30	perm-low	0.30
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
FWOP	semiperm-low/ perm/low	0.45 /0.4	semiperm-low/ perm/low	0.45 /0.4	semiperm-low/ perm-low	0.45 /0.4	semiperm-low/ perm-low	0.45 /0.4	perm-low	0.4
high influence	semiperm-low	0.45	seasonal-high	1.00	seasonal-high	1.00	seasonal-high	1.00	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	seasonal-high	1.00	seasonal-high	1.00	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	seasonal-moderate	0.85	semiperm-mod	0.65	semiperm-moderate	0.65
no influence	semiperm-low	0.45	seasonal-low	0.70	seasonal-low	0.70	seasonal-low	0.70	semiperm-low	0.45
FWOP	semiperm-low	0.45	semiperm-low	0.45	perm-mod	0.45	perm-mod	0.45	perm-mod	0.45
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	perm-high	0.65
moderate	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	perm-high	0.65
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	perm-moderate	0.45	perm-mod	0.45	perm/high	0.65
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-moderate	0.65	semiperm-moderate	0.65	perm-mod	0.45

* Accretion rates were not considered

Table 3: Comparison of Benefits under Low, Intermediate, and High Sea Level Rise Scenarios

Average Annual Habitat Units (AAHUs)

Benefits	Alternative 2	Low SLR	High SLR
High IA, 20-30 years to marsh	77	81	71
High IA, 30-50 years to marsh	1350	1399	1189
High IA, >50 years to marsh	1293	1291	1004
Moderate IA, 20-30 years to marsh	93	98	86
Moderate IA, 30-50 years to marsh	243	251	213
Moderate IA, >50 years to marsh	745	744	580
Low IA, 20-30 years to marsh	935	1008	788
Low IA, 30-50 years to marsh	527	594	405
Low IA, >50 years to marsh	110	114	69
No IA, 20-30 years to marsh	72	81	74
No IA, 30-50 years to marsh	585	651	607
No IA, >50 years to marsh	431	470	415
Benefits Total	**6,462**	**6,782**	**5,500**
Impacts			
Transmission Channel			
FWetlands, Seasonally Flooded	-25.87	-26	-26
FWetlands, Temporarily Flooded	-1.67	-2	-2
FWetlands, Semipermanent Flooded	-13.5	-14	-13
Impacts Total	-41.04	-41	-41
Combined Total AAHUs	6,421	6,741	5,459

Table 4. Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) over 20, 30 and 50 years for the entire project site.				
Existing Conditions (with Berm Cuts)				
	Project Life (yr)	**Low SLR**	**Intermediate SLR**	**High SLR**
Average Annual Water Depth (ft)	20	0.96	1.01	1.21
	30	1.11	1.22	1.62
	50	1.48	1.76	2.69
Frequency of Dryout Conditions (%) (<0.5 ft)	20	14%	13%	6%
	30	8%	6%	2%
	50	3%	2%	1%
Backflow Prevention (%)	20	11%	9%	6%
	30	7%	6%	3%
	50	4%	3%	1%

Table 5. Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) over 20, 30 and 50 years for the entire project site.				
Alternative 2: Romeville Diversion = 3,000 cfs				
	Project Life (yr)	**Low SLR**	**Intermediate SLR**	**High SLR**
Average Annual Water Depth (ft)	20	1.46	1.54	1.79
	30	1.67	1.8	2.26
	50	2.11	2.42	3.46
Frequency of Dryout Conditions (%) (< 0.5ft)	20	8%	6%	2%
	30	4%	2%	1%
	50	1%	1%	0%
Backflow Prevention (%)	20	38%	36%	33%
	30	34%	33%	29%
	50	31%	28%	21%
Average Annual TSS Loading (mm/yr)	20	2.1	2.2	2.4
	30	2.3	2.4	2.6
	50	2.6	2.7	2.8

748

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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Lafayette, Louisiana 70506

September 8, 2010

Colonel Edward R. Fleming
District Commander
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Fleming:

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. Enclosed is our Final Fish and Wildlife Coordination Act Report for the LCA - Small Diversion at Convent/Blind River project. Comments provided by the Louisiana Department of Wildlife and Fisheries (LDWF) and the National Marine Fisheries Service (NMFS) have been incorporated into the final report.

Should your staff have any questions regarding the enclosed draft report, please have them contact Angela Trahan of this office at 337/291-3137.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosures

TAKE PRIDE IN AMERICA

cc: FWS, Atlanta, GA (ES/HC)
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NMFS, Baton Rouge, LA
Corps, New Orleans, LA (Attention: Dr. William Klein, CEMVN-PM-RS)
LDWF, Region 7 Office, Baton Rouge, LA
LDWF, Baton Rouge, LA (Attn.: Kyle Balkum)
LDWF, Natural Heritage Program, Baton Rouge, LA
LDWF, Scenic Rivers Program, Baton Rouge, LA
LOCPR, Baton Rouge, LA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
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September 8, 2010

Mr. Rick Hartman
Branch Chief
Habitat Conservation Division
National Marine Fisheries Service
C/O LSU Center for Wetland Resources
Baton Rouge, Louisiana 70803-7535

Dear Mr. Hartman:

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. Enclosed is our Final Fish and Wildlife Coordination Act Report for the LCA - Small Diversion at Convent/Blind River project. Your comments have been incorporated into this final report.

Should your staff have any questions regarding the enclosed draft report, please have them contact Angela Trahan of this office at 337/291-3137.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosure

TAKE PRIDE IN AMERICA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
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September 8, 2010

Mr. Robert Barham
Secretary
Louisiana Department of Wildlife and Fisheries
Post Office Box 98000
Baton Rouge, Louisiana 70898-9000

Dear Mr. Barham:

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. Enclosed is our Final Fish and Wildlife Coordination Act Report for the LCA - Small Diversion at Convent/Blind River project. Your comments have been incorporated into the final report.

Should your staff have any questions regarding the enclosed draft report, please have them contact Angela Trahan of this office at 337/291-3137.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosure

TAKE PRIDE IN AMERICA

FINAL
FISH AND WILDLIFE COORDINATION ACT REPORT

ON

LOUISIANA COASTAL AREA –
SMALL DIVERSION AT CONVENT/BLIND RIVER

Submitted To
New Orleans District
U.S. Army Corps of Engineers

And

Louisiana Office of Coastal Protection and Restoration

Prepared by
Angela Trahan
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Ecological Services
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September 2010

TABLE OF CONTENTS

INTRODUCTION 1

DESCRIPTION OF THE STUDY AREA 2

FISH AND WILDLIFE RESOURCES 6
- Major Habitat Types 6
  - Cypress/Tupelo Swamps 6
  - Bottomland Hardwoods 6
  - Fresh Marsh 7
  - Open Water 7
  - Developed Areas 8
- Fishery Resources 8
- Wildlife Resources 10
- Invasive Species 10
- Threatened and Endangered Species 10
- Species of Special Interest 12
- Refuges and Wildlife Management Areas 13

ALTERNATIVE EVALUATION 14

FINAL ARRAY OF ALTERNATIVES 14

EVALUATION METHODOLOGY 15

FUTURE WITHOUT PROJECT FISH AND WILDLIFE RESOURCES 18

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN 19

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN 20

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES 22

SERVICE POSITION AND RECOMMENDATIONS 23

LITERATURE CITED 27

APPENDIX A A-1

APPENDIX B B-1

INTRODUCTION

The Louisiana Coastal Area (LCA) – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration (OCPR), under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. This authorization was recommended by the Chief of Engineer's Report, dated January 31, 2005. That report recommended projects and features in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related water resources purposes.

The Small Diversion at Convent/Blind River Project was identified in the Louisiana Coastal Area Ecosystem Restoration Study, dated November 2004 (2004 LCA Plan), as a near-term critical restoration feature. WRDA 2007 directed that a feasibility report for the Small Diversion at Convent/Blind River project be submitted to Congress by December 31, 2008. The WRDA also directed that a Report of the Chief of Engineers be completed by December 31, 2010. Specifically, Section 7006(e)(3) requires the Secretary of the Army to submit feasibility reports to Congress on six projects by December 31, 2008, and a Chief's Report by December 31, 2010. Due to delays in executing a Feasibility Cost Sharing Agreement for the projects the requested feasibility reports were not submitted to the Congress by the December 31, 2008 deadline. The contingent authorization provided in Section 7006(e)(3)(B) for the six projects however remains subject to the December 31, 2010 deadline for a Chief's report.

The LCA - Small Diversion at Convent/Blind River Project includes the construction of a small diversion (i.e., less than 5,000 cubic feet per second) from the Mississippi River into Blind River through a new control structure to introduce sediments and nutrients along with freshwater into the southeast portion of Maurepas Swamp. Diverting Mississippi River water into the Maurepas Swamp will assist in improving biological productivity and restoring the natural hydrologic regime within that degraded swamp habitat. This diversion project in concert with two other LCA near-term critical features, the Small Diversion at Hope Canal Project and the Amite River Diversion Channel Modification Project, will help to restore Mississippi River water, sediment, and nutrient flows into the Maurepas Swamp ecosystem.

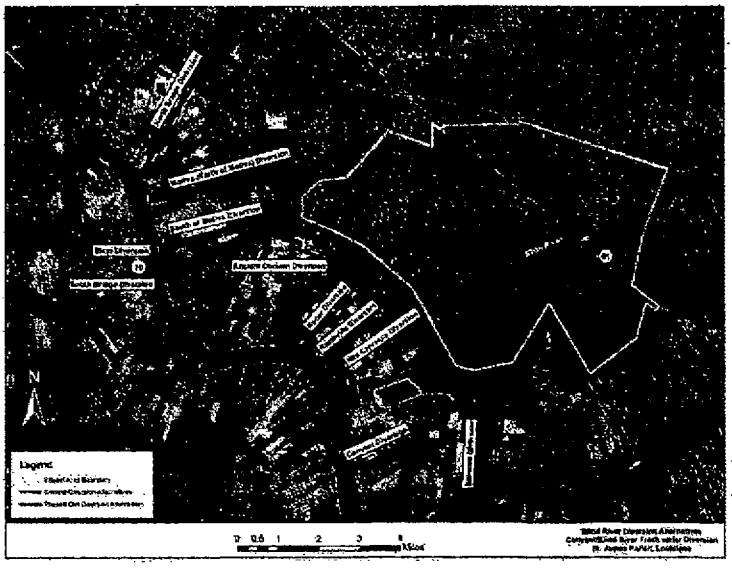
Previous U.S. Fish and Wildlife Service (Service) involvement includes a Final Programmatic Fish and Wildlife Coordination Act (FWCA) Report for the Near Term Plan for the LCA Study (Grouchy and Paille 2004); this draft report supplements that 2004 Programmatic Report. The Service has also submitted comments dated October 20, 2008, on the State of Louisiana, OCPR's Draft Interim Feasibility Study; comments dated January 30, 2009, were provided in regards to the Corps' Notice of Intent to prepare a Supplemental Environmental Impact Statement; and the Service provided a programmatic planning-aid Report dated January 21, 2010. Furthermore, Service comments were provided on the Draft Monitoring and Adaptive Management Plan dated April 7, 2010. This report constitutes the report of the Secretary of the Interior as required by Section 2(b) of the FWCA (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). This report has been reviewed by the Louisiana Department of Wildlife and Fisheries (LDWF) and the National

Marine Fisheries Service (NMFS), and their comments have been incorporated within the report and are included as an appendix.

DESCRIPTION OF THE STUDY AREA

The project area is located within the Maurepas Swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1, Figure 1). The U.S. Interstate 10 (I-10) corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the distribution area (i.e., diversion influence area). The Maurepas Swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the LDWF, Maurepas Swamp Wildlife Management Area.

Figure 1. LCA- Small Diversion at Convent/Blind River Study Area and Alternative Diversion Locations.



Alternative locations for the proposed control structure have been investigated in the vicinity of Convent, Louisiana, located at Mississippi River mile 159. Prior to extensive human modification, overbank flow of the Mississippi River during spring floods and tidal inflow,

through Pass Manchac, into Lake Maurepas, and southwest to the study area, significantly influenced the hydrologic conditions. Overbank flows from the Mississippi River brought nutrients, sediment, and freshwater that promoted productivity and sustained the health of the swamp ecosystem. As floodwaters receded, surface flows traveled eastward as sheet flow into existing channels and subsequently Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10 and Airline Highway corridor. Development along the I-10 and Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of cypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

Since the construction of the Mississippi River flood control levees, the Maurepas Swamp has been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands; and preliminary evaluations suggest that productivity in the stressed Maurepas Swamp may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas Swamp and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas Swamp study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas Swamp will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined (LCWCRTF 1999). Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. Subsidence may be caused by compaction, oxidation, and consolidation of sediments, faulting, groundwater depletion, or decreased organic deposition as a result of decreased vegetation biomass

production; while land elevations increase as a result of sediment accretion from direct sediment input from riverine sources or from organic vegetation deposition. The soil characteristics of the western Maurepas Swamp indicate a lack of riverine influence as evidenced by high soil organic matter content and low bulk density values (DeLaune et al. 1979, Hatton 1983, Messina and Conner 1998). Consequently, soil building within the Maurepas Swamp is almost exclusively a result of organic productivity (Shaffer et al. 2001, 2003, 2006, Rybczyk et al. 2002, Roberts 1985). With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, doubling flood frequency over the last four decades (Thompson 2000), so that the swamps are now persistently flooded.

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA - River Reintroduction into Maurepas Swamp Project, has revealed in some areas of Maurepas Swamp floor elevations are often lower than Lake Maurepas. This results in Lake Maurepas stage exerting a significant influence (backflow) on water levels within Blind River and adjoining channels rendering swamp water levels and dry-out periods dependent on the water levels in Lake Maurepas. Flooding is essentially semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and hydrologic impoundments caused by major transportation corridors as well as parish canal embankments. These adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., I-10, U.S. Highway 61, and Kansas City Southern Railroad (KCS RR)], flood waters within the project area are the last to recede from the basin.

Saltwater intrusion has increased in this general area, partly due to net subsidence and the lack of riverine freshwater inputs. Salinities as low as three parts per thousand (ppt) can reduce growth of both bald cypress and water tupelo saplings (Pezeshki et al. 1990). Salinity, combined with flooding stress, can substantially reduce bald cypress growth. Consequently, salinity significantly contributes to swamp deterioration, particularly combined with stressors such as flooding and herbivory. Storm surges from Lake Maurepas caused by tropical cyclones also exert a stochastic but severe stress on the swamp habitat through salinity spikes in swamp surface waters. Embankments along the parish canals and associated with the railroad and highways prevent higher salinity water from being flushed out of the system. Storm surge waters remain in the impounded swamps cumulatively increasing salinities in impounded waters and soils.

Some uncertainty surrounds the historic frequency of flooding events in the study area due to the natural variability of these events and limited historic record. Lopez (2003) estimated that flooding of the Mississippi River historically occurred once every 3.5 years in the Lake Pontchartrain Basin. Between 1799 and 1931, the frequency of major flood events for the

Mississippi River was approximately every 2.8 years (Gagliano and van Beek, 1970), with twenty-three flood years recorded below Baton Rouge from 1849 to 1927 (Vogel 1930).

While the LCA - Small Diversion at Convent/Blind River Project is primarily a freshwater diversion project; the project area is expected to receive some sediment from the proposed diversion contributing to swamp productivity. For an evaluation of potential sediment loading at Bayou Lafourche, Mashriqui and Kemp (1996) reported the mean sediment load of the Mississippi River at Tarbert's Landing to be 226 mg/l, of which about 26% was sand, with silts and clays each contributing between 30% and 40%. Lee Wilson & Associates, Inc. (2001) concluded even if only clays are conveyed by the channel to the swamps north of I-10 along Hope Canal, about 30% of the river load could be expected to reach the swamps. If only 30% of that potential sediment load is delivered to the primary swamp receiving areas, and an exceedingly low capture efficiency by the swamp of only one-third is assumed, it will represent a loading per area of about 1,098 g/m2/yr, or about twice the quantity needed as estimated by Templet and Meyer-Arendt (1988). It is, therefore, anticipated that sediments introduced with diverted water will increase accretion rates, likely holding or increasing existing swamp elevations against subsidence, at least for those areas within the high influence areas of the diversion. Those sediments will also increase soil bulk densities, and with increased elevations contribute to increased tree health, survival, and productivity, and the potential for tree regeneration (Lee Wilson & Associates, Inc. 2001).

Study evaluations conducted for the River Reintroduction into Maurepas Swamp Project (PO-29) and funded through the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) program determined that the volume of water that would be delivered by a 1,500 cubic feet per second (cfs) diversion running most of the year would be the equivalent of two complete replacements of lake volume per year. In addition, the diversion design would be capable of, on the average, operating at full flow even during the late summer and fall low-flow period, when high salinities and saltwater intrusion are the biggest threat. Thus, it is expected that Lake Maurepas would experience significant freshening as a benefit beyond direct benefits to the swamps as a result of the River Reintroduction into Maurepas Swamp CWPPRA Project. Such freshening could have a positive impact on fisheries as well as other ecosystem components (Lee Wilson & Associates, Inc. 2001).

The Mississippi River Sediment, Nutrient, and Freshwater Redistribution (MRSNFR) Study conducted by the Corps (2000) concluded that there were no issues of water or sediment quality that would preclude consideration of diversion of river water (and sediment) for restoration purposes. Only a few compounds, mainly mercury and some organochlorine pesticides that have been banned from use for well over a decade, were found to occasionally exceed water or sediment standards. However, the absence of significant observed bioaccumulation of these compounds was taken as evidence for no overall problems (Corps 2000). Furthermore, studies conducted for the CWPPRA - River Reintroduction into Maurepas Swamp Project determined that nutrients added with diverted river water would be essentially completely taken up within the swamp (Lee Wilson & Associates, Inc. 2001).

FISH AND WILDLIFE RESOURCES

The Service has provided a Final FWCA Programmatic Report for the Near Term Plan for the LCA Study (Grouchy and Paille 2004). That report contains a through discussion of the significant fish and wildlife resources (including those habitats) that occur within the study area as well as fish and wildlife concerns that occurs within coastal Louisiana and future without project conditions. That discussion is incorporated by reference herein, but the following information is provided to update to that report and provide project specific information and recommendations.

Major Habitat Types

Cypress/Tupelo Swamps

The study influence area (distribution area) contains approximately 21,844 acres the majority of which is dominated by bald cypress/tupelo swamp habitat and is semi-permanently or permanently flooded. Persistent flooding has resulted in the impairment of cypress/tupelo seedling establishment/regeneration (CWPPRA Task Force 2002). Cypress/tupelo regenerates well when the seedbed is moist but not flooded during the time period of seed germination and seedling establishment. Cypress/tupelo seeds cannot germinate in standing water, and seedlings must grow tall enough during dry periods for their crowns to extend above the water surface to survive flooding during the growing season. Excessive flooding will reduce regeneration even though overstory trees may still be thriving. Ultimately, the lack of regeneration due to prolonged inundation will eliminate forest cover, resulting in the conversion of swamp habitat to open water over time (CWPPRA Task Force 2002). In addition, saltwater intrusion from storm events has stressed the swamp habitat along the Blind River.

Cypress swamps in the project area provide substantial fish and wildlife values. Wildlife species typical of cypress swamps include green tree frog, bullfrog, mud and musk turtles, American alligator, various species of water snakes, anhinga, barred owl, northern parula, great blue heron, great egret, white ibis, and mink. Often surrounding backwater lakes, these areas also provide essential habitat for aquatic species when inundated.

While bald cypress is the canopy dominant in a few locations within the study area, water tupelo was the predominant species across sites. In addition to bald cypress and water tupelo, Drummond red maple, green ash, and various oak species are also found in the cypress/tupelo swamp habitat within the study area, with Drummond red maple and green ash comprising sub-dominant midstory species (Conner and Day 1976; Hoeppner 2008; Shaffer et al. 2003). Scrub species, including black willow, wax myrtle, and common buttonbush are sporadically present, particularly in areas with diminished canopy cover caused by impaired health or mortality of overstory species. Shrub-scrub swamps provide important nesting habitat for colonial wading birds as well as various species of aquatic wildlife.

Bottomland Hardwoods

Bottomland hardwood forests are generally intolerant of inundation during the growing season

(Putnam et al. 1960; Hodges 1997). Fluctuations in water level are more prevalent in the bottomland hardwood forest than bald cypress-tupelo swamp, with characteristic alternating wet and dry periods. Where bottomland hardwood forests experience increased flooding regimes the forest stand begins to transition into a more flood tolerant community composition and becomes more characteristic of a swamp habitat. Bottomland hardwoods are present within the distribution area as elevations increase near the natural levee of the Mississippi River and along several ridge remnants and spoil banks that traverse the study area. Also the alternative transmission canal alignments traverses bottomland hardwood forests along the natural levee and within the Mississippi River batture. Dominant tree species in the higher elevated area include Drummond red maple, black willow, green ash, laurel oak, water oak, sweet gum, sugarberry, American elm, and Chinese tallow. The areas between the ridges and the swamp show a transition in species and are dominated by green ash and Drummond red maple. Wax myrtle, rough-leaf dogwood, black willow, Chinese tallow, Chinese privet, yaupon, and deciduous holly typically are common shrub species. Vines such as poison ivy, greenbrier, pepper vine, and trumpet creeper are present.

Bottomland hardwood forests typically provide high wildlife habitat values to a variety of species, including amphibians such as the Gulf coast toad and Cope's gray tree frog; reptiles such as the copperhead and green anole; many species of birds, including wood duck, barred owl, pileated woodpecker, red-shouldered hawk, Acadian flycatcher, Swainson's warbler and northern parula; and mammals including white-tailed deer, swamp rabbit, gray fox, bobcat, raccoon, opossum, and squirrels. In addition to terrestrial wildlife, many species of fish utilize flooded bottomland hardwoods as well; some species are specifically adapted for spawning in these backwater flood plains.

Fresh Marsh

Within the study area fresh marsh habitat mainly consists of pipeline and powerline easements. While some of these easements have ditches, many of the easements are slightly elevated above the adjacent swamp and are thickly vegetated with grasses and forbs. These areas are usually saturated to the surface, and flooded only during higher water periods. Therefore, it is unlikely that fresh marshes within the Study Area currently provide nursery habitat for estuarine species. However, these fresh marshes would provide habitat for other wildlife species such as reptiles and amphibians.

Open Water

The Blind River is the major waterway influencing the project area wetlands and is designated as a state water bottom along with the Mississippi River and Lake Maurepas also within the study area. Several parish canals, transmission line and pipeline canals, and borrow canals transect the study area swamp habitat. Because of the stagnant conditions, the loss of sediment input, reduced primary productivity, and limited consolidation, net phosphorus and organic matter export from the swamp is likely low. Therefore, support for dependent systems downstream (e.g., Lake Maurepas) is likely limited and substantially reduced from historic levels.

In their *2006 Water Quality Integrated Report*, the Louisiana Department of Environmental Quality (LDEQ) indicated that water within the study area (i.e., LDEQ sub-segment 040403) supports the designated standards for primary and secondary contact recreation, but does not support those standards for fish and wildlife propagation. Suspected sources of impairment include were mercury, nitrate/nitrite, non-native aquatic plants, total phosphorus (TP), and turbidity. The suspected sources for mercury were listed as atmospheric deposition and unknown sources. Site clearance (land development or redevelopment) and flow alterations from water diversions were listed as the suspected sources for nitrate/nitrite, dissolved oxygen, and TP. The suspected causes of impairment for the outstanding natural resource waters designation were sedimentation/siltation and turbidity, which are believed to be caused by site clearance.

Developed Areas

Developed areas within the study area occur along the Mississippi River levee and are dominated by industry facilitated by Mississippi River commerce and associated business and residential development. Historically, agriculture has been a major industry within both parishes and is still relevant today primarily in the form of sugarcane farming. Two railways run through the study area. The KCS RR transects the distribution area and parallels U.S. Highway 61 to the south. The Canadian National Railway extends to the south of the distribution area and would be transected by the Romeville and South Bridge transmission canals. U.S. Interstate 10 and U.S. Highway 61 pass through the distribution area. Where U.S. Highway 61 and Blind River intersect the St. James Boat Club, a boat launch facility, provides boat access to the upper Blind River. Also a second boat launch is located at the north terminus of Louisiana Highway 642 with access to Grand Point Canal. Numerous transmission and pipeline rights-of-way also intersect the study area.

Fishery Resources

Lower Mississippi River

Baker et al. (1991) noted at least 91 species of freshwater fishes occupy the Lower Mississippi River as their primary population center; 30 or more species may be present sporadically. From what is known of its physical attributes, few species could regularly inhabit the upper and middle water column in this habitat. 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 moving among other habitats (Baker et al. 1991).

Blind River /Swamp

Freshwater sport fishes likely present include white crappie, bluegill, warmouth, channel catfish, and blue catfish. Other fishes likely present include yellow bullhead, freshwater drum, bowfin, carp, buffaloes, and gars. In addition, aquatic and wetland habitats within the study area provide nursery and foraging habitats supportive of a variety of fishery species including economically important estuarine-dependent fishery species (e.g., the blue crab, striped mullet, and Gulf menhaden), some of which may serve as prey for other fish species.

During a survey conducted from January 1976 to August 1977, Watson et al. (1981) sampled fisheries species at six locations along Blind River from south of Highway 61 to Lake Maurepas. In doing so, 57 species of finfish were collected and included 12 estuarine, 43 freshwater, and two diadromous species. Freshwater species were dominant both spatially and temporally. Finfish diversity appeared to be higher at the lower stretches of Blind River, below the Amite River Diversion Canal and nearer Lake Maurepas. The lower Blind River had the greatest species diversity, primarily due to the presence of estuarine species.

A survey conducted by Davis et al. (1970) between 1967 and 1969 in the Lake Maurepas revealed forty species of finfishes and shell fishes. Some of the fishes included Gulf menhaden, gizzard shad, striped and bay anchovy, blue and channel catfish, sand and spotted seatrout, Atlantic croaker, striped mullet, southern flounder, largemouth bass, bluegill, and several species of gar as well as shrimp. In a later fisheries survey of Lake Maurepas, Hastings et al. (1987) reported an equal proportion of freshwater (55 percent) and marine (40 percent) fish species with four-percent of individuals being diadromous. A correlation was observed between the fisheries species present in the lake and mouth of Blind River and salinity levels in Lake Maurepas: marine species exhibited a higher contribution to the fisheries of Lake Maurepas and had a greater likelihood of presence in Blind River with increasing salinity levels, with the opposite trend apparent for freshwater species.

Essential Fish Habitat

Lake Maurepas is designated as Essential Fish Habitat (EFH) postlarval and juvenile life stages of white shrimp and red drum. Detailed information on Federally-managed fisheries and their EFH is provided in the most recently updated 2005 generic amendment of the Fishery Management Plans for the Gulf of Mexico, prepared by the Gulf of Mexico Fishery Management Council (GMFMC). That generic amendment was prepared in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), (P.L. 104-297).

In addition to being designated as EFH for red drum and white shrimp, water column and water bottoms, in Lake Maurepas provide nursery and foraging habitats that support a variety of economically important marine fishery species such as Atlantic croaker, sand seatrout, black drum, southern flounder, blue crab, and striped mullet. Some of these species serve as prey for other fish species managed under the MSFCMA by the GMFMC (e.g., mackerels, snappers, and groupers) and highly migratory species (e.g., billfishes and sharks) managed by the NOAA-Fisheries.

According to the Corps analysis the TSP could influence Lake Maurepas although Lake Maurepas is not designated within the study area. The level of change and adverse impacts to EFH, if any, are considered by the Corps to be minor. NOAA's NMFS determined EFH consultation requirements in accordance with the MSFCMA to be complete. That determination was based on the project being completed and operated as proposed in the Supplemental EIS. However, should the project scope change or should additional hydrologic modeling determine that the proposed project would significantly influence Lake Maurepas water quality, additional consultation with NOAA's NMFS will be necessary.

Wildlife Resources

The coastal marshes and forested wetlands of the Lake Pontchartrain Basin have been identified by the North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCJV): Mississippi River Coastal Wetlands Initiative as a key waterfowl wintering area. The Gulf Coast is the terminus of the Central and Mississippi Flyways and is therefore one of the most important waterfowl areas in North America, providing both wintering and migration habitat for significant numbers of the continental duck and goose populations that use both flyways. The Mississippi River Coastal Wetlands Initiative area is dominated by coastal marsh, forested swamps, and seasonally flooded bottomland hardwoods that provide habitat for several species of wintering waterfowl. Wood ducks are the primary waterfowl species in forested wetlands, while other ducks (e.g., mallard, American widgeon, gadwall, blue- and green-winged teal, Northern shovelers, ring-necked ducks, and lesser scaup) use those forested habitats to a lesser degree.

Strategies to achieve the goals and objectives of the GCJV include but are not limited to: 1) maintaining the existing functions and values of those habitats and preventing additional losses and degradation of those wetlands and 2) modifying existing spoil banks and canals to restore hydrology (Wilson et al. 2002). Numerous other game birds are present in or adjacent to the study area, including American coot, rails, gallinules, common snipe, and American woodcock. Non-game bird species also utilize the study area marshes, including least bittern, pied-billed grebe, black-necked stilt, American avocet, killdeer, black-bellied plover, willet, and various species of sandpipers, gulls, and terns. The study area supports many resident and transient hawks and owls including red-shouldered hawk, barn owl, common screech owl, great horned owl, and barred owl. Winter residents include red-tailed hawk, northern harrier, and American kestrel, while the Mississippi kite, swallow-tailed kite and broad-winged hawk are common summer residents. In addition, the project area supports many species of resident and migratory passerine birds. Some neo-tropical migrants that are currently experiencing a population decline (e.g., white-eyed vireo, northern parula) are dependent on large forested acreage to successfully reproduce. Also, present are cuckoos, swifts, hummingbirds, nighthawks, woodpeckers, and the belted kingfisher.

Invasive Species

Within the study area invasive mammal species present include nutria and feral hogs. Invasive plant species present within that area include: water hyacinth, alligator weed, hydrilla, common salvinia, giant salvinia, variable-leaf milfoil, Chinese tallow, and Chinese privet. Those species displace native aquatics and degrade water and/or habitat quality. In addition, Chinese tallowtree is tolerant to flooding and salt stress and can establish self-replacing monocultures that provide less foraging value to migrating birds and interrupt the natural succession of woody species (Louisiana Coastal Protection and Restoration 2008).

Threatened and Endangered Species

West Indian Manatee

Federally listed as an endangered species, West Indian manatees (*Trichechus manatus*) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals.

Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the Service and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project, however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

By letter dated June 29, 2010, the Service, through the Department of Interior, concurred with the Corps determination of not likely to adversely impact the West Indian manatee and the Gulf sturgeon. However, should there be changes in the scope or location of the proposed project or should the project not been initiated within one year, follow-up consultation should be accomplished with the Service prior to making expenditures because our threatened and endangered species information is updated annually. If the scope or location of the proposed project is changed, consultation should occur as soon as such changes are made. Furthermore, should additional hydrologic modeling determine that the proposed would influence Lake Maurepas salinities and water temperatures, additional consultation regarding the Gulf sturgeon will be necessary.

Pallid Sturgeon

The pallid sturgeon (*Scaphirhynchus albus*) is an endangered fish found in Louisiana, in both the Mississippi and Atchafalaya Rivers (with known concentrations in the vicinity of the Old River Control Structure Complex); it is possibly found in the Red River as well. The pallid sturgeon is adapted to large, free-flowing, turbid rivers with a diverse assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known,

but it is believed to spawn in Louisiana. Habitat loss through river channelization and dams has adversely affected this species throughout its range. Entrainment issues associated with dredging operations in the Mississippi and Atchafalaya Rivers and through diversion structures off the Mississippi River are two potential effects that should be addressed in future planning studies and/or in analyzing current project effects. Impacts to the pallid sturgeon via entrainment through the diversion structure should be addressed in planning studies.

By letter dated July 14, 2010, the Corps initiated formal ESA, Section 7 consultation with the Service for potential impacts to the pallid sturgeon. The Service expects to provide the Corps with our biological opinion no later than October 13, 2010.

Species of Special Interest

Bald Eagle

The project-area forested wetlands provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. Several active and inactive bald eagle nests are documented within and adjacent to the study area. Other nests may also be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. Eagles typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. 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.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The Service developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at:
http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf.

Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

Colonial Nesting Birds

The proposed project would be located in an area where colonial nesting waterbirds may be present. Colonies may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries. That database is updated primarily by monitoring the colony sites that were previously surveyed during the 1980s. Until a new, comprehensive coast-wide survey is conducted to determine the location of newly-established nesting colonies, we recommend that a qualified biologist inspect the proposed work site for the presence of undocumented nesting colonies during the nesting season. To minimize disturbance to colonial nesting birds, the following restriction on activity should be observed:

1) For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present).

2) On-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

Refuges and Wildlife Management Areas

There are no U.S. Fish and Wildlife Service National Wildlife Refuges located within the study area. A majority of the study area is located within the state-operated Maurepas Swamp Wildlife Management Area. Please contact the LDWF, Region 7 Office in Baton Rouge, Louisiana, (225/765-2360) for their comments regarding potential project impacts to this area.

Blind River is designated as a Louisiana Natural and Scenic River. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

ALTERNATIVE EVALUATION

Based on a review and analysis of prior studies, initial site visits, and input received through the scoping process, an initial list of management measures (i.e., restoration features that are elements of an alternative) was developed. Examples of management measures includes water management modifications within Maurepas Swamp (e.g., weirs, flow control gates, and control valves); alternate measures and approaches to distributing freshwater throughout the distribution area (e.g., pumps and control structures); alternative transfer systems to transfer the freshwater from the diversion point to the swamp (e.g., trapezoidal earthen or concrete-lined channel, underground conduits, or existing natural and man-made drainage systems); and alternative diversion system features including alternative diversion locations and levee crossing measures (siphon vs. culverts). An example of nonstructural management measures includes alternative diversion operation plans to achieve certain restoration goals and planting cypress seedlings in targeted areas.

After management measures were screened and evaluated, the management measures were then grouped into an array of preliminary alternatives for further evaluation to achieve the overall project goals and objectives. The alternatives in the initial array underwent a screening and evaluation process to develop the final array of alternatives. The screening process analyzed the specific components or features that were included in the alternatives including diversion location, diversion flow rates, and diversion methods.

FINAL ARRAY OF ALTERNATIVES

The evaluation determined that the Romeville and Sunshine Bridge locations are hydraulically efficient locations from which to provide freshwater, nutrients, and sediments to an effective portion of the benefit area. It was determined that 3,000 cubic feet per second (cfs) of flow is needed to provide both prevention of saline backflow and inundation from Lake Maurepas and also achieve the overall goal of reversing the trend of degradation in the swamp. Further, an analysis of construction costs indicates that siphons are more cost effective for flow rates below 1,000 cfs and gated culvert systems are more cost effective for flow rates greater than 1,000 cfs. Considering the preliminary results of initial screen and evaluations efforts, the following five alternatives were identified for further consideration and inclusion in the final array:

No Action Alternative (Future without Project Conditions)
Alternative - 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
Alternative - 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
Alternative - 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
Alternative - 6 – Two 1,500 cfs (3,000 cfs combined) Diversions at Romeville and South Bridge (Siphons)

Alternative 2 – 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S.

Highway 61.

Alternative 4 – 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4B – 3,000 Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds 3 new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

Alternative 6 – 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system and a transfer canal along the Romeville alignment and a gated culvert system and transfer canals along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

EVALUATION METHODOLOGY

Evaluation of project-related impacts on fish and wildlife resources was conducted using the Wetland Value Assessment (WVA) methodology developed for the evaluation of proposed CWPPRA projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force [LCWCRTF] 2006). The WVA methodology is similar to the Service's Habitat Evaluation Procedures (HEP), in that habitat quality and quantity are measured for baseline conditions and predicted for future without-project (FWOP) and future with-project (FWP) conditions. Instead of the species-based approach of HEP, each model utilizes an assemblage of variables considered important to the suitability of a given habitat type for supporting a diversity of fish and wildlife species. As with HEP, these models allow a numeric comparison of each future condition and provide a combined quantitative and qualitative estimate of project-related impacts to fish and wildlife resources.

The WVA models operate under the assumption that optimal conditions for fish and wildlife habitat within a given coastal wetland type can be characterized, and that existing or predicted conditions can be compared to that optimum to provide an index of habitat quality. Habitat quality is estimated and expressed through the use of a mathematical model developed specifically for each habitat type. Each model consists of: 1) a list of variables that are considered important in characterizing fish and wildlife habitat; 2) a Suitability Index graph for each variable, which defines the assumed relationship between habitat quality (Suitability

Indices) and different variable values; and 3) a mathematical formula that combines the Suitability Indices for each variable into a single value for wetland habitat quality, termed the Habitat Suitability Index (HSI).

The WVA methodology was first developed in 1991 by the CWPPRA Environmental Work Group (LCWCRTF 2006). Initially, emergent marsh habitat models were developed for fresh, intermediate, brackish and saline marsh types. Subsequently, models were also developed for swamps, barrier islands, barrier headlands, and coastal forested ridges. The habitat variable-habitat suitability relationships within the WVA models have not been verified by field experiments or validated through a rigorous scientific process. However, the variables were originally derived from HEP suitability indices taken from species models for species found in that habitat type. It should also be noted that some aspects of the WVA have been defined by policy and/or functional considerations of CWPPRA. However, habitat variable-habitat suitability relationships are, in most cases, supported by scientific literature and research findings. In other cases, best professional judgment by a team of fisheries biologists, wildlife biologists, ecologists, and university scientists may have been used to determine certain habitat variable-habitat suitability relationships. In addition, the WVA models have undergone a refinement process and habitat variable-habitat suitability relationships, HSIs, and other model aspects are periodically modified as more information becomes available regarding coastal fish and wildlife habitat suitability, coastal processes, and the efficacy of restoration projects being evaluated.

The WVA models assess the suitability of each habitat type for providing resting, foraging, breeding, and nursery habitat to a diverse assemblage of fish and wildlife species. This standardized, multi-species, habitat-based methodology facilitates the assessment of project-induced impacts on fish and wildlife resources. The CWPPRA swamp WVA model used consists of four variables: 1) stand structure; 2) stand maturity; 3) water regime; and 4) mean high salinity during the growing season.

Using the WVA methodology, impact assessments were conducted by the Habitat Evaluation Team (HET), which included representatives from the Service, the Corps, Office of Coastal Protection and Restoration, LDWF, NMFS, Southeast Louisiana University (SLU), and CDM, Incorporated. To assess impacts the HET used habitat information collected during four separate field trips from March through September of 2009, surveys, expert opinions, knowledge of the area, experience with similar projects, Digital Ortho-quarter Quadrangle aerial photographs (DOQQ), and preliminary hydraulics and hydrology modeling information.

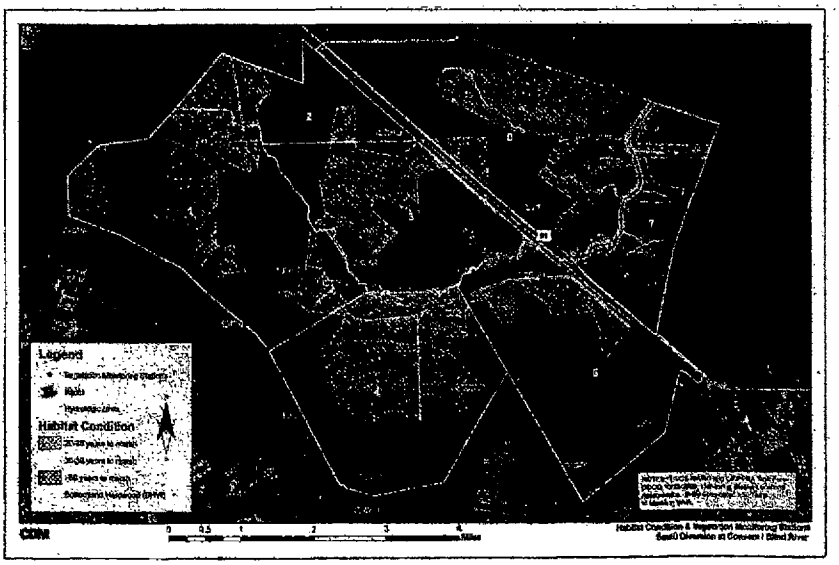
For the LCA - Small Diversion at Convent/Blind River Project those elements above were used in conjunction with the WVA models to compute an HSI value for each target year (TY). Selection of target years is based on anticipated changes in the area being evaluated. Three levels of habitat condition class were defined within the project area (i.e., 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh) based on the degree of degradation and according to classifications used by Dr. Gary Shaffer (SLU) at other areas within the Maurepas Swamp (Figure 2). Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level of degradation and not necessarily the target years that the habitats will convert to marsh.

Alternatives were analyzed using target years reflective of those habitat condition classes. The target years used for this project were TY0, TY1, TY20, TY30, and TY 50. The standard period of analysis for Corps projects is 50 years.

The product of an HSI and the acreage of available habitat for a given target year is known as the Habitat Unit (HU). The HU is the basic unit for measuring project effects on fish and wildlife habitat. Future HUs change according to changes in habitat quality and/or quantity. Results are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type.

Prior to running the WVA analysis, the hydrologic units (i.e., benefit areas) associated with each alternative were designated based on the location of the hydrologic unit within the watershed in relation to the diversion outfall. It was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). For purposes of the WVA, the Service assumed that the high influence areas would receive the most benefits from sediments, nutrients, and freshwater flow (i.e., freshwater throughput); moderate influence areas would receive benefits from nutrients and freshwater flows; and low influence areas would experience benefits as a result of freshwater flow. However, assuming the diversion would be operated to maximize dry-out frequency all hydrologic units see increased benefits in the form of dry-out frequency as a result of the berm cuts.

Figure 2. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Subsequent to the mapping of influence areas for each alternative, WVAs were run for each habitat condition class (i.e., 20-30 years to marsh, 30-50 years to marsh, and greater than 50 years to marsh) present within those areas. Once benefits were calculated, adverse temporary and permanent impacts to swamp and bottomland hardwood habitats associated with construction of the transmission channels were calculated. The change in AAHUs for each FWP scenario, compared to FWOP project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the habitat being evaluated; a net loss of AAHUs indicates that the project is damaging to that habitat type.

The WVA initial analysis was completed on the benefit areas for all alternatives under the intermediate sea level rise (SLR) scenario. As requested by the Corps, additional WVAs were later run to quantify impacts under the low and high SLR scenarios for the Tentatively Selected Plan (TSP) and the National Ecosystem Restoration (NER) Plan. A combined total of 79 WVA evaluations has been completed.

The Project Information Sheet (including assumptions used by the HET) for the project are presented in Appendix A. The complete WVA analysis can be obtained from the Service's Lafayette, Louisiana Ecological Services Office upon request.

FUTURE WITHOUT-PROJECT FISH AND WILDLIFE RESOURCES

According to the Coast 2050 Report (LCWCRTF 1999), in 1990, this unit contained approximately 138,930 acres of swamp and 3,440 acres of marsh. Under future without-project conditions continued impoundment, flooding, subsidence, and herbivory are expected to increasingly stress area swamps in the future. The current problems associated with altered hydrology are expected to continue. The lack of overbank flooding from the Mississippi River into the swamp and hydrologic connectivity within the swamp would result in the continued impoundment of the project-area swamp, with an associated reduction in canopy cover, degradation of water quality, and transition of swamp habitat to marsh, with the eventual conversion to open-water habitat similar to areas further east. Storm surges from tropical cyclone events would increase salinity levels and the frequency of saltwater inundation is expected to increase with relative sea level rise (RSLR). Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

The lack of freshwater, sediments, and nutrients would continue to reduce tree vigor and growth, increase tree mortality, increase the presence of invasive species, and reduce ecological functions. In addition, the assumed RSLR would exacerbate swamp degradation in the future. The anticipated conversion of swamp habitats to marsh and open water would result in the loss of wetland values and functions. While the Service recognizes the ecological importance of freshwater marshes, in this case, the anticipated conversion of swamp to marsh habitat is a transitional phase resulting from habitat deterioration and conversion and is not indicative of a healthy sustainable ecosystem. Keddy et al. (2007) reports that the vast majority of the Maurepas Swamp is typical of swamps identified as either nutrient poor and stagnant or near-continuously flooded. Flood durations in the Maurepas Swamp have doubled, on average, over the past half-century (Thomson et al. 2002). The flooding and impoundment within the study

area prevents seed germination and recruitment and, as a result, swamps are converting to marsh and open water.

Keddy et al. (2007) identified priority actions for habitat restoration within the Maurepas Swamp. Two of the primary recommendations addressed include diverting several freshwater diversions into the area and re-establishing sheet flow via removal or gapping of spoil banks and road and railroad beds. That report noted that pulsing of water flow from the river was a historical occurrence and that a sufficient volume to carry sediment and nutrients at least as far as the Manchac land bridge is necessary. That report further explains that sheet flow (or shallow water flow over the surface of the soil) was, most likely, the principle way in which water and nutrients moved through this system. Now, however, the presence of man-made hydrologic barriers impedes sheet flow. Canals decrease overbank flooding and accelerate the flow of water, sediment, and nutrients out of the area, while spoil banks and other such man-made features block sheet flow. Implementation of the proposed project would restore an historic ecosystem and increase the fish and wildlife habitat values of the project area.

This project would work in concert with other recently constructed and proposed projects to restore the Lake Pontchartrain Basin ecosystem including the de-authorization and closure of the Mississippi River Gulf Outlet (MRGO) channel at Bayou La Loutre authorized under WRDA 2007; and three Near-Term LCA projects, the MRGO Ecosystem Restoration Project, the Amite River Diversion Channel Modification Project, and Small Diversion at Hope Canal (Maurepas Swamp) Project.

DESCRIPTION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN

After comparing the four alternative plans carried forward for detailed analysis and the No Action Alternative, the NER Plan, Alternative 2, a 3,000 cfs diversion at Romeville was selected, as the TSP. Alternative 2 best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Corps' Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the southeast part of the Maurepas Swamp. Alternative 2 would improve a total of 21,369 acres of baldcypress-tupelo swamp that are in various stages of deterioration.

Alternative 2 has the following six major components:

1. **Diversion structure** – three, 10 x 10-foot concrete box culverts with sluice gates are proposed under the Mississippi River's east bank levee and Louisiana Highway 44. The sluice gates would include motor operators on the culvert inlets. The diversion structure would also include trash racks, an inlet canal across the batture, and other ancillary structures.

2. **Transmission canal** - the transmission canal will be designed for 3,750 cfs and will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The canal will be an earthen

trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2-foot freeboard. The top width will be approximately 250 feet. A railroad and highway crossing will require eight, 12 x 8-foot concrete box culverts.

3. **Control structures** - Control structures will be installed at key locations in the existing channels to distribute the diverted flow throughout and into the swamp. The control structure locations and designs will be determined during more detailed planning and engineering.

4. **Berm gaps (spoil bank gaps)** - new 500-foot wide berm gaps will be excavated in the spoil banks at an approximate spacing of 2,500 feet on center. The gaps will be excavated to the elevation of the adjacent swamp natural ground elevations, and the spoil will be disposed behind the existing spoil banks. As proposed, the spoil will be placed up to Elevation +6 North American Vertical Datum of 1988 (NAVD 88) to provide additional refuge areas for wildlife during flood events in the swamp.

5. **Cross culverts** - at four locations along U.S. Highway 61 and KSC RR. Each installation will consist of three, 3 x 4-foot concrete box culverts. There may be sufficient cross drainage openings at the KCS RR, and additional culverts may not be required. Earthen channels (large ditches) will be excavated across the 500-foot space between the KCS RR and U.S. Highway 61 to interconnect the drainage capacity at the railroad with the new culverts at U.S. Highway 61.

6. **Water level and flow rate instrumentation** – instrumentation to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the swamp will be installed. Additional instrumentation may be required as part of monitoring and adaptive management.

Operation Plan

Currently the operation plan will be designed to divert the water from the Mississippi River at 3,000 cfs for 6 to 9 months each year. The remaining 3 to 6 months will be operated at a lower flow to allow the swamp to drain and for the seeds to germinate ensure survival of saplings. The exact flow rates will be determined once all of the parameters of the system area determined and operational plan elements are defined. Operational plan elements will include such things as target water surface elevations necessary within the swamp to efficiently assimilate nutrient loads and nutrient level thresholds within Blind River and Lake Maurepas. The operation plan will allow for seasonal and annual flexibility and will be operated to achieve the defined goals of the operational plan elements.

EVALUATION OF NATIONAL ECOSYSTEM RESTORATION PLAN AND TENTATIVELY SELECTED PLAN

Alternative 2 is one of three cost-effective and best-buy alternatives. Alternative 2 provides over

90 percent of the benefits for about 67% of the cost of Alternative 6, the cost per AAHU is much lower for Alternative 2 than that for the other two alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Current habitat analysis indicates that the highest net benefits would be achieved through implementation of Alternative 6 (7,114 AAHUs). However, due to the high incremental cost per habitat unit going from Alternative 2 to Alternative 4B or 6, those alternatives were not considered to be justified. Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the NER Plan and the TSP.

Based on preliminary hydrologic modeling results, which at this stage of the study have focused on transfer of flow between benefit areas, Alternative 2 directly influences a larger area (i.e., hydrologic units 1 and 4) providing 8,088 acres with sediments, nutrients, and freshwater. Approximately 3,415 acres of swamp would benefit through the addition of freshwater and nutrients. An additional 4,535 acres would experience freshwater benefits. Aside from the benefits achieved from diverting freshwater into the system, the project area will experience increased throughput, hydrologic connectivity, and dryout periods as a result of in swamp management measures benefiting an additional 5,331 acres. The WVA analysis indicates that the NER and TSP for the project would result in net gains of 6,741; 6,421; and 5,459 AAHUs under the low, intermediate, and high SLR scenarios, respectively.

Swamp habitat for fish and wildlife species would be restored, mimicking as closely as possible, conditions which occurred historically in the area. Restored hydrologic connections would: 1) increase the nutrient and sediment input, 2) increase acreage of high-quality swamp habitats used by fish and wildlife for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements, and 3) increase vegetative growth and productivity. In addition, when compared to the future without project scenario, implementation of this alternative would significantly reduce the likelihood of existing swamp habitat converting to marsh and eventual open water habitat over the life of the project.

Because of the expedited schedule many specific details regarding the design, operation, and associated effects of the TSP are not yet available at the current level of planning. Therefore, the habitat analysis conducted provides a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. Subsequent detailed planning, engineering, design, and construction of specific project measures, along with more-definitive project information should be made available during planning, engineering, design (PED) phase. Additional Service and natural resource agency involvement during those phases will be prudent to ensure impacts and benefits on fish and wildlife resources are addressed. Should future analyses result in significant changes in hydrodynamic data outputs and/or the project scope, additional evaluations of project feature effects on fish and wildlife resources will be necessary to ensure our reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act are complete.

To fully evaluate the benefits of the TSP the following additional information and actions should be considered:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit under the operational plan identified.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease).

FISH AND WILDLIFE CONSERVATION AND MITIGATION MEASURES

Swamp habitats are considered by the Service to be aquatic resources of national importance due to their increasing scarcity and high habitat value for fish and wildlife within Federal trusteeship (i.e., migratory waterfowl, wading birds, other migratory birds, threatened and endangered species, and interjurisdictional fisheries). Restoring coastal swamp habitat through implementation of the proposed project would be preferable to the continued loss and degradation of coastal wetlands and Louisiana's nationally significant fish and wildlife resources.

A critical design challenge for the Maurepas Swamp will be the distribution of flow into and throughout the swamp habitat. Modifications to drainage patterns, distribution channels, and installation of control structures will be necessary to distribute water, sediment, and nutrients throughout the swamp and avoid adverse impacts to existing drainage features. To accommodate changing goals and restoration needs for the region, the diversion structure, as well as the outfall management system, should be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

We recognize that the legislatively mandated study schedule (i.e., study completion within three years from authorization) was developed to respond to the significant and ongoing loss of coastal wetlands. Considering the scope and complexity of the some of the projects, that schedule, because of a one year delay in getting cost-sharing documents signed, should be acknowledged as a key potential planning constraint and risks and uncertainties associated with meeting such an abbreviated study schedule (i.e., reduced to two years) should also be thoroughly considered in any planning and NEPA documents.

The expedited schedule of the impact (i.e., benefit) analyses has curtailed time available for hydrological modeling work, precluding the correction of known model limitations and errors and also required utilizing assumptions and data interpolations in the impacts analysis that would have normally been more refined. During a more typical project planning study, when sufficient time to conduct detailed impact analyses is available, the Service would usually rely upon more robust data and assumptions than is currently available.

The shortened time frame of the planning process has also reduced the amount of time used to fully develop and refine alternatives and alternative features. While many good alternatives for the LCA - Small Diversion at Convent/ Blind River Project were developed, the reiterative process of alternative refinement and selection was reduced which could preclude the

development of alternatives or alternative features which could increase restoration benefits. Therefore, while selection of a TSP has occurred changes to the TSP and/or the TSP features may be warranted based on further planning efforts and review of existing assumptions and modeling (i.e., quality control).

The intent of the habitat assessment is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. As the interagency team moves forward in developing project design and operation plans and more extensive hydrologic modeling is conducted, habitat assessments previously conducted may need to be revised. Careful consideration should be given to include relative sea level rise and accretion rates in assessments of salinity changes for future with and future without project conditions.

Artificial structures within the swamp system can impede organism ingress and egress and result in individual organism entrainment and mortality. When designing water control structures and culverts within the project area, consideration should be given to providing adequate access to fish and wildlife. For example, water control structures should include shoreline baffles and/or ramps and should maintain the pre-project cross section when the diversion is not in operation.

Additionally, the Service recommends project designs for cross culverts proposed under U.S. Highway 61 and the Kansas City Southern Railroad and other bridge openings incorporate fish and wildlife passage. This should not be a burden to the design of the project as culverts and bridge crossings designed to provide organism access would also facilitate other restoration initiatives of the project (e.g., improving hydrology, and the movement of sediment and nutrients). Please refer to the following websites for additional information:

- Wildlife and Roads: A resource for mitigating the effects of roads on wildlife using wildlife crossings such as overpasses, underpasses, and crosswalks.

  http://www.wildlifeandroads.org/decisionguide/

- Evaluation of the Use and Effectiveness of Wildlife Crossings, Final Report Prepared by U.S. Geological Survey for the National Cooperative Highway Research Program Transportation Research Board of The National Academies

  http://www.trb.org/NotesDocs/25-27_FR.pdf

SERVICE POSITION AND RECOMMENDATIONS

The TSP will benefit the fish and wildlife resources that depend on the Maurepas Swamp by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increase organic production, increase biological productivity, and reduce conversion of swamp habitat to open water. Approximately 21,369 acres would benefit from the proposed project resulting in 6,421 AAHUs of swamp habitat at the end of the project life. The Service supports implementation of Alternative 2, a 3,000 cfs diversion at Romeville, provided the

following fish and wildlife recommendations are implemented concurrently with project implementation:

1. Because of the expedited schedule, we recommend that the Corps continue to coordinate with the agencies during the remaining Feasibility phase and the Preconstruction, Engineering, and Design (PED) phase to ensure any new project features, development of the operational plan, finalization of the monitoring and adaptive management plan, and/or changes in the design fully incorporate adequate fish and wildlife conservation measures and that those features can be adequately evaluated with regards to impacts to fish and wildlife resources.

2. We recommend that hydrologic modeling efforts better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit under the proposed operational plan. Those hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and conduct detailed impacts analysis. Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease).

3. To accommodate changing goals and restoration needs for the region, we recommend that the diversion structure, as well as the outfall management system, be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

4. We recommend that water levels and swamp floor elevations be determined on a refined scale and incorporated into the hydrologic modeling.

5. We recommend that hydrologic modeling address future with and without project salinity conditions.

6. If the proposed project feature is changed significantly, is not implemented within one year of the Endangered Species Act consultation letter, or additional modeling reveals additional potential impacts, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

7. Should additional hydrodynamic modeling determine impacts to Lake Maurepas water quality (e.g., salinity and temperature), we recommend that the Corps reinitiate coordination with the NMFS regarding EFH consultation.

8. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

9. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

10. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

11. Please coordinate with the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on the Maurepas Swamp Wildlife Management Area (WMA).

12. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

13. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable. Land clearing for access to the maintenance canals should be limited to one side of the channel bank to minimize fish and wildlife impacts.

14. Project designs for cross culverts proposed under U.S. Highway 61 and the Kansas City Southern Railroad and other bridge openings and water control structures should incorporate fish and wildlife passage. We recommend coordinating with the natural resource agencies during the PED phase to ensure fish and wildlife conservation measures are incorporated into the design of those structures.

15. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) and any adaptive management and monitoring plans should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

16. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office

of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

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APPENDIX A

AGENCY COMMENTS

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09-EA-2841 DW

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southeast Regional Office
263 13th Avenue, South
St. Petersburg, Florida 33701

May 14, 2010 F/SER46/KC,RH:jk
225/389-0508

Mr. James F. Boggs, Field Supervisor
Louisiana Field Office
U.S. Fish and Wildlife Service
646 Cajundome Blvd., Suite 400
Lafayette, Louisiana 70506

Dear Mr. Boggs:

NOAA's National Marine Fisheries Service (NMFS) has received the draft Fish and Wildlife Coordination Act Report (Report) titled "Louisiana Coastal Area – Small Diversion at Convent/Blind River Project". The Report discusses the U.S. Fish and Wildlife Service's findings and recommendations associated with plans to construct a small diversion, less than 5,000 cubic feet per second (cfs), from the Mississippi River into Blind River through a new control structure to introduce sediments, nutrients, and fresh water into the southeast portion of Maurepas Swamp in St. James, Ascension, and St. John the Baptist Parishes, Louisiana.

As described in the Report, after comparing the four alternative plans carried forward for detailed analysis and the No Action Alternative, a 3,000 cfs diversion at Romeville was identified as the Tentatively Selected Plan (TSP). The TSP meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Corp of Engineer's Environmental Operating Principles; and would contribute to reversing the trend of deterioration in the southeast part of the Maurepas Swamp. To facilitate fresh water flow within the project area, the selected plan proposes: 1) a gated culvert system and transfer canal along the Romeville alignment for the diversion; 2) to restore and improve 160 existing berm cuts; 3) the addition of 30 new 500-foot wide berm cuts; 4) the construction of up to six control structures at strategic locations in the swamp; and, 5) the addition of three culverts under U.S. Highway 61. The TSP would improve a total of 21,369 acres of bald cypress-tupelo gum swamp that are in various stages of deterioration.

NMFS has reviewed the description of the fish and wildlife resources contained in the Report. While we understand that NMFS has not previously identified essential fish habitat (EFH) as being in the project area, we had no expectation that the project would impact portions of Lake Maurepas. However, the third paragraph on page 3 of the Report indicates that "Lake Maurepas would experience significant freshening" as a result of project implementation. If this is correct, project implementation has a potential to reduce the quantity and quality of EFH in Lake Maurepas. As such, NMFS recommends the Report be revised to indicate that water bottom and water column habitat categories of Lake Maurepas have been categorized as EFH for juvenile life stages of white shrimp and red drum. The Report should then discuss the likely impacts of project implementation on those categories of EFH and associated fishery life stages. Not

knowing the expected changes in monthly salinities in Lake Maurepas or hydrodynamics of tidal flows at Pass Manchac, we are unable to provide input on likely impacts to EFH or the utilization of those habitats by marine fishery resources. If such information is available, NMFS recommends it be provided to NMFS and further discussions be held regarding revisions to the Report. If that information is not available, the Report should be revised to discuss, in general terms, the potential for project implementation to reduce the quantity and quality of EFH in Lake Maurepas, or the capability of early life stages of marine fishery species to access those habitats.

We appreciate the opportunity to review and comment on this Report.

Sincerely,

for Miles M. Croom
Assistant Regional Director
Habitat Conservation Division

c:
LA DNR, Consistency, Ducote
F/SER46, Swafford
F/SER4, Dale
File

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BOBBY JINDAL
GOVERNOR

State of Louisiana

ROBERT J. BARHAM
SECRETARY

DEPARTMENT OF WILDLIFE AND FISHERIES
OFFICE OF WILDLIFE

JIMMY L. ANTHONY
ASSISTANT SECRETARY

July 1, 2010

Attn: Dr. William Klein Jr.
Planning, Programs, and Project Management Division
Environmental Planning and Compliance Branch
United States Army Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160-0267

RE: *Application Number: draft EIS Convent/Blind River Diversion*
Applicant: U.S. Army Corps of Engineers-New Orleans Division
Notice Date: May 21, 2010

Dear Mr. Serio:

The professional staff of the Louisiana Department of Wildlife and Fisheries (LDWF) has reviewed the above referenced notice. Based upon this review, the following has been determined:

LDWF supports the implementation of Alt 2 and we concur with the positions and recommendations outlined by the U.S. Fish and Wildlife Service in their April 30, 2010 draft report.

LDWF believes that operational flexibility should be incorporated into the operation plan and that the plan be modified as needed in response to monitoring and recommendations of regulatory and resource agencies.

The operation plan should allow for a drawdown or dry out period every 3-5 years to promote woody species regeneration. This period should coincide with naturally drier years and lower ambient water levels (as they are identified) to maximize the likelihood of a successful draw down

The control structures in the swamp should be designed to allow for fish passage.

Portions of the proposed activity are within Maurepas Swamp Wildlife Management Area. No activities shall occur on any LDWF Wildlife Management Area or Refuge without obtaining a Special Use Permit from LDWF. Please contact Chris Davis at (985) 543-4777 for more information.

This project is located in the vicinity of the Blind River, a Louisiana designated Natural and Scenic River. The applicant must obtain authorization from the Louisiana Department of Wildlife and Fisheries, Scenic Rivers Program prior to initiating any of the proposed activities within or adjacent to the banks of the Blind River. Scenic Rivers Coordinator Keith Cascio can be contacted at 318-343-4045.

The Louisiana Department of Wildlife and Fisheries appreciates the opportunity to review and provide recommendations to you regarding this proposed activity. Please do not hesitate to contact Habitat Section biologist Matthew Weigel at 225-763-3587 should you need further assistance.

Sincerely,

Kyle F. Balkum
Biologist Program Manager

mw

c: Matthew Weigel, Biologist
Chris Davis, Biologist
Keith Cascio, Scenic Rivers Coordinator
EPA, Marine & Wetlands Section
USFWS Ecological Services

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701

July 1, 2010 F/SER46/KC:jk
225/389-0508

Ms. Joan M. Exnicios, Chief
Environmental Planning and Compliance Branch
Planning, Programs, and Management Division
New Orleans District, U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Ms. Exnicios:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the Draft Integrated Feasibility Study and Supplemental Environmental Impact Statement for the Louisiana Coastal Area Small Diversion at Convent/Blind River, in St. James Parish, Louisiana. The document was transmitted for our review by your letter dated May 21, 2010. Your letter indicates that submittal of the document to NMFS initiates essential fish habitat consultation as required by provisions of the Magnuson-Stevens Fishery Conservation and Management Act. It should be noted that NMFS has agreed to serve as a cooperating agency on this project under provisions of the National Environmental Policy Act.

The overall study area is located in the vicinity of Romeville, Louisiana. The tentatively selected plan (Alternative 2) calls for construction of a water diversion system, near Romeville, with the capacity to divert 3,000 cubic feet per second of Mississippi River water into Maurepas Swamp to facilitate maintenance and rebuilding of the swamp's ecosystem. Specific components of the project include a gated culvert system and transfer canal, restoration and improvement of 160 existing berm cuts, addition of 30 new 500-foot-wide berm cuts, construction of up to six water control structures at strategic locations in the swamp, and addition of three new culverts under U.S. Highway 61. The tentatively selected plan is estimated to improve and protect 21,369 acres of bald cypress-tupelo swamp projected to be lost over the 50-year period of analysis, including: 1) 3,300 acres of bald cypress-tupelo swamp that would convert to marsh in 20 to 30 years; 2) 7,900 acres of bald cypress-tupelo swamp that would convert to marsh in 30 to 50 years; and 3) 10,140 acres of bald cypress-tupelo swamp that would convert to marsh in more than 50 years. The project would negatively impact 53 acres of forested wetland and is estimated to have a net value of 6,421 Average Annual Habitat Units over the 50-year period of analysis.

The enclosed comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) and 600.920 of the Magnuson-Stevens Fishery Conservation and Management Act.

Related correspondence should be directed to the attention of Mr. Richard Hartman at the NMFS Southeast Region, Habitat Conservation Division office at: c/o LSU, Baton Rouge, Louisiana 70803-7535. He may be contacted by telephone at (225) 389-0508, ext. 203 or by e-mail at richard.hartman@noaa.gov. The NMFS Protected Resources Division is responsible for issues pertaining to threatened and endangered species and marine mammals. The contact person for that Division is Mr. David Bernhart. He may be contacted at the letterhead address, by telephone at (727) 824-5312, or by e-mail at david.bernhart@noaa.gov.

Sincerely,

Miles M. Croom

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

Enclosure

cc:
FWS, Lafayette, Walther
EPA, Dallas, Ettinger
LA DNR, Consistency, Ducote
F/SER46, Swafford
F/SER4, Dale
NOAA PPI, Reid
Files

NOAA's National Marine Fisheries Service (NMFS) Comments on the Draft Supplemental Environmental Impact Statement (SEIS) for the Louisiana Coastal Area (LCA)
Small Diversion at Convent/Blind River, St. James Parish, Louisiana
Authorized under the 2007 Water Resources Development Act

Essential Fish Habitat (EFH) Consultation

Based on our review of the SEIS, NMFS has determined the document and related coordination with the NMFS fulfills consultation requirements contained in section 600.920 of the essential fish habitat (EFH) rules and regulations of the Magnuson-Stevens Fishery Conservation and Management Act.

According to the SEIS, Lake Maurepas, which adjoins the project area, is designated EFH for red drum (*Sciaenops ocellatus*) and white shrimp (*Litopeneaus setiferus*). Although Lake Maurepas is technically located outside of the study area, the SEIS notes that some shift and possible decrease in "optimal habitat" for red drum and white shrimp is possible with the tentatively selected plan. The SEIS indicates the level of change and adverse impact, if any, to EFH would be minor; while considerable benefit to EFH is possible since ongoing conversion of wetlands to open water would be reduced. Best management practices, environmental monitoring, and adaptive management would be implemented with the preferred plan.

Based on the preceding, NMFS has no EFH conservation recommendations to offer at this time. Provided that the project is completed and operated as proposed, no further consultation is required.

General comments

The SEIS for the proposed action is generally well written and sufficiently describes the affected environment and environmental impacts. The information presented supports the determination that the selected plan is environmentally acceptable and would promote the long-term recovery and health of one of Louisiana's largest tracts of freshwater swamp and a major ecological component of the Lake Pontchartrain Basin.

Specific comments

SECTION 1.0 STUDY INFORMATION
1.5 Prior Reports and Existing Projects
1.5.3 Existing Water Projects
1.5.3.3 Coastal Restoration Projects

Page 1-15, lines 37-42 According to this section, the LCA Small Diversion at Hope Canal consists of diverting approximately 1,500 cubic feet per second from the

Mississippi River into the Hope Canal at Garyville, Louisiana. Information is needed concerning the duration and seasonal timing of the diversion period.

SECTION 3.0 ALTERNATIVES
3.3 Preliminary Alternatives Plans
3.3.1 Development of Preliminary Alternative Plans
CB-6 Obtain Total Maximum Daily Load (TMDL) waiver for diversion into Blind River

Page 3-27, lines 26-30 According to this section, the overall project has an extensive monitoring plan and includes costs for adaptive management "to assure that the overall water quality in the Blind River is not degraded." Also, as noted in section 3.7.7 (page 3-104, line 28) water quality impairment is a potential risk endpoint of the project. NMFS recommends that both the final SEIS and the Monitoring and Adaptive Management Plan (MAMP) (Appendix I) clearly state that water quality in Blind River and Lake Maurepas will be monitored and that management measures will be implemented when needed to remedy project-related water quality degradation.

Also according to this section: "The State agencies will work together to monitor the diversion operation to assist with the overall environmental improvement of the Blind River." This section should be modified to note that federal resource agencies, including the NMFS and U.S. Fish and Wildlife Service (FWS), would be consulted with regard to environmental monitoring and adaptive management measures needed to protect and restore fish and wildlife resources and habitat, including EFH in Lake Maurepas.

3.7 Plan Selection – Tentatively Selected Plan
3.73 Components

Page 3-95, lines 12-17 NMFS recommends the description for the control structures in the selected plan include a map of the project area illustrating the expected locations of the various features including the control structures. NMFS recommends the map be accompanied by a diagram depicted the design plans and specifications of the control structures, as well as a detailed operational scheme.

3.7.6 Operations and Maintenance Considerations

Page 3-99, lines 35-38 NMFS understands the need to provide access to the maintenance canal; however, the final SEIS should address the possibility that mowing be limited to one side of the canal and shrubs and trees be allowed to grow on the un-mowed bank. Establishment of trees along one side of the canal would reduce maintenance and disturbance, lessen water temperature increases in summer, and provide cover for wildlife.

Page 3-100, lines 24-25 The diversion flow period (six to nine months per year) should be identified and discussed, as appropriate, throughout the final SEIS. Currently, the diversion flow period is not mentioned elsewhere in the document.

Page 3-101, lines 6-10 NMFS recommends this section be modified to note that planned maintenance excavation within the transmission canal will be coordinated with state and Federal resource agencies. Coordination should address beneficial use of excavated material, excavation and disposal methodologies, timing, and other considerations as needed to protect fish and wildlife.

3.7.7 Monitoring Plan and Adaptive Management

Pages 3-101 through 3-104 The MAMP is an essential component of the project. Environmental monitoring is needed to assess project related impacts and establish operational changes needed to protect and restore EFH and other habitat and resources. By letter dated April 7, 2010, the FWS, in consultation with NMFS, provided detailed comments concerning needed changes in the project's MAMP. NMFS recommends the MAMP be modified in accordance with FWS and NMFS recommendations. Also, as noted below (see "APPENDIX I"), the MAMP should be modified to include performance measures that call for water quality monitoring and adaptive management to remedy water quality problems in Blind River if they should occur.

The MAMP also should include water quality monitoring and adaptive management as needed to remedy potential water quality problems in Lake Maurepas if such problems occur. Depending on the amount and rate of nutrient assimilation by wetlands after repeated or long term nutrient loading, NMFS is concerned the proposed diversion of river water could create algal blooms in and eutrophication of waterways in the project area. The MAMP should identify sampling locations, frequency, and duration for measuring dissolved oxygen levels in Lake Maurepas, which is designated as EFH for red drum and white shrimp, with particular emphasis on collecting data during the summer months. Potential adverse impacts to EFH in Lake Maurepas also include displacement of these designated fishery species from the area due to extreme turbidity and salinity changes, as well as colder water temperatures. These water quality parameters should be included in the MAMP for the lake.

Page 3-101, line 27 The feasibility level MAMP is provided in Appendix I, not Appendix J, as stated.

3.8 Risk and Uncertainty
3.8.2 Environmental Uncertainties

Page 3-113, lines 9-21 This section should be expanded to note that uncertainty exists regarding salinity change and nutrient input into Blind River and other downstream waters and that this uncertainty will be addressed through project monitoring and adaptive management.

Page 3-114, lines 19-24 NMFS supports plans to conduct salinity monitoring. As noted in comments below (APPENDIX I), the final SEIS should acknowledge that salinity

monitoring will be conducted in the lower reaches of Blind River and, if warranted, the southeastern portion of Lake Maurepas.

This section also should be expanded to note that uncertainty exists regarding the need for increases in frequency and duration of operational closures of the project area water control structures and that this uncertainty will be addressed through project monitoring and adaptive management.

SECTION 4.0 AFFECTED ENVIRONMENT
4.2 Significant Resources
4.2.10 Essential Fish Habitat (EFH)

Page 4-82, lines 12-13 According to this section, the February 20, 2009, letter from NMFS states that no EFH exists in the project area. However, NMFS did state that Lake Maurepas is designated as EFH for red drum and white shrimp. NMFS recommended water quality impacts be modeled to evaluate the potential for the proposed freshwater diversion to influence changes in salinity, water temperature, and dissolved oxygen levels in the lake. Those potential impacts should be addressed in the document and included in the monitoring and adaptive management plan.

SECTION 5.0 ENVIRONMENTAL CONSEQUENCES
5.3 Water Quality and Salinity
5.3.4 Salinity

Page 5-71, lines 21-27 This section provides summary statistics regarding the expected project impacts on salinity in Lake Maurepas. For example, the SEIS indicates a 2,500 cfs diversion would reduce salinities in Lake Maurepas by 30% and a larger diversion would likely reduce salinities more than that. Section 4.2.3.3 of the SEIS provides data on historical salinity levels at various locations relevant to the project. Given the discussion in other sections of the document pertaining to marine fishery species and EFH, this section should be revised to indicate what the expected future salinities will be at various locations with project implementation. NMFS suggests a table be provided in the final SEIS identifying mean and maximum historic salinities at various locations in the project area and what the modeled salinities would be at those locations with project implementation.

5.10 Essential Fish Habitat (EFH)

Page 5-110, lines 11-30 The first sentence in this section (lines 12-14) is confusing and should be rewritten to clarify where and to what extent salinity might decrease and how this might affect "optimal habitat" for red drum and white shrimp. NMFS recommends the final SEIS indicate that any reduction in salinity in Lake Maurepas would represent movement in the direction of historical conditions that existed prior to anthropogenic alteration (disruption) of water flow into the Maurepas Swamp.

Salinity monitoring as called for in section 3.8.2.1 (page 3-114; line 19) is vital to a determination of the level of habitat alteration in Lake Maurepas. As such, NMFS recommends this section be modified to note that while the consequences of salinity modification are expected to be negligible, salinity and water quality monitoring are planned, as well as the implementation of adaptive management, as needed, to preclude significant adverse impacts to EFH.

APPENDIX I

Page 10: Objective 4: Improve fish and wildlife habitat in the swamp and in Blind River

According to the Alternatives Analysis (page 3-27; lines 26-30) "The overall project has an extensive monitoring plan and includes costs for adaptive management to assure that the overall water quality in the Blind River is not degraded." Despite this statement, the MAMP performance measures contain no parameters associated with water quality monitoring for nutrient input or modification of dissolved oxygen and salinity. NMFS recommends this be addressed in the SEIS and that the MAMP be modified to specifically state that water quality monitoring for nutrients, salinity, and dissolved oxygen will be undertaken and adaptive management will be implemented, if needed, to remedy water quality problems in the Blind River. As noted in preceding comments concerning page 3-27; lines 26-30, NMFS further recommends the SEIS and MAMP be modified to state that federal resource agencies, including NMFS and FWS, will be consulted with regard to environmental monitoring and adaptive measures needed to protect and restore fish and wildlife resources and habitat in the study area, including EFH in Lake Maurepas.

APPENDIX B

PROJECT INFORMATION SHEET WITH ASSUMPTIONS FOR LCA- SMALL DIVERSION AT CONVENT/ BLIND RIVER

Wetland Value Assessment Project Information Sheet
Comparing Final Array of Alternatives

September 8, 2010

Prepared for:
U.S. Army Corps of Engineers
and
Louisiana Department of Natural Resources

Prepared by
U.S. Fish and Wildlife Service

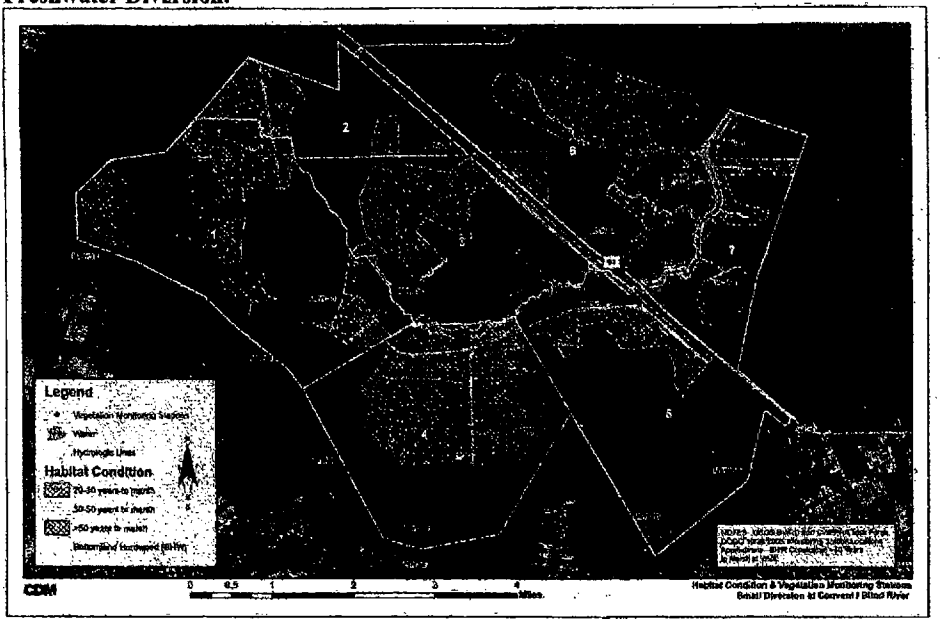
Project Name: Louisiana Coastal Area – Small Freshwater Diversion at Convent/Blind River

Project Type(s): Freshwater diversion and hydrologic restoration within swamp habitat

Project Area: The project area is within the Maurepas Swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1). The U.S. Interstate 10 corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the project area. The Maurepas swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the Louisiana Department of Wildlife and Fisheries, Maurepas Swamp Wildlife Management Area.

For planning and hydrologic modeling purposes, the project area was divided into three benefit areas (i.e., benefit area 1, 2, and 3) and within those benefit areas are several sub-basins. Benefit areas and sub-basins are defined by topographic high areas (e.g., spoil banks, relict railroad grade, road embankments) or channels, natural or artificial (e.g., rivers, canals, channels, intermittent tributaries) that would serve to impede or intercept hydrologic flows. The area south and southwest of Blind River is defined as benefit area 1 (i.e., 100 sub-basin series). The area north of Blind River and west of U.S. Highway 61 is benefit area 2 (i.e., 200 sub-basin series), and the area north of Blind River and east of U.S. Highway 61 is benefit area 3 (i.e., 300 sub-basin series). For the purposes of the Wetland Value Assessment (WVA) the sub-basins are grouped into hydrologic units (Figure 1), or units that are considered to be under the same hydrological influences.

Figure 1. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Problem: Since the construction of the Mississippi River flood control levees, the Maurepas Swamps have been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. Preliminary evaluations suggest that productivity in the stressed Maurepas Swamps may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas swamps and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas Swamps will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

U.S. Army Corps of Engineers guidance requires project performance to be assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. Using the rate of 9.20 mm/yr, a starting year of 2011, and a 50-year project life, a sea-level rise of 1.5 feet is projected for the year 2061 (Table 1). A historic rate considered to be representative of the project area is calculated using the West End at Lake Pontchartrain gauge (85625). The rate of 9.20 mm/yr is considered to include both the eustatic and local subsidence contributions to the estimated total sea-level rise.

In order to estimate the local subsidence rate for the project area, the global eustatic rate (1.7 mm/yr) is subtracted from the local sea level rate or:

Local subsidence rate = 9.20 mm/yr – 1.7 mm/yr = 7.50 mm/yr.

Table 1. Summary of total sea level rise (i.e., considers subsidence) for each scenario.

Project year	Scenario 1, Low Rate (feet)	Scenario 2, Intermediate Rate (feet)	Scenario 3, High Rate (feet)
2011	0.0	0.0	0.0
2016	0.2	0.2	0.2
2021	0.3	0.3	0.5
2026	0.5	0.5	0.8
2031	0.6	0.7	1.1
2036	0.8	0.9	1.4
2041	0.9	1.1	1.7
2046	1.1	1.3	2.0
2051	1.2	1.5	2.4
2056	1.4	1.7	2.8
2061	1.5	1.9	3.2

The estimate for the local subsidence rate is used in conjunction with estimates for the eustatic rates using NRC curves I and III to determine the intermediate and high projections of sea level rise for the project area. The following formula is used to estimate the total rise in eustatic sea level for the project life for the intermediate and high rate scenarios of sea level rise:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,
t_1 is the time in years between the project's construction date and 1986,
and
t_2 is the time between a future date at which one wants an estimate for sea-level rise and 1986.

These eustatic estimates are added to the local subsidence estimate to get the total sea-level rise for the intermediate and high rate scenarios. For the purposes of hydrologic modeling for this project the intermediate rate was used.

Project Goal: Reverse the trend of degradation in the southeast portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

Objectives:

1. Promote water distribution in the swamp which, in turn, will increase freshwater throughput and nutrient input thereby increasing swamp productivity and wetland assimilation.
2. Facilitate swamp building: by increasing swamp productivity and sediment input by up to 1000 g/sq meter per year to decrease the annual subsidence rate (or accretion deficit).
3. Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and seed germination and survival. This is proposed by decreasing flood duration for high flood events within the swamp, increasing the length of dry periods in the swamp, and increasing the number of cypress and tupelo saplings per acre from existing conditions.
4. Improve fish and wildlife habitat in the swamp and in Blind River by increasing sediment and nutrient input, freshwater flow, and dry periods which will contribute to an increase in swamp productivity. This will result in a diversity of stand structure components (tree species composition and a combination of herbaceous, midstory and overstory vegetation), thus improving fish and wildlife habitat needs. Direct project related benefits fish and wildlife resources (i.e., swamp habitat) are quantified by acreage and habitat quality using the Wetland Value Assessment, and are defined by average annual habitat units or AAHUs.

Alternatives:

No Action Alternative (Future without Project Conditions)
Alternative - 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
Alternative - 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
Alternative - 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
Alternative - 6 – Two 1,500 cfs (3,000 cfs combined) Diversions at Romeville and South Bridge (Siphons)

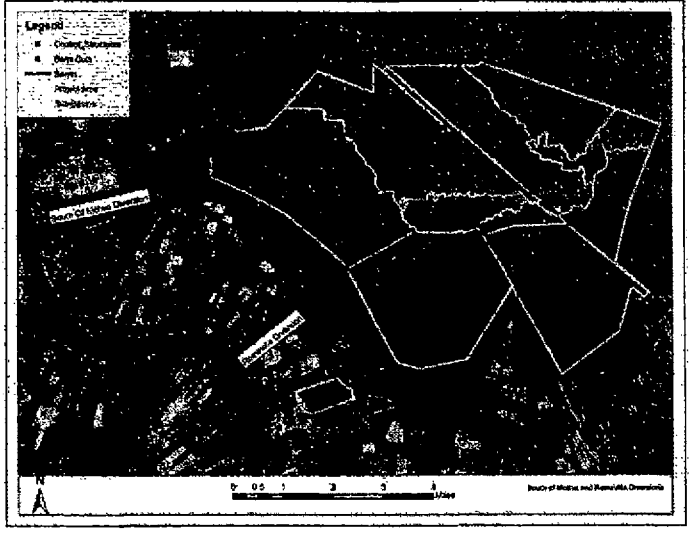
Alternative 2 – 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4 – 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4B – 3,000 Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds 3 new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

Alternative 6 – 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Figure 2. Alternative Diversion Locations and Water Management Measures.



HEC-RAS and HEC-HMS Modeling

The Hydrologic Engineering Centers - River Analysis System (HEC-RAS) is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels to determine hydrologic flow simulation, sediment transport, and water quality analysis. The HEC - Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems including large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, flood damage reduction, floodplain regulation, and systems operation.

Preliminary HEC-RAS and HMS modeling has been conducted by the contractor, CDM. The HEC-RAS was simulated over an average year, 2003 being the representative average water year. HEC-HMS used a 15-year simulation period from 1989-2004. One of the major constraints with directing freshwater into the study area is the efficiency of the Blind River to remove water from the system greatly reducing the exchange and widespread distribution of water throughout the system. A diversion directed to the southern portion of the project area and within benefit area 1 has limited influence on the other benefit areas because Blind River acts as a hydrologic barrier, and vice versa.

Modeling for this project, as well as the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) River Reintroduction into Maurepas Swamp Project (PO-29) has revealed that the Maurepas Swamps are often lower in elevation than Lake Maurepas. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput (EPA 2001).

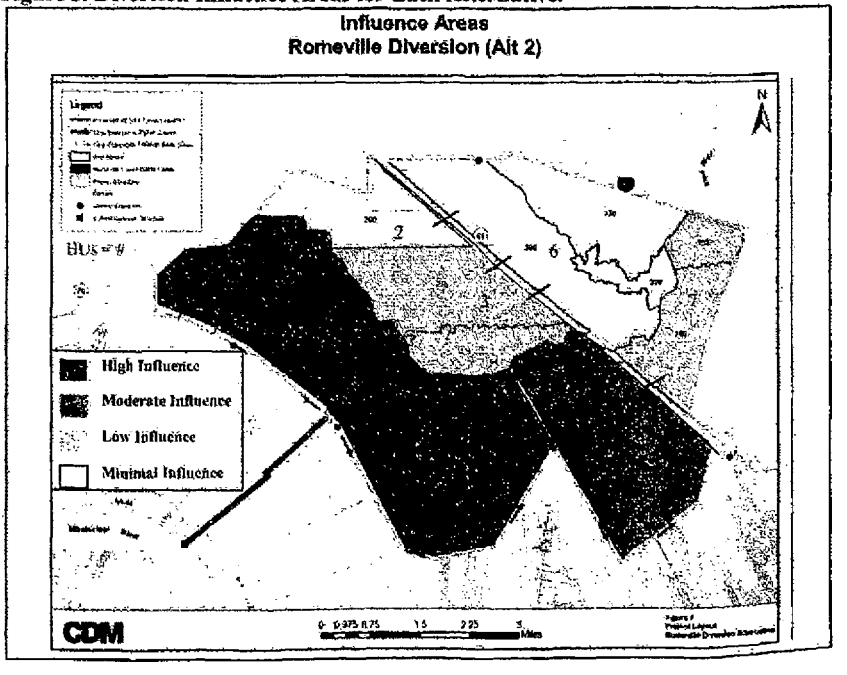
Investigations into diversion capacity determined that changes related to swamp productivity within the system require a minimum diversion flow of 1,000 cubic feet per second (cfs), and 1,500 cfs is required to prevent backflow from Lake Maurepas into the Blind River and swamps. Modeling results also indicate that hydrologic benefits within the system (described by modeling reports as average water depth, water depth exceedence, frequency above Lake Maurepas, and average annual freshwater inflow) either stabilize or do not see incremental benefits as a diversion flow magnitude exceeds 3,000 cfs. Another constraint affecting diversion operations is the availability of water from the Mississippi River. To meet design flow rates Mississippi River water elevations need to be at a minimum of 11 feet; the Mississippi River is at or above that elevation 60 % of the year. It was determined that a 3,000 cfs diversion would be required to provide enough water when available to offset unavailability during low flow periods in the Mississippi River.

Table 2. Diversion Influence for Each Alternative by Habitat Condition Class
(construction impacts considered).

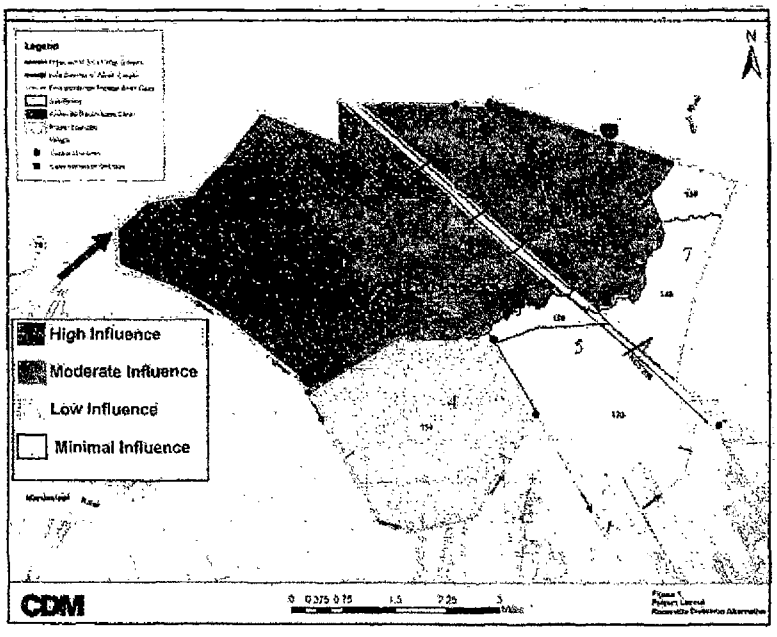
	Degree of Diversion Influence	20-30 Years to Marsh[1]		30-50 Years to Marsh		>50 Years to Marsh	
		HUs[2]	acres	HUs	acres	HUs	acres
Alternative 2 (Romeville)	High	1,4	169	1,4	3364	1,4	4555
	Moderate	5	204	5	604	5	2607
	Low	3,7	2397	3,7	1669	3	469
	No /Minimal	2,6	525	2,6	2297	2,6	2509
Alternative 4 (Hwy 70 Bridge)	High	1,2	169	1,2	1827	1,2	3550
	Moderate	6,3	1837	6,3	2972	6,3	2070
	Low	4	0	4	2013	4	1799
	No /Minimal	5,7	1289	5,7	1073	5	2607
Alternative 6 (Total Div)	High	1,2,4	169	1,2,4	3848	1,2,4	5361
	Moderate	3,5,6	2041	3,5,6	3579	3,5,6	4691
	Low	7	1085	7	469	--	0
	No /Minimal	--	0	--	0	--	0

[1]Habitat Classes as defined under Habitat Assessment Method [2]Hydrologic Units (see Figure 1)

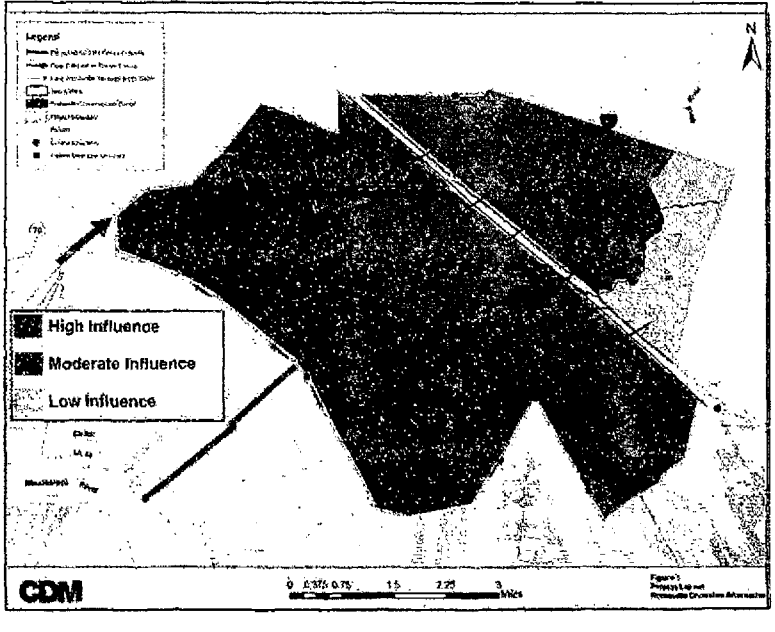
Figure 3. Diversion Influence Areas for Each Alternative.



Influence Areas
Sunshine Bridge Diversion (Alt 4)
(Original – No split southward)



Influence Areas
2 Diversions (or entry points)
(Alts 4b, 6)



Habitat Assessment Method

The procedure for evaluating project benefits on swamp habitats, the WVA swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed diversion project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the swamp for the given time period. The habitat suitability index (HSI) is combined with the acres of swamp to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

Existing and Future without Project Conditions

To characterize existing conditions CDM established 28 vegetation monitoring stations throughout and adjacent to the project area during four separate field trips from March through September of 2009. A trend apparent to Shaffer et al. (2003) in the Maurepas swamp was increasing habitat degradation with proximity to Lake Maurepas. Therefore, two vegetation stations were positioned outside of the project area, closer to Lake Maurepas, to reference and track the progression of more degraded habitat conditions and to suggest potential future conditions for the project area under the no-action alternative. Data was collected on hydrology, wildlife, vegetation, community structure, composition, and health (per WVA methodology) at all vegetation monitoring stations. Soils data were also recorded at most monitoring stations.

On October 7, 2009, the team met with Dr. Gary Shaffer [Southeastern Louisiana University, (SELU)] and Bernard Wood (Research Assistant, SELU) to inspect the project area and compare habitat quality and swamp degradation to other areas of the Maurepas swamp that they are currently studying. Based on observations made during that field trip, data collected during previous field trips, knowledge of the habitat condition of the entire Maurepas swamp by Dr. Shaffer and Mr. Wood, and aerial photography, a habitat condition class map was then developed to categorize the different areas of swamp habitat (levels of degradation) according to classifications used by Dr. Shaffer at other areas within the Maurepas swamp (Figure 1). The intersection of diversion influence and habitat condition class defines the different areas that would require a separate WVA for each alternative (32 WVAs, not including WVAs for construction related impacts).

Three levels of habitat condition class were defined within the project area: 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh. Data obtain from representative vegetation monitoring stations were then summarized according to each habitat class to get a representative value for each habitat class for the WVA. Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level or rate of degradation and not necessarily

the target years that the habitats will be removed from the habitat assessment or converted to marsh habitat.

Variable V_1 - Stand Structure (Table 3)

Most swamp tree species do not produce hard mast; consequently, wildlife foods predominantly consist of soft mast, other edible seeds, invertebrates, and vegetation. Because most swamp tree species produce some soft mast or other edible seeds, the actual tree species composition is not usually a limiting factor. More limiting is the presence of stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy and preferably as a combination of all three. This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.

Conversion of forested wetlands to open water or marsh within the project area has not been observed during field investigations. Minimal windthrow of canopy trees was observed; however, light to moderate crown damage and windthrow of midstory trees was evident and likely occurred from recent hurricanes and tropical storm events. Similar damage was observed throughout Maurepas swamp, with data suggesting that midstory windthrow was inversely related to canopy density (Effler et al. 2007, Shaffer personal communication per DEIS). Decreasing canopy is also indicative of stress due to prolonged inundation and/or stagnant water conditions. Decreased vigor may increase susceptibility of trees to tropical storm damage.

Plant diversity in baldcypress-tupelo swamps is typically low due to low light penetration into the understory and the extended hydroperiod, which limit the establishment and survival of understory vegetation. Baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) are common codominant canopy species in this habitat, with swamp red maple (*Acer rubrum var. drummondii*) predominant and green ash (*Fraxinus pennsylvanica*) codominant, in the midstory and understory strata. Common herbaceous species include arrow arum (*Peltandra virginica*), pennywort (*Hydrocotyle* spp.), smartweed (*Polygonum punctatum*), and lizard's tail (*Saururus cernuus*). Salvinia (*Salvinia* spp.), a non-native invasive aquatic fern, is prolific in many areas. Savanna panicum (*Phanopyrum gymnocarpon*), thought to be an indicator of flow and nutrients, was also observed in the higher quality swamps. A complete list of species and existing habitat conditions at each vegetation monitoring station is provided in CDM's October 2, 2009, "Existing Environmental Condition of Project Area" Memorandum.

Stand Structure for 20-30 Years-to-Marsh

Existing –The 20-30 years-to-marsh habitat class is characterized by having 23 percent canopy cover, 33 percent midstory cover, and 80 percent herbaceous or ground cover (Class 1). Of the overstory canopy cover, 81 percent is tupelo and other species, and the remaining 18 percent is cypress, with some monitoring sites being comprised of 100 percent tupelo. While basal area averages 113.85 ft^2/ac (moderately dense), one monitoring site has a basal area of 34.52 ft^2/ac

which is considered open, and one site is 64.43 ft²/ac which is considered to be moderately open. One aspect of stand structure that is not reflected in the data is crown damage or loss of tree tops. While this is localized within the project area it is expected to be a common characteristic in the future as conditions deteriorate which is evident in other areas of Maurepas swamp. Crown damage also contributes to the low canopy cover phenomenon in an area were basal area is moderately dense, which consequently results in a high herbaceous cover. Water tolerance by tupelo has allowed the swamp stand structure to be dominated by tupelo in those areas experiencing prolonged flooding. Coupled with occasional salinity spikes, some tupelo dominated areas are experiencing either canopy top-off or complete canopy die off.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover will persist below 33 percent (Table 3).

FWP – Depending on the location of this habitat class within the influence of the diversion, the 20-30 years to marsh is expected to see some benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. According to FWP modeling of "existing conditions with berm cuts", the project area is expected to be constantly inundated with an average annual water depth throughout the project area of 1.01 feet by target year 20 and 1.75 feet by target year 50. Additional flows from a 3,000 cfs diversion would only increase flood duration. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest period of drying. With the diversion average, annual water depths are predicted to be in some areas as high as 3.71 feet (Alternative 6, hydrologic sub-basin series 200) and 5.82 feet (Alternative 4, hydrologic sub-basin series 200) during operation of the diversion. Therefore, the stand structure class was reduced at target year 50 (Table 3) to reflect prolonged inundation and a reduced herbaceous and midstory component.

Areas not affected by the diversion should see some benefits of increased hydrologic flow/throughput as a result of the in-swamp management measures. However, these benefits are short term as total sea level rise contributes to these areas returning to a persistent flooding regime by target year 20. It is projected that those areas of 20-30 years-to-marsh habitat class within areas not influenced by the diversion will not have enough time and benefits to regenerate and maintain a healthy forested stand, and, therefore, returns to a Class 1 by target year 30.

Table 3. Future-with and Future-without Project Stand Structure Conditions.

FWOP

Habitat Condition Class	TY0					TY1	TY20				TY30				TY50			
		%O	%M	%H	Class	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh		23	33	80	1	1	<33			1	<33			1	<33			1
30-50 yrs. to marsh		38	39	51	5	5	33<50	<33	<33	2	33<50	<33	<33	2	<33			1
>50 yrs. to marsh		64	46	22	4	4	50<75	>33	<33	4	50<75	>33	<33	4	33<50	<33	<33	2

FWP

Habitat Condition Class	Level of Influence	TY0				TY1				TY20				TY30				TY50			
		%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh	High Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	50<75	>33	<33	4
	Moderate Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	50<75	>33	<33	4
	Low Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	2
	No Influence**	23	33	80	1	23	33	80	1	33<50	>33	>33	5	<33			1	<33			1
30-50 yrs. to marsh	High Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	≥50	>33	>33	6	≥50	>33	<33	4
	Moderate Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	≥50	>33	>33	6	≥50	>33	<33	4
	Low Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	2
	No Influence**	38	39	51	5	38	39	51	5	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	2
>50 yrs. to marsh	High Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	Moderate Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	Low Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	No Influence**	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4

Stand Structure for 30-50 Years-to-Marsh

Existing – The 30-50 years-to-marsh habitat class is characterized by having 38 percent canopy cover, 39 percent midstory cover, and 51 percent herbaceous or ground cover (Class 5). Of the overstory canopy cover, 85 percent is tupelo and other species and the remaining 15 percent is cypress. Similar to the 20-30 years-to-marsh habitat class, several of the monitoring vegetation sites were 100 percent tupelo. Basal area varied from 133.42 ft^2/ac to 320.79 ft^2/ac, or moderately dense to dense; however, light penetration appears to be suitable enough to support a midstory and herbaceous cover component.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, especially to tupelo, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover is predicted to drop below 33 percent by target year 50.

FWP – High to moderate influenced areas are predicted to see benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. As noted above, flood duration is expected to increase as total sea level rise increases, resulting in an eventual decrease in herbaceous cover by target year 50.

Areas that are not affected (no influence areas) or are minimally affected (low influence areas) by the diversion see no increase in stand structure, but rather maintain the existing stand structure until target year 50. Consistent with the previously mentioned hydrologic conditions, stand structure is reduced at target year 50 as a result of a reduced herbaceous component.

Stand Structure for Greater than 50 Years-to-Marsh

Existing – The greater than 50 years-to-marsh habitat class is characterized by having 64 percent canopy cover, 46 percent midstory, and 22 percent herbaceous or ground cover. Of the overstory canopy cover, 44 percent is tupelo and other species and 56 percent is cypress. While the percentage indicates an even distribution, the individual monitoring vegetation sites were dominated by either one or the other species. Basal area and percent canopy cover is considered optimal, or dense, with an average basal area of 256.09 ft^2/ac. The midstory is also considered suitable; however, herbaceous cover is less than optimal likely due to lack of light penetration and nutrients.

FWOP – In comparison to other areas of the Maurepas swamp, this habitat class is considerably healthier and is expected to maintain a Class 4 stand structure through much of the FWOP life. By target year 50 conditions will begin to deteriorate and the canopy begins to thin.

FWP – This habitat class is expected to see benefits as a result of increased sediments, nutrients, and freshwater from the diversion, and due to increased throughput as a result of in-swamp management measures. Consequently, an increase in herbaceous cover is expected within the short term for all areas of influence. However, as canopy closure becomes even more prevalent

and as flood duration is expected to increase as total sea level rise increases, a decrease in herbaceous cover by target year 30 is predicted.

Variable V_2 - Stand Maturity (Table 8)

The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important component of this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, but only average DBH, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically an adequate number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Existing Conditions

Seven vegetation monitoring stations were identified that were representative of the 20-30 years-to-marsh class. Basal area averaged 113.85 ft²/acre. The average DBH measured 11.21 inches for cypress and 13.08 inches for tupelo and other canopy co-dominant species. Even though this is the most degraded habitat, class basal area is still considered to be moderate.

Six vegetation monitoring stations were identified that were representative of the 30-50 years-to-marsh class. Basal area averaged 222.73 ft²/acre. The average DBH measured 14.71 inches for cypress and 14.20 inches for tupelo and other canopy co-dominant species.

Nine vegetation monitoring stations were identified that were representative of the greater-than 50 years-to-marsh class. Basal area averaged 256.09 ft²/acre. The average DBH measured 15.76 inches for cypress and 13.97 inches for tupelo and other canopy co-dominant species.

FWOP

Numerous bald cypress and tupelo growth rates have been documented in deep water swamp habitats and are summarized by Visser and Sasser (1995). For FWOP conditions we assumed mean annual growth rates documented by Dr. Shaffer (unpublished) (Table 4) for target years 1-20. These assumptions are similar to what was used for the LCA, Amite River Diversion Channel Modification project. Since subsidence, total sea level rise and associated stresses are expected to continue mean annual growth rates were reduced for target years 20-50.

Increase in basal area was estimated by species and habitat condition class by calculating and projecting the increase in basal area using the predicted growth rates and tree mortality. Percent composition of canopy trees in the FWOP was estimated based on best professional judgment of expected mortality of tupelo among the habitat condition classes taking into consideration

Table 4. Cypress and Tupelo Annual Growth Rates FWOP

	Cypress (inches)	Tupelo et al (inches)
TY 0-20		
20-30 yrs to marsh	0.11	0.08
30-50 yrs to marsh	0.15	0.1
>50 yrs to marsh	0.15	0.1
TY 20-50		
20-30 yrs to marsh	*0.064	**0.073
30-50 yrs to marsh	*0.064	0.08
>50 yrs to marsh	*0.064	0.08

*Visser and Sasser (1995) ** Day (1985) from Visser and Sasser (1995)

assumptions made for the CWPPRA River Reintroduction into Maurepas Swamp Project. The CWPPRA River Reintroduction into Maurepas Swamp Project estimated that 50% of tupelo would die over the 20 year FWOP life, but that actual mortality of cypress would be minimal. Because habitat conditions within the Convent/Blind River project area are more favorable and are not at the same stage of degradation we assumed a reduced tupelo mortality rate for the first 20 years and for higher quality habitat condition classes (Table 5). Because tupelo is more flood tolerant highly degraded areas have become dominated by tupelo. Those areas have also experienced continued degradation as a result of seasonal salinity spikes and are seeing increased tupelo mortality and reduced vigor. In order to be conservative only tupelo mortality was assumed when determining FWOP mortality and projected project benefits because lower quality habitats were dominated by tupelo.

Table 5. Tupelo Mortality FWOP

	TY 20	*TY 50
20-30 yrs to marsh	50%	50%
30-50 yrs to marsh	25%	50%
>50 yrs to marsh	25%	25%

*percent mortality is of the TY 0 (existing) stand

Table 6. Tupelo Mortality FWP

	TY 1	TY 20	TY 50	Total Mortality
High Influence				
20-30 yrs to marsh	0%	0%	5%*	5%
30-50 yrs to marsh	0%	0%	5%*	5%
> 50 yrs to marsh	0%	0%	0%	0%
Moderate Influence				
20-30 yrs to marsh	0%	0%	10%*	10%
30-50 yrs to marsh	0%	0%	10%*	10%
> 50 yrs to marsh	0%	0%	0%	0%
Low Influence				
20-30 yrs to marsh	0%	0%	20%*	20%
30-50 yrs to marsh	0%	0%	20%*	20%
> 50 yrs to marsh	0%	0%	10%*	10%
No Direct Influence				
20-30 yrs to marsh	0%	40%*	40%*	80%
30-50 yrs to marsh	0%	10%*	40%*	50%
> 50 yrs to marsh	0%	10%*	20%*	30%

*% of existing stand @ TY0

ible 8. Future-with and Future-without Project Stand Maturity Conditions.

Future Without Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft²/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	FWOP	baldcypress	11.87	13.96	14.60	15.88	10.42	18.87	18.87	100.00	122.35	82.98	90.81	18.42
		tupelo et al.	13.56	15.08	15.81	0.00	89.58	81.13	81.13	0.00				
30-50 yrs. to marsh	FWOP	baldcypress	15.61	18.46	19.10	20.38	17.57	22.13	22.13	46.02	241.96	247.88	269.12	157.24
		tupelo et al.	14.80	16.70	17.50	19.10	82.43	77.87	77.87	53.98				
>50 years to marsh	FWOP	baldcypress	16.66	19.51	20.15	21.43	41.51	48.62	48.62	58.67	280.03	320.24	345.15	338.32
		tupelo et al.	14.57	16.47	16.47	18.87	58.49	51.38	51.38	41.33				

Future With Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft²/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	High Influence	baldcypress	11.98	16.16	17.25	18.91	10.42	10.42	10.42	10.91	123.80	185.60	213.14	247.37
		tupelo et al.	13.64	16.68	17.92	19.82	89.58	89.58	89.58	89.09				
	Moderate Influence	baldcypress	11.95	15.50	16.33	17.61	10.42	10.42	10.42	11.44	123.37	174.97	195.25	208.04
		tupelo et al.	13.62	16.20	17.15	18.61	89.58	89.58	89.58	88.56				
	Low Influence	baldcypress	11.91	14.62	15.26	16.54	10.42	10.42	10.42	12.69	122.79	161.30	176.18	170.34
		tupelo et al.	13.59	15.56	16.29	17.75	89.58	89.58	89.58	87.31				
	No Influence**	baldcypress	11.87	13.96	14.60	15.88	10.42	16.23	16.23	36.76	122.35	96.67	105.81	54.07
		tupelo et al.	13.56	15.08	15.81	17.27	89.58	83.77	83.77	63.24				
30-50 yrs. to marsh	High Influence	baldcypress	15.56	21.26	22.35	24.01	17.57	17.57	17.57	18.32	241.69	383.85	435.66	500.91
		tupelo et al.	14.80	18.60	19.96	22.04	82.43	82.43	82.43	81.68				
	Moderate Influence	baldcypress	15.52	20.36	21.19	22.47	17.57	17.57	17.57	19.15	240.70	359.05	397.06	423.01
		tupelo et al.	14.77	18.00	19.04	20.64	82.43	82.43	82.43	80.85				
	Low Influence	baldcypress	15.46	19.16	19.80	21.08	17.57	17.57	17.57	21.04	239.40	327.36	355.08	348.08
		tupelo et al.	14.73	17.20	18.00	19.60	82.43	82.43	82.43	78.96				
	No Influence**	baldcypress	15.41	18.26	18.90	20.18	17.57	19.15	19.15	29.89	238.42	280.58	305.05	232.82
		tupelo et al.	14.70	16.60	17.40	19.00	82.43	80.85	80.85	70.11				
>50 yrs. to marsh	High Influence	baldcypress	16.81	22.51	23.60	25.27	41.51	41.51	41.51	41.51	275.69	454.73	510.25	601.75
		tupelo et al.	14.67	18.47	19.83	21.91	58.49	58.49	58.49	58.49				
	Moderate Influence	baldcypress	16.77	21.61	22.45	23.73	41.51	41.51	41.51	41.51	274.46	423.36	464.05	530.56
		tupelo et al.	14.64	17.87	18.91	20.51	58.49	58.49	58.49	58.49				
	Low Influence	baldcypress	16.71	20.41	21.05	22.33	41.51	41.51	41.51	44.09	272.83	383.33	412.97	450.44
		tupelo et al.	14.60	17.07	17.87	19.47	58.49	58.49	58.49	55.91				
	No Influence**	baldcypress	16.66	19.51	20.15	21.43	41.51	44.09	44.09	50.34	271.61	336.31	363.08	372.21
		tupelo et al.	14.57	16.47	17.27	18.87	58.49	55.91	55.91	49.66				

**NO INFLUENCE GROWTH RATES SET AS FWOP.

FWP

The proposed diversion is expected to substantially stimulate productivity, and so stimulate growth of the cypress and tupelo (as well as other species). The amount of stimulation is assumed to be related to level of influence of the diversion. Depending on the alternative diversion location certain hydrologic units will receive different levels of influence. Those areas within the high influence area will receive freshwater, nutrients, and sediments; so it is assumed those hydrologic units will see the greatest increase in growth. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (EPA 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing levels of productivity in Maurepas are ½ to ¼ of average values (EPA 2001). Southeast Louisiana University study sites within the Maurepas swamp that receive non-point source runoff (i.e., containing nutrients and sediment) have documented an average 1 centimeter of diameter increase per year. When sewage effluent is involved some study sites average 1.5 cm of growth per year close to such a source (Bernard Wood, personal communication). As a very conservative projection, a 2-fold increase in growth rate (i.e., 200% of growth rates listed in Table 4) was applied to the high influence areas for the first 19 years to capture the anticipated stimulation of growth from the diversion. Reduced growth rates were assumed as the level of influence decreased and as the area returned to a more semi-permanent flooding regime (Table 7). DBH and basal area in the FWP were estimated as for FWOP, by applying the increased growth rates and mortality rates.

Table 7. Percent Increase in DBH growth rate based on Level of Diversion Influence (50 yr project life) FWP

	TY 1	TY 20	TY 30
High Influence Area	200%	170%	130%
Moderate Influence Area	170%	130%	100%
Low-Direct Influence Area	130%	100%	100%

Areas not affected by the diversion may still experience benefits as a result of the berm cuts and in-swamp management modifications. Tupelo mortality was assumed based on flood duration and existing stand health. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest possible dry out period in some years.

Variable V_3 - Water Regime (Table 9)

The optimal water regime is assumed to be seasonally flooded with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. In addition, abundant and consistent input and water flow-through is optimal, because under that regime the full functions and values of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable. Habitat

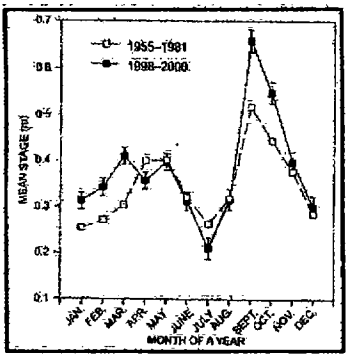
suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be the least desirable (SI=0.1). Those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production (WVA Procedure Manual).

Existing

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA River Reintroduction into Maurepas Swamp project, has revealed that the Maurepas swamp floor elevations [i.e., 1.12 feet NAVD per the CWPPRA, Coastwide Reference Monitoring System (CRMS) station 5167] are often lower than Lake Maurepas bottom elevations. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and the hydrologic impoundments caused by major transportation corridors. Adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., U.S. Interstate 10, U.S. Highway 61, and Kansas City Southern Railroad (KCSRR)]; flood waters within the project area are the last to recede from the basin. It is appears that within hydrologic unit 3 interior elevations are low enough to allow ponding of water for longer periods of time, and is, therefore, considered permanently flooded with low water exchange.

Lunar tidal fluxes in Maurepas swamp average 30 cm but are typically overwhelmed by meteorological tidal fluxes. Wind is also a significant forcing agent for water level in Maurepas swamp and may exhibit daily and seasonal variability. During the summer and early fall, storms and prevailing winds from the southeast raise water levels in the swamp as they push Gulf water into the system. Conversely, during the winter months, continental fronts with prevailing winds from the northeast often lower water levels in the swamp as they push water out of the system and towards the Gulf. Fluctuations in water level are generally expected to be similar throughout Maurepas swamp, acknowledging slight variability associated with landscape position and elevation. Within any given year, water stage is characterized by a bimodal hydrograph (Figure 4). Water level rises in the spring, then falls to its lowest level during the summer, rises to its highest level in the fall, and again falls to low levels in the winter (Thomson 2000, Keddy et al. 2007). The intensity of peaks and troughs is typically associated with those meteorological events.

Figure 4. Intra-annual variability of montly mean stage comparing the periods 1955-1981 (historical) and 1998-2000 (drought period). The duration of flooding (percentage of the year that the marshes by Schleider's Ditch flood) more than doubled over the period of record for the USACE tide gage (from Thomson 2000, referenced in Keddy 2007)



Water exchange between the project area swamps and adjacent swamps is reduced to what the Blind River and other small tributaries can exchange across the embankments of the three transportation corridors (i.e., U.S. Interstate 10, U.S. Highway 61, and KCSRR). These embankments act as hydrologic barriers and reduce flow-through across the project area swamp. Within the project area interior drainage and hydrologic exchange has been altered by the construction of drainage canals and associated berms, pipeline and transmission line rights-of-way, and remnant logging infrastructure (i.e., roads, pull boat ditches, and temporary railroad track embankments). Historically, seasonal overbank flooding over the natural Mississippi River levees facilitated hydrologic exchange and freshwater input on average every three to five years. Today the only additional freshwater input is through rainwater runoff, and even those contributions can by-pass the wetland system through the many storm water drainage canals that direct floodwaters directly into Blind River and Lake Maurepas. The project area swamp habitat has been altered and disrupted to a point that adequate water exchange does not exist, and is considered to have low water exchange.

FWOP

Future without project conditions flood durations are expected to worsen as sea level rise and subsidence continues and storm water control projects continue to force storm water into an already flooded system. It is assumed that the entire project area swamp habitat will become permanently flooded and continue to have low flow exchange.

Table 9. Summary for Average Annual Water Depth (ft)

No Sea Level Rise (existing conditions)

Alternatives	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.90	1.73	1.83	2.09	1.34	1.53	1.61	1.72
	Existing Conditions; With Berm Cuts	0.78	0.74	0.69	0.82	0.55	0.58	0.65	0.69
2	Romeville Diversion	2.13	0.74	1.30	2.18	0.55	0.59	0.66	1.16
4	South of Highway 70 Bridge Diversion	1.79	3.40	1.62	0.85	0.54	0.59	0.65	1.35
6	Total Diversion	1.82	2.08	1.47	1.54	0.55	0.59	0.65	1.24

20-year Sea Level Rise

	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.92	1.76	1.84	2.11	1.37	1.56	1.65	1.75
	Existing Conditions; With Berm Cuts	1.10	1.08	0.99	1.20	0.81	0.89	1.02	1.01
2	Romeville Diversion	2.75	1.08	2.03	2.93	0.82	0.90	1.02	1.65
4	South of Highway 70 Bridge	2.42	4.66	2.46	1.27	0.81	0.89	1.02	1.93
6	Total Diversion	2.44	2.84	2.30	2.13	0.81	0.90	1.02	1.78

30-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions	1.95	1.82	1.87	2.14	1.42	1.61	1.71	1.79
	Existing Conditions; With Berm Cuts	1.29	1.30	1.17	1.42	0.98	1.08	1.26	1.21
2	Romeville Diversion	2.99	1.30	2.38	3.21	0.99	1.12	1.27	1.89
4	South of Highway 70 Bridge	2.77	5.13	2.91	1.54	0.98	1.09	1.26	2.24
6	Total Diversion	2.76	3.16	2.70	2.45	0.99	1.10	1.27	2.06

50-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions;	2.15	2.07	2.04	2.33	1.64	1.83	2.02	2.01
	Existing Conditions; With Berm Cuts	1.83	1.88	1.68	1.96	1.48	1.58	1.86	1.75
2	Romeville Diversion	3.49	1.88	3.06	3.73	1.51	1.68	1.88	2.46
4	South of Highway 70 Bridge	3.52	5.82	3.83	2.16	1.48	1.60	1.85	2.90
6	Total Diversion	3.42	3.71	3.47	3.16	1.51	1.69	1.88	2.69

FWP

Depending on the location of the hydrologic unit within the watershed in relation to the diversion outfall it was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). However, all HUs see increased benefits in the form of dry-out frequency as a result of the berm cuts assuming the diversion would be operated to maximize dry-out frequency. At this time an operational plan has not been developed. In target year 1 (defined as "existing conditions with berm cuts" in Table 9), without a diversion water depths are lower than existing conditions throughout all hydrologic units for all alternatives, and below swamp floor elevations in most hydrologic units (Table 9).

Hydrologic data indicates that by TY 20 water levels within all areas are at or above swamp floor elevations. Within areas of high influence sediment accretion is expected and should keep up with total sea level rise. Nutrient input into areas moderately influenced would facilitate increased growth rates contributing to above ground biomass. While this has been taken into

consideration, accretions rates have not been predicted or analyzed at this time. As displayed in Table 10, FWP water regime was evaluated by each hydrologic unit for each alternative and grouped according to level of influence by the diversion.

Table 10. Future With Project Water Regime Conditions.

	TY0		TY1		TY20		TY30		TY50	
	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI
Alternative 2										
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
Alternative 3										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	semiperm-low	0.45	seasonal-moderate	0.85	semiperm-moderate	0.65	semiperm-moderate	0.65	semiperm-moderate	0.65
no influence	perm-low	0.30	seasonal-low	0.70	semiperm-low	0.45	perm-low	0.30	perm-low	0.30
Alternative 4										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	permanent-low	0.30	semiperm-moderate	0.65	semiperm-moderate	0.65	permanent-moderate	0.45	permanent-moderate	0.45
no influence	-	-	-	-	-	-	-	-	-	-

Variable V_4 - Mean high salinity during the growing season.

Swamps can tolerate increased salinities; however increased salinity spikes coupled with prolonged flooding has been shown to be detrimental to those forested swamps. Baldcypress is able to tolerate higher salinities compared to other swamp species such as tupelogum and many herbaceous species which are salinity-sensitive. Salinity recorded at Pass Manchac during the 1999-2000 drought spiked at 8 parts-per-thousand (ppt) and averaged around 5 ppt until heavy rains in July 2000 ended the drought (Keddy et al. 2007). For the Swamp WVA optimal conditions for salinity are assumed when mean high salinities during the growing season are equal to or less than 1.0 ppt. Habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

For the CWPPRA River Reintroduction into Maurepas Swamp project the lowest existing salinities documented were 1.53 ppt for the "Hope" station group (EPA 2001). The Convent/Blind River Diversion project area is located further inland from the "Hope" station group and is landward of several hydrologic barriers (i.e., I-10, US 61, KCSRR), thereby being protecting from the higher salinity waters coming from the Gulf. Because of these barriers it is likely salinity levels remain relatively consistent throughout the project area and do not fluctuate within the project area. While salinity spikes still affect the project area through the hydrologic

connectivity of Blind River and other small tributaries, those salinity spikes are not representative of typical salinities and are not represented in this variable. For 2008, average salinities during the growing season recorded at CRMS stations (0065 and 5167) located west of U.S. Hwy 61 were measured at 0.25 ppt. The highest salinity measured during the growing season was 0.33 ppt. Salinities have been collected periodically in Blind River at US Hwy 61 by LDEQ (LA040403), and average annual salinities taken from 1981 to 1998 were 0.95 ppt. Average salinities recorded during the growing season at that station range from 0.15 ppt in 1996 to 0.70 ppt in 1995. However, those values were only obtained from the months of April, June, August, and October. For two CRMS stations located west of U.S. Hwy 61 and in the project area average salinities in the growing season were measured at 0.35 ppt (CRMS0039) and 0.53 ppt (CRMS5167), slightly higher than the interior sites.

According to the data available for the entire project area it appears that mean high salinity during the growing season is less than 1.0 ppt. Should coastal restoration and protection projects (e.g., MRGO Ecosystem Restoration Project and features of the Federal Hurricane and Storm Damage Risk Reduction System) proposed for the Lake Pontchartrain Basin not be implemented, it is highly likely that the project area will continue to see slight increases in average salinities and a greater frequency in salinity spikes. This is evident from the salinity trends observed in the forested swamps to the east and closer to Lake Maurepas. However, average high salinities during the growing season are not expected to exceed 1.0 ppt over the project life. The suitability index for salinities 1.0 ppt or less is 1.0.

It is assumed that the project area can be subdivided into two salinity regions. Areas east of U.S. Hwy 61 and south of Interstate 10 experience slightly higher salinity levels as a result of being closer to the lake. Areas further inland and west of U.S. Hwy 61 are slightly fresher due to the hydrologic barriers impeding the salinity gradient and the contribution of freshwater run-off from the adjacent upland areas.

Existing conditions for areas east of U.S. Hwy 61 are estimated based on the CRMS data for 0065 and 5167. Salinities were consistent throughout the 2008 growing season so mean high salinities were not calculated. Because of freshwater runoff and the hydrologic barriers, average mean high salinities are not expected to increase; however, salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes. Average high salinities during the growing season are not expected to exceed 1.0 ppt over the 50-year future without project life.

Existing conditions for areas west of U.S. Hwy 61 are estimated using data from the two CRMS stations (0039 and 5167) within the area. It is likely that in the 50-year future without project life the area will experience a slight increase in salinities, but will still be within the optimal range. Project area salinities are greatly influenced by adjacent storm water and agricultural freshwater runoff, and hydrologic barriers prevent high saline waters from entering the swamps. Salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes.

Modeling conducted for the closure of the MRGO at Bayou La Loutre showed that salinities would decrease within the adjacent marshes and associated waterways on the order of 1.0 to 3.0 ppt as a result of that closure (Draft IER 11 Tier 2 Pontchartrain 2009). Higher saline waters that

commonly entered through the MRGO into the southern end of Lake Pontchartrain have been cut off as a result of that closure and the Lake Borgne surge barrier currently being constructed.

Summary/Results

According to initial results from the hydrologic modeling, benefits are achieved through gapping spoil banks and modifying other hydrologic barriers to allow the redistribution of hydrologic flow throughout the swamp system. Because in-swamp management is a feature of all three alternatives, all three alternatives see considerable WVA benefits in the first 20 years as a result of those features; therefore, the difference in AAHUs between alternatives is minimized. The analysis then becomes a comparison of diversion influence areas. Based on preliminary hydrologic modeling results which at this stage of the study has focused on transfer of flow between benefit areas, the Romeville diversion alternative (Alternative 2) directly influences a larger area (i.e., HUs 1 and 4) compared to Alternative 4, the South of Hwy 70 Bridge diversion alternative (i.e., HUs 1 and 2). The "Total diversion" alternative (i.e., Alternative 6 and 4b) consequently has the highest benefits because sediments, nutrients, and freshwater are influencing a larger receiving area. Another observation in the analysis is that basal area throughout most of the project area is considered to be within the optimal range (i.e., >161 sq. ft./ac) to support wildlife habitat. The WVA, therefore, does not show a distinction (or change in suitability indices) between habitat classes and between FWP and FWOP for this variable. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The project area is semi-permanently flooded and future-with-project modeling projections indicates that the flooding regime within most of the project area will return to pre-project conditions by target year 20 as a result of total sea level rise. However, hydrologic flow will be improved and will provide additional benefits by increasing forest stand vigor, accretion, water quality and back flow prevention.

Data Gaps and Additional Information Needs for Analyzing Benefits of the Tentatively Selected Plan (TSP)

Because of the expedited schedule, limited data was available at the time of this analysis. Therefore, the intent of this habitat analysis is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Diversion operations need to be developed by alternative and incorporated into the hydrologic modeling.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

IMPACTS

For each alternative, impacts to swamp habitat are associated with the transmission channel from the Mississippi River to the outfall area (benefit area) and with transmission canal construction and modification within the outfall area (Tables 11 & 12). For FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed alternative.

Table 11. Forested Wetland Impacts (Acres)

	Alternative 2 Romeville 3000cfs	Alternative 4 Southbridge 3000cfs	Alternative 4B Southbridge 3000 cfs split flows	Alternative 6 Romeville 1500 cfs Southbridge 1500 cfs
Diversion Channel	53	107	107	160
Northern Transmission Canal	-	163	126	126
Widening of St James Canal	-	-	72	-
Total	**53**	**270**	**305**	**286**

Impacts associated with the transmission channel were quantified using the highest quality habitat (i.e., greater than 50 years-to-marsh) variable assumptions from the WVA assessing benefits. Field data was not obtained along the proposed transmission channels due to limited time associated with the expedited schedule; therefore, variable assumptions were made to give advantage to the forested resources being impacted (e.g., stand structure and maturity were assumed to have the highest suitability index value). Forested areas closer to, and associated with, the natural levee of the Mississippi River are at higher elevations, and prolonged inundation is not expected. Therefore, for areas where water regime is currently classified as seasonal or temporary, stand structure class is expected to increase through the 50-year project life. Water regime was determined using classifications by National Wetlands Inventory 1988. Forested habitat at higher elevations along the natural levee of the Mississippi River is not expected to experience marked salinity influences through the project life. See WVA worksheets for the discrete variable assumptions.

The proposed northern transmission canal (i.e., Alternatives 4A, 4B, and 6) traverses through the "benefit area" and the associated acreage was previously included in the habitat analyses evaluating benefits. Those analyses were revised, and the associated acres impacted were subtracted from the respective analysis by habitat condition class. The associated impacts were then evaluated using the same variable assumptions from those previous habitat analyses assessing benefits for FWOP. Again, for FWP, all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Alternative 4B would include expanding the St. James Parish Canal and constructing channel berms to achieve a head differential sufficient to move diverted water to the southern portion of the project area. While additional indirect impacts would be associated with impounding areas of swamp by constructing these berms, only direct impacts to wetlands were evaluated. Much of this area was already classified in the habitat condition class and the same variable assumptions for FWOP were used. Again, for FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Figure 5. Forested Impacts Associated with the Romeville Diversion Channel (Alts. 2 & 6)

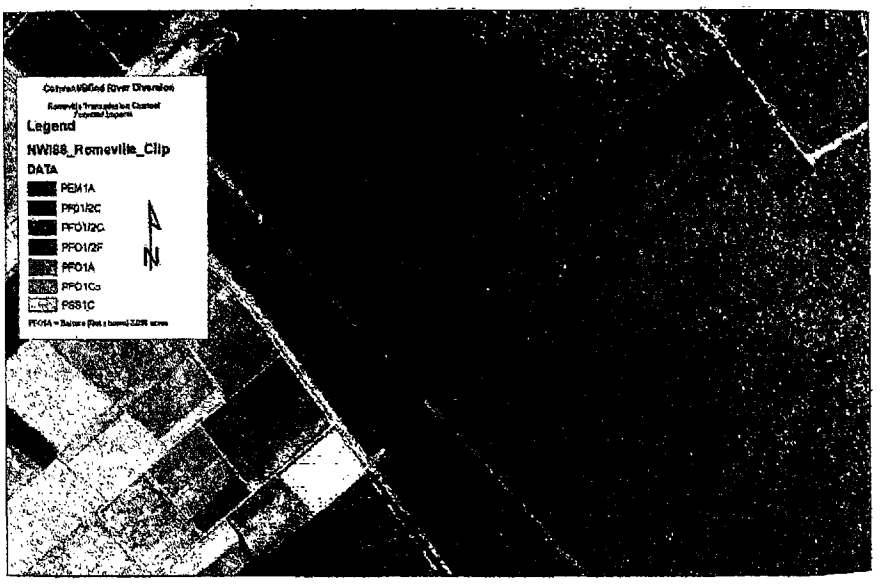


Figure 6. Forested Impacts Associated with the South Bridge Transmission Channel (Alternative 4A and 6)

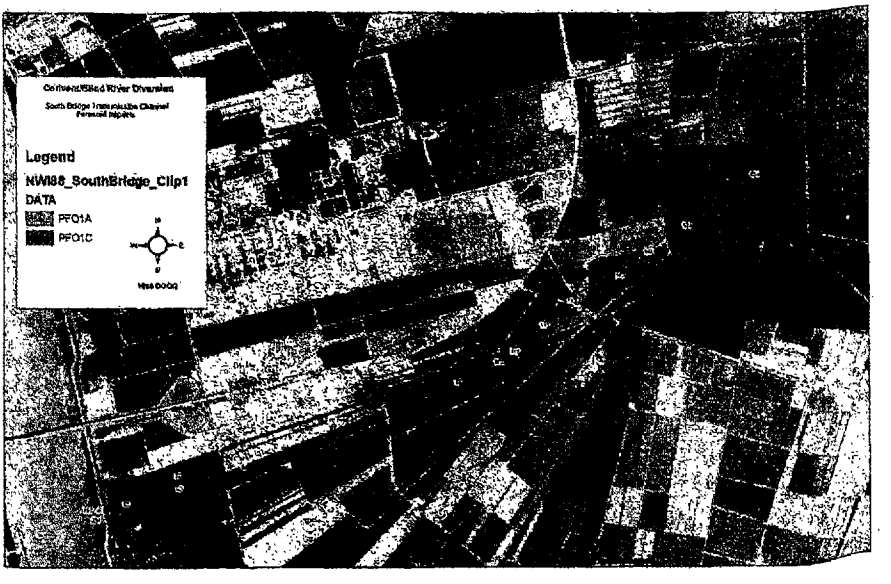


Figure 7. Forested Impacts Associated with the Outfall Canal (Alternatives 4A, 4B, & 6).

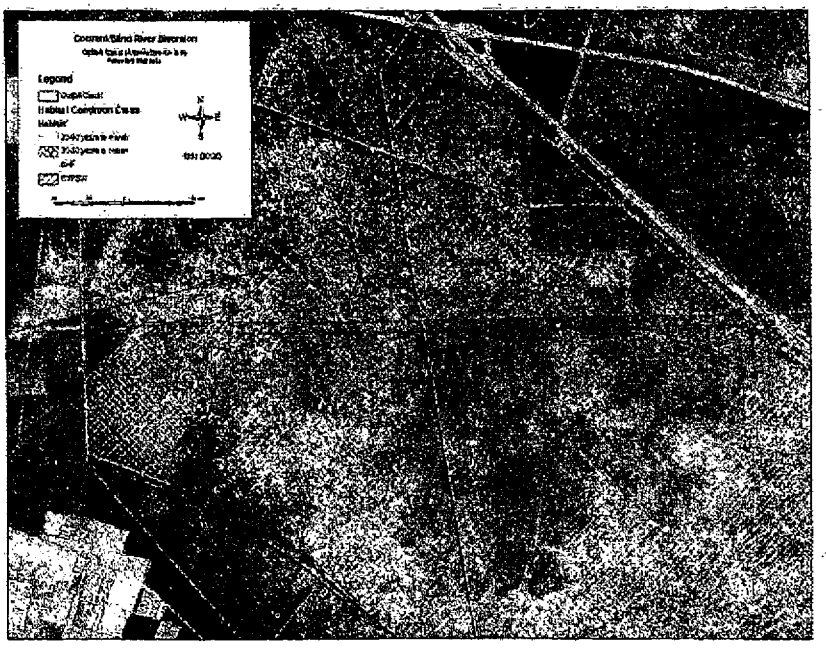


Figure 8. Forested Impacts Associated with Widening St. James Parish Canal (Alt. 4B)

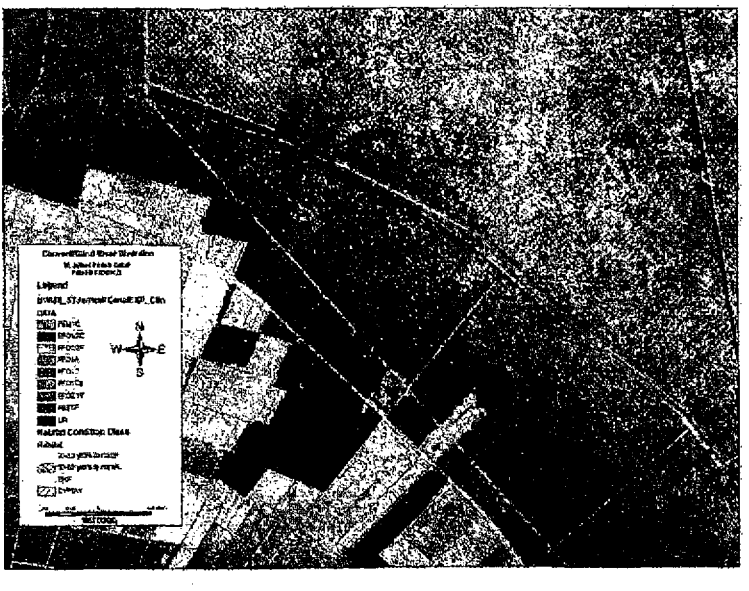


Table 12. Summary of Total Acres Benefited and Impacted.

	Acres			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	169	169	169	169
High IA, 30-50 years to marsh	3364	1827	3848	3848
High IA, >50 years to marsh	4555	3550	5361	5361
Moderate IA, 20-30 years to marsh	204	1837	2041	2041
Moderate IA, 30-50 years to marsh	604	2972	3579	3579
Moderate IA, >50 years to marsh	2607	2070	4691	4691
Low IA, 20-30 years to marsh	2397	0	1085	1085
Low IA, 30-50 years to marsh	1669	2013	469	469
Low IA, >50 years to marsh	469	1799	0	0
No IA, 20-30 years to marsh	525	1289	0	0
No IA, 30-50 years to marsh	2297	1073	0	0
No IA, >50 years to marsh	2509	2607	0	0
Benefits Total	21,369	21,206	21,243	21,243
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	36	28	28
High IA, >50 years to marsh	0	52	40	40
Moderate IA, 30-50 years to marsh	0	13	10	10
Moderate IA, >50 years to marsh	0	62	48	48
Transmission Channel				
FWetlands, Seasonally Flooded	31	39	70	39
FWetlands, Temporarily Flooded	2	69	71	69
FWetlands, Semipermanent Flooded	20	0	20	0
St. James Parish Canal Modificaitons				
FWetlands, Seasonally Flooded	0	0	0	22
FWetlands, Semipermanent Flooded	0	0	0	50
Impacts Total	53	271	287	306
Combined Total Acres	21,422	21,477	21,530	21,549

Table 13. Summary of Total AAHUs.

	Average Annual Habitat Units (AAHUs)			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	77	77	77	77
High IA, 30-50 years to marsh	1350	733	1545	1545
High IA, >50 years to marsh	1293	1014	1532	1532
Moderate IA, 20-30 years to marsh	93	828	919	919
Moderate IA, 30-50 years to marsh	243	1182	1423	1423
Moderate IA, >50 years to marsh	745	585	1325	1325
Low IA, 20-30 years to marsh	936	0	354	354
Low IA, 30-50 years to marsh	527	663	137	137
Low IA, >50 years to marsh	110	447	0	0
No IA, 20-30 years to marsh	72	163	0	0
No IA, 30-50 years to marsh	585	237	0	0
No IA, >50 years to marsh	431	373	0	0
Benefits Total	**6,462**	**6,302**	**7,313**	**7,313**
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	-17.07	-13.28	-13.28
High IA, >50 years to marsh	0	-30.19	-23.22	-23.22
Moderate IA, 30-50 years to marsh	0	-6.09	-4.69	-4.69
Moderate IA, >50 years to marsh	0	-35.69	-27.63	-27.63
Transmission Channel				
FWetlands, Seasonally Flooded	-25.87	-32.55	-58.43	-32.55
FWetlands, Temporarily Flooded	-1.67	-56.33	-57.96	-56.33
FWetlands, Semipermanent Flooded	-13.50	0	-13.5	0
St. James Parish Canal Modifications				
FWetlands, Seasonally Flooded	0	0	0	-18.36
FWetlands, Semipermanent Flooded	0	0	0	-33.76
Impacts Total	-41.04	-177.92	-198.71	-209.82
Combined Total AAHUs	6,421	[illegible]	7,114	[illegible]

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Comparison of Relative Sea-level Rise Scenarios

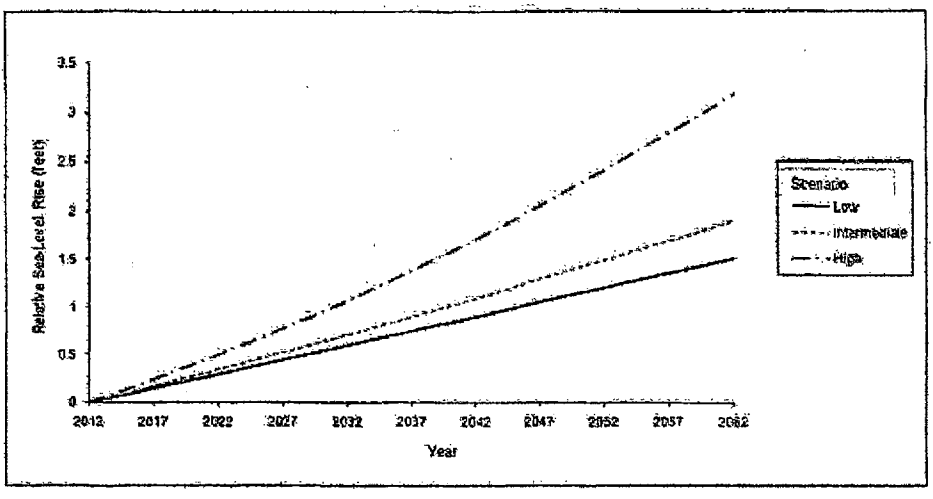
The direct impact of the diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp.

Based on hydrologic and hydrodynamic modeling, CDM has projected that for the low relative sea level rise scenario the project area will experience average annual water depths of 1.46, 1.67, and 2.11 feet in target years 20, 30, and 50, respectively. For the high sea level rise scenario the project area will experience average annual water depths of 1.79, 2.26, and 3.46 feet in target years 20, 30, and 50, respectively. Finally, for the intermediate sea level rise scenario the project area will experience average annual water depths of 1.54, 1.80, and 2.42 feet in target years 20, 30, and 50, respectively (Figure 1).

Table 1. Projected relative sea-level rise (feet) over the project life (2012-2062) in 5-year increments for low, intermediate, and high scenarios in the project area based on West End at Lake Pontchartrain tide gage daily stage data from 1959-2009 and USACE Circular No. 1165-2-211 (2009).

	Relative Sea Level Rise (feet)		
YEAR	LOW	INTERMEDIATE	HIGH
2012	0	0	0
2017	0.15	0.17	0.24
2022	0.30	0.35	0.51
2027	0.45	0.53	0.78
2032	0.60	0.72	1.08
2037	0.75	0.90	1.39
2042	0.91	1.10	1.72
2047	1.06	1.29	2.06
2052	1.21	1.49	2.42
2057	1.36	1.70	2.80
2062	1.51	1.90	3.19

Figure 1. Projected relative sea-level Rise (ft) over the project life (2011-2061) for low, intermediate and high scenarios.



Based on the available hydrologic hydrodynamic modeling the following assumptions were made (Table 2). The direct impact of the diversion of water from the Mississippi River at Romeville for the low sea level rise scenario would be a reduction in the average water depth relative to the existing condition in the Blind River and Maurepas Swamp for 20 years and 30 years. For the intermediate sea level rise scenario there would be a reduction in the average water depth relative to the existing condition for 20 years. For the high sea level rise scenario there would be no reduction in the average water depth relative to the existing condition. As sea level rises water depth can be expected to increase accordingly throughout the swamp.

Table 2: Alternative 2, Water Regime Relative to Sea Level Rise

	TY0		TY1		TY20		TY30		TY50	
RSLR*	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI
Intermediate										
FWOP	semiperm-low	0.45	perm-low	0.45	perm-low	0.30	perm-low	0.30	perm-low	0.30
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
Low										
FWOP	semiperm-low/ perm/low	0.45 /0.4	semiperm-low/ perm/low	0.45 /0.4	semiperm-low/ perm-low	0.45 /0.4	semiperm-low/ perm-low	0.45 /0.4	perm-low	0.4
high influence	semiperm-low	0.45	seasonal-high	1.00	seasonal-high	1.00	seasonal-high	1.00	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	seasonal-high	1.00	seasonal-high	1.00	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	seasonal-moderate	0.85	semiperm-mod	0.65	semiperm-moderate	0.65
no influence	semiperm-low	0.45	seasonal-low	0.70	seasonal-low	0.70	seasonal-low	0.70	semiperm-low	0.45
High										
FWOP	semiperm-low	0.45	semiperm-low	0.45	perm-mod	0.45	perm-mod	0.45	perm-mod	0.45
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	perm-high	0.65
moderate	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	perm-high	0.65
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	perm-moderate	0.45	perm-mod	0.45	perm/high	0.65
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-moderate	0.65	semiperm-moderate	0.65	perm-mod	0.45

* Accretion rates were not considered

Table 3: Comparison of Benefits under Low, Intermediate, and High Sea Level Rise Scenarios

Average Annual Habitat Units (AAHUs)			
Benefits	Intermediate SLR (Alternative 2)	Low SLR	High SLR
High IA, 20-30 years to marsh	77	81	71
High IA, 30-50 years to marsh	1350	1399	1189
High IA, >50 years to marsh	1293	1291	1004
Moderate IA, 20-30 years to marsh	93	98	86
Moderate IA, 30-50 years to marsh	243	251	213
Moderate IA, >50 years to marsh	745	744	580
Low IA, 20-30 years to marsh	935	1008	788
Low IA, 30-50 years to marsh	527	594	405
Low IA, >50 years to marsh	110	114	69
No IA, 20-30 years to marsh	72	81	74
No IA, 30-50 years to marsh	585	651	607
No IA, >50 years to marsh	431	470	415
Benefits Total	**6,462**	**6,782**	**5,500**
Impacts			
Transmission Channel			
FWetlands, Seasonally Flooded	-25.87	-26	-26
FWetlands, Temporarily Flooded	-1.67	-2	-2
FWetlands, Semipermanent Flooded	-13.5	-14	-13
Impacts Total	-41.04	-41	-41
Combined Total AAHUs	6,421	6,741	5,459

Table 4. Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) over 20, 30 and 50 years for the entire project site.				
Existing Conditions (with Berm Cuts)				
	Project Life (yr)	**Low SLR**	**Intermediate SLR**	**High SLR**
Average Annual Water Depth (ft)	20	0.96	1.01	1.21
	30	1.11	1.22	1.62
	50	1.48	1.76	2.69
Frequency of Dryout Conditions (%) (<0.5 ft)	20	14%	13%	6%
	30	8%	6%	2%
	50	3%	2%	1%
Backflow Prevention (%)	20	11%	9%	6%
	30	7%	6%	3%
	50	4%	3%	1%

Table 5. Metric Analysis Summary for Average Annual Water Depth, Frequency of Dryout, and Backflow Prevention for Sea Level Rise (SLR) over 20, 30 and 50 years for the entire project site.				
Alternative 2: Romeville Diversion = 3,000 cfs				
	Project Life (yr)	**Low SLR**	**Intermediate SLR**	**High SLR**
Average Annual Water Depth (ft)	20	1.46	1.54	1.79
	30	1.67	1.8	2.26
	50	2.11	2.42	3.46
Frequency of Dryout Conditions (%) (<0.5ft)	20	8%	6%	2%
	30	4%	2%	1%
	50	1%	1%	0%
Backflow Prevention (%)	20	38%	36%	33%
	30	34%	33%	29%
	50	31%	28%	21%
Average Annual TSS Loading (mm/yr)	20	2.1	2.2	2.4
	30	2.3	2.4	2.6
	50	2.6	2.7	2.8

834

Volume IV

APPENDIX C:

NOAA Fisheries Service Coordination Letter

(Response to NOAA Comments from the Letter dated July 1, 2010, are presented in Appendix G)

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701

February 20, 2009 F/SER46/RH:jk
225/389-0508

Dr. William P. Klein
Environmental Compliance and Analysis Branch
New Orleans District
Department of the Army, Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Dr. Klein:

NOAA's National Marine Fisheries Service (NMFS) has received the public notice advertising a scoping meeting to be held for the Louisiana Coastal Area (LCA), Louisiana; Small Diversion at Convent/Blind River project. According to the public notice, the U.S. Army Corps of Engineers intends to undertake a feasibility study and prepare a supplemental environmental impact statement (SEIS) to evaluate the impacts and benefits of constructing a small diversion from the Mississippi River into the Blind River through a control structure to be installed near Convent, in St. James Parish, Louisiana.

The objective of the river diversion is to introduce fresh water, fine sediments, and nutrients into the southeast portion of the Maurepas swamp. Such nutrients and sediment would help offset wetland degradation processes currently affecting the bottomland hardwood and cypress swamp habitats in the project area. The Corps of Engineers has requested the public and natural resource agencies provide recommendations on: 1) the environmental problems and needs that should be addressed in the document; 2) the important resources in the project area; and, 3) reasonable restoration alternatives to be considered in the feasibility study and SEIS.

Aquatic and wetland habitats in the study area provide foraging and nursery habitat for a few economically important estuarine-dependent fishery species that use fresh water habitats in the project vicinity. Those species include blue crab, striped mullet and gulf menhaden. NMFS recommends the SEIS include a section titled "Fishery Resources" that identify the fisheries resources of the study area, including these species, and describe the potential impacts and benefits to those resources that could be caused by the proposed river diversion. Potential adverse impacts include displacement of fishery species from some areas due to extreme turbidity or cold water temperatures. Descriptions also should include the potential for algal blooms in and eutrophication of waterways in the project area depending on the amount and rate of nutrient assimilation by wetlands after repeated or long term nutrient loading. Potential project benefits could result from increasing the health of bottomland hardwood and swamp habitats supportive of marine fishery resources.

02/20/2009 13:26 FAX 8122538059 NOAA NMFS BR HCD 002/005

We appreciate the opportunity to identify resources that should be evaluated in the SEIS. If you have any questions regarding comments and recommendations provided herein, please contact Mr. Richard Hartman of our Louisiana Habitat Conservation Division office at (225) 389-0508, ext 203.

Sincerely,

for Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

c:
FWS, Lafayette
EPA, Dallas
LA DNR, Consistency
F/SER46, Swafford
Files

02/20/2008 13:25 FAX 9122538905O8 NOAA NMFS SR HCD 003/005

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701

July 1, 2010 F/SER46/KC:jk
225/389-0508

Ms. Joan M. Exnicios, Chief
Environmental Planning and Compliance Branch
Planning, Programs, and Management Division
New Orleans District, U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Ms. Exnicios:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the Draft Integrated Feasibility Study and Supplemental Environmental Impact Statement for the Louisiana Coastal Area Small Diversion at Convent/Blind River, in St. James Parish, Louisiana. The document was transmitted for our review by your letter dated May 21, 2010. Your letter indicates that submittal of the document to NMFS initiates essential fish habitat consultation as required by provisions of the Magnuson-Stevens Fishery Conservation and Management Act. It should be noted that NMFS has agreed to serve as a cooperating agency on this project under provisions of the National Environmental Policy Act.

The overall study area is located in the vicinity of Romeville, Louisiana. The tentatively selected plan (Alternative 2) calls for construction of a water diversion system, near Romeville, with the capacity to divert 3,000 cubic feet per second of Mississippi River water into Maurepas Swamp to facilitate maintenance and rebuilding of the swamp's ecosystem. Specific components of the project include a gated culvert system and transfer canal, restoration and improvement of 160 existing berm cuts, addition of 30 new 500-foot-wide berm cuts, construction of up to six water control structures at strategic locations in the swamp, and addition of three new culverts under U.S. Highway 61. The tentatively selected plan is estimated to improve and protect 21,369 acres of bald cypress-tupelo swamp projected to be lost over the 50-year period of analysis, including: 1) 3,300 acres of bald cypress-tupelo swamp that would convert to marsh in 20 to 30 years; 2) 7,900 acres of bald cypress-tupelo swamp that would convert to marsh in 30 to 50 years; and 3) 10,140 acres of bald cypress-tupelo swamp that would convert to marsh in more than 50 years. The project would negatively impact 53 acres of forested wetland and is estimated to have a net value of 6,421 Average Annual Habitat Units over the 50-year period of analysis.

The enclosed comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) and 600.920 of the Magnuson-Stevens Fishery Conservation and Management Act.

Related correspondence should be directed to the attention of Mr. Richard Hartman at the NMFS Southeast Region, Habitat Conservation Division office at: c/o LSU, Baton Rouge, Louisiana 70803-7535. He may be contacted by telephone at (225) 389-0508, ext. 203 or by e-mail at richard.hartman@noaa.gov. The NMFS Protected Resources Division is responsible for issues pertaining to threatened and endangered species and marine mammals. The contact person for that Division is Mr. David Bernhart. He may be contacted at the letterhead address, by telephone at (727) 824-5312, or by e-mail at david.bernhart@noaa.gov.

Sincerely,

Miles M. Croom

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

Enclosure

cc:
FWS, Lafayette, Walther
EPA, Dallas, Ettinger
LA DNR, Consistency, Ducote
F/SER46, Swafford
F/SER4, Dale
NOAA PPI, Reid
Files

NOAA's National Marine Fisheries Service (NMFS) Comments on the Draft Supplemental Environmental Impact Statement (SEIS) for the Louisiana Coastal Area (LCA)
Small Diversion at Convent/Blind River, St. James Parish, Louisiana
Authorized under the 2007 Water Resources Development Act

Essential Fish Habitat (EFH) Consultation

Based on our review of the SEIS, NMFS has determined the document and related coordination with the NMFS fulfills consultation requirements contained in section 600.920 of the essential fish habitat (EFH) rules and regulations of the Magnuson-Stevens Fishery Conservation and Management Act.

According to the SEIS, Lake Maurepas, which adjoins the project area, is designated EFH for red drum (*Sciaenops ocellatus*) and white shrimp (*Litopeneaus setiferus*). Although Lake Maurepas is technically located outside of the study area, the SEIS notes that some shift and possible decrease in "optimal habitat" for red drum and white shrimp is possible with the tentatively selected plan. The SEIS indicates the level of change and adverse impact, if any, to EFH would be minor; while considerable benefit to EFH is possible since ongoing conversion of wetlands to open water would be reduced. Best management practices, environmental monitoring, and adaptive management would be implemented with the preferred plan.

Based on the preceding, NMFS has no EFH conservation recommendations to offer at this time. Provided that the project is completed and operated as proposed, no further consultation is required.

General comments

The SEIS for the proposed action is generally well written and sufficiently describes the affected environment and environmental impacts. The information presented supports the determination that the selected plan is environmentally acceptable and would promote the long-term recovery and health of one of Louisiana's largest tracts of freshwater swamp and a major ecological component of the Lake Pontchartrain Basin.

Specific comments

SECTION 1.0 STUDY INFORMATION
1.5 Prior Reports and Existing Projects
1.5.3 Existing Water Projects
1.5.3.3 Coastal Restoration Projects

Page 1-15, lines 37-42 According to this section, the LCA Small Diversion at Hope Canal consists of diverting approximately 1,500 cubic feet per second from the

Mississippi River into the Hope Canal at Garyville, Louisiana. Information is needed concerning the duration and seasonal timing of the diversion period.

SECTION 3.0 ALTERNATIVES
3.3 Preliminary Alternatives Plans
3.3.1 Development of Preliminary Alternative Plans
CB-6 Obtain Total Maximum Daily Load (TMDL) waiver for diversion into Blind River

Page 3-27, lines 26-30 According to this section, the overall project has an extensive monitoring plan and includes costs for adaptive management "to assure that the overall water quality in the Blind River is not degraded." Also, as noted in section 3.7.7 (page 3-104, line 28) water quality impairment is a potential risk endpoint of the project. NMFS recommends that both the final SEIS and the Monitoring and Adaptive Management Plan (MAMP) (Appendix I) clearly state that water quality in Blind River and Lake Maurepas will be monitored and that management measures will be implemented when needed to remedy project-related water quality degradation.

Also according to this section: "The State agencies will work together to monitor the diversion operation to assist with the overall environmental improvement of the Blind River." This section should be modified to note that federal resource agencies, including the NMFS and U.S. Fish and Wildlife Service (FWS), would be consulted with regard to environmental monitoring and adaptive management measures needed to protect and restore fish and wildlife resources and habitat, including EFH in Lake Maurepas.

3.7 Plan Selection – Tentatively Selected Plan
3.73 Components

Page 3-95, lines 12-17 NMFS recommends the description for the control structures in the selected plan include a map of the project area illustrating the expected locations of the various features including the control structures. NMFS recommends the map be accompanied by a diagram depicted the design plans and specifications of the control structures, as well as a detailed operational scheme.

3.7.6 Operations and Maintenance Considerations

Page 3-99, lines 35-38 NMFS understands the need to provide access to the maintenance canal; however, the final SEIS should address the possibility that mowing be limited to one side of the canal and shrubs and trees be allowed to grow on the un-mowed bank. Establishment of trees along one side of the canal would reduce maintenance and disturbance, lessen water temperature increases in summer, and provide cover for wildlife.

Page 3-100, lines 24-25 The diversion flow period (six to nine months per year) should be identified and discussed, as appropriate, throughout the final SEIS. Currently, the diversion flow period is not mentioned elsewhere in the document.

Page 3-101, lines 6-10 NMFS recommends this section be modified to note that planned maintenance excavation within the transmission canal will be coordinated with state and Federal resource agencies. Coordination should address beneficial use of excavated material, excavation and disposal methodologies, timing, and other considerations as needed to protect fish and wildlife.

3.7.7 Monitoring Plan and Adaptive Management

Pages 3-101 through 3-104 The MAMP is an essential component of the project. Environmental monitoring is needed to assess project related impacts and establish operational changes needed to protect and restore EFH and other habitat and resources. By letter dated April 7, 2010, the FWS, in consultation with NMFS, provided detailed comments concerning needed changes in the project's MAMP. NMFS recommends the MAMP be modified in accordance with FWS and NMFS recommendations. Also, as noted below (see "APPENDIX I"), the MAMP should be modified to include performance measures that call for water quality monitoring and adaptive management to remedy water quality problems in Blind River if they should occur.

The MAMP also should include water quality monitoring and adaptive management as needed to remedy potential water quality problems in Lake Maurepas if such problems occur. Depending on the amount and rate of nutrient assimilation by wetlands after repeated or long term nutrient loading, NMFS is concerned the proposed diversion of river water could create algal blooms in and eutrophication of waterways in the project area. The MAMP should identify sampling locations, frequency, and duration for measuring dissolved oxygen levels in Lake Maurepas, which is designated as EFH for red drum and white shrimp, with particular emphasis on collecting data during the summer months. Potential adverse impacts to EFH in Lake Maurepas also include displacement of these designated fishery species from the area due to extreme turbidity and salinity changes, as well as colder water temperatures. These water quality parameters should be included in the MAMP for the lake.

Page 3-101, line 27 The feasibility level MAMP is provided in Appendix I, not Appendix J, as stated.

3.8 Risk and Uncertainty
3.8.2 Environmental Uncertainties

Page 3-113, lines 9-21 This section should be expanded to note that uncertainty exists regarding salinity change and nutrient input into Blind River and other downstream waters and that this uncertainty will be addressed through project monitoring and adaptive management.

Page 3-114, lines 19-24 NMFS supports plans to conduct salinity monitoring. As noted in comments below (APPENDIX I), the final SEIS should acknowledge that salinity

monitoring will be conducted in the lower reaches of Blind River and, if warranted, the southeastern portion of Lake Maurepas.

This section also should be expanded to note that uncertainty exists regarding the need for increases in frequency and duration of operational closures of the project area water control structures and that this uncertainty will be addressed through project monitoring and adaptive management.

SECTION 4.0 AFFECTED ENVIRONMENT
4.2 Significant Resources
4.2.10 Essential Fish Habitat (EFH)

Page 4-82, lines 12-13 According to this section, the February 20, 2009, letter from NMFS states that no EFH exists in the project area. However, NMFS did state that Lake Maurepas is designated as EFH for red drum and white shrimp. NMFS recommended water quality impacts be modeled to evaluate the potential for the proposed freshwater diversion to influence changes in salinity, water temperature, and dissolved oxygen levels in the lake. Those potential impacts should be addressed in the document and included in the monitoring and adaptive management plan.

SECTION 5.0 ENVIRONMENTAL CONSEQUENCES
5.3 Water Quality and Salinity
5.3.4 Salinity

Page 5-71, lines 21-27 This section provides summary statistics regarding the expected project impacts on salinity in Lake Maurepas. For example, the SEIS indicates a 2,500 cfs diversion would reduce salinities in Lake Maurepas by 30% and a larger diversion would likely reduce salinities more than that. Section 4.2.3.3 of the SEIS provides data on historical salinity levels at various locations relevant to the project. Given the discussion in other sections of the document pertaining to marine fishery species and EFH, this section should be revised to indicate what the expected future salinities will be at various locations with project implementation. NMFS suggests a table be provided in the final SEIS identifying mean and maximum historic salinities at various locations in the project area and what the modeled salinities would be at those locations with project implementation.

5.10 Essential Fish Habitat (EFH)

Page 5-110, lines 11-30 The first sentence in this section (lines 12-14) is confusing and should be rewritten to clarify where and to what extent salinity might decrease and how this might affect "optimal habitat" for red drum and white shrimp. NMFS recommends the final SEIS indicate that any reduction in salinity in Lake Maurepas would represent movement in the direction of historical conditions that existed prior to anthropogenic alteration (disruption) of water flow into the Maurepas Swamp.

Salinity monitoring as called for in section 3.8.2.1 (page 3-114; line 19) is vital to a determination of the level of habitat alteration in Lake Maurepas. As such, NMFS recommends this section be modified to note that while the consequences of salinity modification are expected to be negligible, salinity and water quality monitoring are planned, as well as the implementation of adaptive management, as needed, to preclude significant adverse impacts to EFH.

APPENDIX I

Page 10; Objective 4: Improve fish and wildlife habitat in the swamp and in Blind River

According to the Alternatives Analysis (page 3-27; lines 26-30) "The overall project has an extensive monitoring plan and includes costs for adaptive management to assure that the overall water quality in the Blind River is not degraded." Despite this statement, the MAMP performance measures contain no parameters associated with water quality monitoring for nutrient input or modification of dissolved oxygen and salinity. NMFS recommends this be addressed in the SEIS and that the MAMP be modified to specifically state that water quality monitoring for nutrients, salinity, and dissolved oxygen will be undertaken and adaptive management will be implemented, if needed, to remedy water quality problems in the Blind River. As noted in preceding comments concerning page 3-27; lines 26-30, NMFS further recommends the SEIS and MAMP be modified to state that federal resource agencies, including NMFS and FWS, will be consulted with regard to environmental monitoring and adaptive measures needed to protect and restore fish and wildlife resources and habitat in the study area, including EFH in Lake Maurepas.

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Volume IV

APPENDIX D:

404 (b)(1) Water Quality Report

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Louisiana Coastal Area
Small Diversion at Convent/Blind River
Section 404(b)(1) Water Quality Evaluation

1.0 Project Description

1.1 Location and General Description

The study area for this project includes as portions of the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. Louisiana parishes in the study area include St. John the Baptist, St. James, and Ascension. The Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River. The project area consists of the Maurepas Swamp and Blind River southwest of I-10 and is almost entirely located within the Maurepas Wildlife Management Area.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of cypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

1.2 Authority and Purpose

Title VII of the Water Resources Development Act (WRDA) of 2007 authorizes the Louisiana Coastal Area Near-term Restoration Plan. The authority includes requirements for comprehensive coastal restoration planning, program governance, project modification investigations, a Science and Technology (S&T) program, restoration project construction, a program for beneficial use of previously dredged material, feasibility studies for restoration plan components, and other program elements.

In total the LCA Near-term Restoration Plan has authority for 25 elements falling into various components including investigations, research, demonstrations, and construction. This report outlines the study elements requiring Congressional reporting that will be undertaken in partnership between the USACE and the State of Louisiana.

Specifically, Section 7006(e)(3) requires the Secretary of the Army to submit feasibility reports to Congress on six projects by December 31, 2008 and a Chief's Report by 31 December 2010. The six elements are:

1) LCA Multipurpose Operation of Houma Navigation Lock

2) LCA Terrebonne Basin Barrier Shoreline Restoration

3) LCA Small Diversion at Convent/Blind River

4) LCA Amite River Diversion Canal Modification

5) LCA Medium Diversion at White Ditch

6) LCA Convey Atchafalaya River Water to Northern Terrebonne Marshes

The Convent/Blind River Diversion Project is proposed to be a small freshwater diversion from the Mississippi River to the southeastern Maurepas Swamp, with a flow rate of 1,000 to 5,000 cfs. The purpose of the project is to reintroduce freshwater, sediment, and nutrients to the Swamp, approximating the natural historic flooding cycle to rebuild wetlands at a rate greater than the subsidence rate. This is to improve biological productivity and reverse the current trend of degradation and restore the Swamp.

An excerpt from WRDA 07 outlining the project authority is listed below:

SEC. 7003. LOUISIANA COASTAL AREA.

(a) IN GENERAL.—The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005.

(b) PRIORITIES.—
(1) IN GENERAL.—In carrying out the program under subsection a), the Secretary shall give priority to—
(A) any portion of the program identified in the report described in subsection (a) as a critical restoration feature;
(B) any Mississippi River diversion project that—
(i) will protect a major population area of the Pontchartrain, Pearl, Breton Sound, Barataria, or Terrebonne basins; and
(ii) will produce an environmental benefit to the coastal Louisiana ecosystem;
(C) any barrier island, or barrier shoreline, project that—
(i) will be carried out in conjunction with a Mississippi River diversion project; and
(ii) will protect a major population area;
(D) any project that will reduce storm surge and prevent or reduce the risk of loss of human life and the risk to public safety; and
(E) a project to physically modify the Mississippi River-Gulf Outlet and to restore the areas affected by the Mississippi River-Gulf Outlet in accordance with the comprehensive plan to be developed under section 7002(a) and consistent with sections 7006(c)(1)(A) and 7013.

Sec 7006. Construction
(c) Initial Projects
(3) PROJECTS SUBJECT TO REPORTS.—
(A) FEASIBILITY REPORTS.—Not later than December 31, 2008, the Secretary shall submit to Congress feasibility reports on the following projects referred to in the restoration plan:

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

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

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

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

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

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

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

1.3 General Description of Excavated or Dredged and Fill Material

General Characteristics of Material. Some of the project components may involve the excavation of previously dredged (spoil) or fill material during construction. Construction of the diversion structure, the transmission canal, the berm gaps, and gated control structures or culverts may require material excavation, predominantly in upland areas. There will be excavation of previously dredged material (that was used to create berms along the transmission canal) to create berm gaps. The excavated material will be placed behind the remaining berms and spread out to build up these upland areas adjacent to the swamp for natural regeneration of upland flora. Excavated material to restore existing gaps will be placed in small mounds in the swamp adjacent to the restored existing gaps to provide for areas for baldcypress and tupelo germination and sapling survival and/or to improve the success of cypress and tupelo tree plantings. Generally, soil characterization in the project area (NRCS, 2009) will consist of silty clay loam with very little sand. Chemical and biological characteristics of the fill material are expected to be of similar composition and quality as those at the previous disposal sites (refer to Section 3.0 Evaluation of Fill Material). The Phase I Environmental Site Assessment completed for this project did not produce any findings to indicate that previously dredged or excavated material will contain hazardous, toxic, or radiological wastes (HTRW).

Quantity of Material. Because the TSP will not require dredging or fill in the swamp, it is currently estimated that no spoil materials will be generated as a result (0.00 cubic yards). It is not anticipated that annual O&M activities will generate material.

Source of Material. Excavated or previously dredged material for canal spoil banks and berm expansion will be generated during construction of the diversion, the transmission canal, the berm gaps, and several types of control structures as well as from O&M activities to maintain integrity of the transmission canal, berms, and structures. This material will be excavated from areas not located in any waterway, wetland or waterbody, but from upland areas.

1.4 Description of Proposed Discharge Sites

Location and Size. Designated disposal sites for previously dredged or excavated materials that are generated during construction of the Blind River diversion system include areas adjacent to the diversion structure, berms adjacent to the transmission canal, and in swamp areas adjacent to control structures and berm gaps.

Type of Site. The types of disposal sites include canal spoil banks and berms..

Type of Habitat. The area adjacent to the diversion location is considered disturbed riparian habitat, in association with the Mississippi River levee. The areas adjacent to the transmission canal are considered prime agricultural land and have been farmed for sugarcane.

Approaching and going into the project benefit area, two types of habitat exist:

Swamp Habitat consists of mature stands of bald cypress tupelo swamps, understory, and ground cover associated with indigenous flora and fauna, much of which is all in one state of degradation or another. Since the construction of the Mississippi River flood control levees, the Maurepas Swamp has been virtually cut off from periodic overflows from the River, which included freshwater, sediment, and nutrient input. Thus, the only soil building has come from organic production within the wetlands, and vegetative productivity may be substantially depressed compared to normal conditions. Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. With minimal soil building and moderately high subsidence rates, there has been a net lowering of ground surface elevation, so that now the swamps are persistently inundated.

Bottomland Hardwood Habitat consists of a forest association found on higher ground and is inundated less frequently than the surrounding swamp. Bottomland hardwoods cannot tolerate much inundation during the growing season. Transitional bottomland hardwoods are only slightly elevated above the marsh and can tolerate wet soil conditions, making the entire bottomland hardwood habitat diverse in terms of herbaceous cover. Bottomland hardwoods provide habitat for many species of wildlife including white-tailed deer, grey squirrels, raccoons, and birds. These areas typically were the first to be cleared when logging in the area occurred. Today, less than 3% of the project area consists of bottomland hardwood habitat.

Timing and Duration of Discharge. The entire project construction schedule is expected to last about 24-36 months. The excavation/dredging activities would occur simultaneously with placement of previously dredged material to disposal areas.

Description of Disposal Method. Previously dredged material will be excavated using various types of equipment for construction of the diversion, the transmission canal, the berm gaps, and for placement of control structures. Front end loaders, backhoes, and trackhoes, as well as barge supported excavators may be used.

2.0 Factual Determinations

2.1 Physical Substrate Determinations

Comparison of Existing Substrate and Fill.
Previously dredged or excavated material will be consistent with existing substrate at the disposal sites (silty clay loam). The sediment will contain varying degrees of organic material not unlike the substrate. Placement of excavated material will increase existing substrate elevation resulting in altered water flow through areas of the swamp. This satisfies one of the objectives for this project—to improve hydrologic connectivity.

Changes to Disposal Area Elevation. Excavated or previously dredged materials used for canal banks and berm expansion will be placed to an initial elevation of 3 to 5 feet above existing grade. The material is expected to settle initially in about 12 months to an elevation of 2 to 4 feet above existing grade after dewatering and compaction.

Migration of Fill. For previously dredged material placed adjacent to canals, some small percentage of migration of finer materials is expected initially until the spoils have stabilized. Similarly, berm expansion with excavated or previously dredged material will result in some percentage of migration into lower-lying areas adjacent to the disposal sites. However, this material is expected to consolidate and stabilize.

Duration and Extent of Substrate Change. Excavated or previously dredged material used for berm enhancement along the channels will be discharged to an initial elevation of 3 to 5 feet. Substrates at the excavation site and disposal areas are of similar physical quality and natural plant colonization would increase organic content of the newly deposited sediments. Tree plantings along berm enhancement areas also will serve to stabilize disposal sites.

Changes to Environmental Quality and Value. The placement of excavated or previously dredged material for spoil banks and berm enhancement will be the foundation for improved habitat. Hydrology will be improved and areas will be created for tree plantings (cypress and tupelo). It is the objective of this project to overall improve the quality and the value of the swamp area.

Actions to Minimize Impacts. The entire project design includes minimizing impacts to the swamp that we are trying to restore. Only temporary disruptions are anticipated during construction activities.

2.1.1 Water Circulation, Fluctuation, and Salinity Determination

Normal water fluctuations in the area consist of daily, seasonal, and annual tidal and flood fluctuations in water level and salinity gradients. Water circulation, stratification, and chemistry as they relate to the discharge/placement of excavated or previously dredged material are currently being evaluated; this section will be updated as chemical analyses and modeling results are finalized with the TSP.

Alteration of Current Patterns and Water Circulation. The distribution of flow into the swamp, its canals, and ultimately into the Blind River will be altered as a result of this project; however, the impacts are designed to be positive rather than adverse—bringing freshwater and nutrients to degraded, stagnant areas in the swamp interior. One of the primary project objectives is to improve the existing hydrology to help reverse degradation. Ongoing hydraulic and sediment modeling will result in additional information to be added to this section.

Interference with Water Level Fluctuation. The project area is primarily influenced by rainfall and tidal fluctuations. Excavation to create berm gaps, and placement of water control structures to improve water flow through the swamp are key components of this project. Water level fluctuation will be altered to improve the hydroperiod within the swamp; however, this project will not impact the range of water level fluctuation in Blind River.

Salinity Gradient Alteration. Salinity gradients in the swamp remain fairly stable with the exception of hurricane events and storm surge; these events may push saltwater into the swamp.. This project should help in reducing storm surge effects and increased salinity levels. However, ongoing hydraulic modeling will result in additional information to be added to this section.

Cumulative Effects on Water Quality:

Salinity. No cumulative effects are expected, however, ongoing hydraulic models will result in additional information to be added to this section.

Clarity. Dredging activities and placement of previously dredged or excavated material in the disposal areas will temporarily reduce water clarity (increase turbidity). The significance of the increase in turbidity will vary with the water stages. During high flows, it would be difficult to detect the increase in turbidity due to already high turbidity in the channels. At low flow, the impacts related to turbidity may become more significant.

Color. Dredging activities and placement of previously dredged or excavated material in the disposal areas will temporarily induce color change from increased particulate matter in the water column (increased turbidity).

Water Chemistry and Dissolved Gases. Excavated and previously dredged material will contain low but variable concentrations of organic matter. Decomposition of organic material within the disposal areas following placement of previously dredged or excavated material may result in a temporary reduction of dissolved oxygen or release of ammonia. However, ongoing hydraulic models will result in additional information to be added to this section.

Temperature. No effect.

Nutrients. Excavated and previously dredged material will contain low but variable concentrations of organic matter. Decomposition of organic material within the disposal areas

following placement of previously dredged or excavated material may result in a temporary reduction of dissolved oxygen or release of ammonia. However, ongoing hydraulic models will result in additional information to be added to this section.

Changes to Environmental Quality and Value. The placement of excavated or previously dredged material for spoil banks and berm enhancement will be the foundation for improved upland habitat. Hydrology will be improved and small mounds will be created to provide for areas for bald cypress and tupelo germination and sapling survival and/or to improve the success of cypress and tupelo tree plantings. It is the objective of this project to overall improve the quality and the value of the swamp area, by improving water quality and flow through the swamp.

Actions Taken to Minimize Impacts. Water column turbidity alterations will be temporary in nature taking place during excavation/dredging activity, and are expected to return to normal once these activities are completed. Minimal impacts would occur if construction and excavation/dredging were timed with low water stages.

2.1.2 Suspended Material/Turbidity Determination

Typical of swamp channels and canals, including Blind River, suspended particulate matter such as very fine silt and organic matter are common in the aquatic ecosystem. Excavation and potential dredging activity and previously dredged material placement will temporarily increase levels of suspended matter. However, the existence of fairly turbid runoff and high naturally occurring levels of suspended matter, make it unlikely that temporary increases in turbidity would adversely impact habitat arrangements.

Alteration of Suspended Particulate Type and Concentration. Particulates suspended at the dredging locations and within the disposal areas during project construction, or by natural forces after project construction, are not expected to differ in type from particulates currently within the project area.

Particulate Plumes Associated with Discharge. Temporary and local particulate plumes may occur during construction activities but will quickly dissipate after construction is complete.

Changes to Environmental Quality and Value. Particulate plumes resulting from any construction activity are not expected to persist after project completion. Particulates suspended within disposal areas during project construction, or by natural forces after construction, are not expected to differ in type from particulates currently within the project area.

Actions to Minimize Impacts. Water column turbidity alterations will be temporary in nature, taking place during excavation/dredging activity, and are expected to return to normal once these activities are completed. Minimal impacts would occur if construction and excavation were timed with low water stages.

2.1.3 Contaminant Determinations

A Phase I Environmental Site Assessment was completed for the project study area and indicated no findings of any HTRW impacts. It is not expected, based on these findings, that any contaminants will go into suspension during the construction of this project.

2.2 Aquatic Ecosystem and Organisms Determinations

Effects on Plankton. Plankton do not exist in the project area as it is a fresh to brackish water environment.

Effects on Benthos. Benthic organisms will be smothered by the discharge of excavated material at disposal areas; however, benthic organisms from adjacent habitat would recolonize substrate material in the disposal areas, but would be precluded from enhancement areas.

Effects on Nekton. Nekton would be temporarily displaced during construction activities and are expected to migrate to adjacent habitats.

Effects on the Aquatic Food Web. All aquatic organisms, in all of their life stages, could potentially be impacted temporarily during construction activities and placement of excavated material that would cause increased turbidity and change in water circulation patterns. Excavation during periods of reproduction/spawning will be minimized or avoided. Impact to or reduction of detrital feeding species or lower trophic level species (immobile or sedentary bottom feeders) will be minimized as much as possible to preserve the food chain populations and nutrient export capability of the ecosystem. While no adverse cumulative effects on the aquatic organisms are expected to result from this project, it is expected that some effects will improve and/or benefit aquatic life within the ecosystem.

Effects on Threatened and Endangered Species. Species that have been found within the study area that are either considered threatened or endangered include the Gulf Sturgeon and Pallid Sturgeon, and the West Indian manatee. Avoidance of other species during any project work will also be required.

Effects on Other Wildlife. Other wildlife associated with the project study area includes resident or transient mammals, birds, reptiles, and amphibians. All species could potentially be impacted temporarily as a result of construction and excavation activities. However, adverse cumulative effects on these organisms are not expected and some effects will improve or benefit the wildlife within this ecosystem.

Actions to Minimize Impacts. Timing of construction, excavation activities to avoid spawning, nesting, or migration seasons and other biologically critical times will be considered.

2.3 Special Aquatic Sites

2.3.1 Effect on Sanctuaries and Refuges

The project study area is almost wholly within the Maurepas Wildlife Management Area (WMA). The purpose, along with objectives and goals of this project, is to improve the existing degrading swamp conditions within the WMA and in surrounding swamp areas.

2.3.2 Effect on Wetlands

Wetlands, as defined within the Corps of Engineers Wetlands Delineation Manual (1987), include swamps, marshes, bogs, and similar areas. The beneficial use of excavated or previously dredged material resulting from this project is intended to enhance, restore, or create wetlands in areas that have been gradually degrading due to naturally occurring or manmade circumstances such as impoundment, logging, subsidence, sea level rise, and pipeline canals.

2.3.3 Effect on Mud Flats

Currently there are no project components proposed in areas where mudflats occur.

2.3.4 Effect on Vegetated Shallows

Some vegetated shallows will be impacted temporarily by construction and excavation/dredging activities. However, cumulative impact to these areas is not expected.

2.3.5 Effect on Coral Reefs

Not applicable to this project.

2.4 Human Use Characteristics

2.4.1 Effect on Municipal and Private Water Supplies

No municipal or private water supplies exist within the project area.

2.4.2 Effect on Recreational and Commercial Fisheries

Harvestable fish, crustaceans, shellfish, and other aquatic species used by man will not be impacted in any way as to jeopardize availability or consumability and will actually be improved by this project. However, during construction and excavation activities and disposal placement, certain areas in the vicinity of the project may be temporarily off limits or otherwise restricted to both commercial and recreational activities until at which time the work is completed.

2.4.3 Effect on Water-related Recreation

Water-related activities, including both consumptive (hunting and fishing) and non-consumptive (canoeing, sightseeing) activities, will not be impacted in any way as to jeopardize availability or consumability and will actually be improved by this project. However, during construction and excavation/dredging activities and disposal placement, certain areas in the vicinity of the project may be temporarily off limits or otherwise restricted to both commercial and recreational activities until at which time the work is completed.

2.4.4 Aesthetic Effects

Aesthetics of the swamp and aquatic ecosystems apply to the perception of beauty and quality of life enjoyed by the general public and property owners. It is expected that all project

components will be in keeping with general characteristics of the area that will likely enhance areas of the aquatic ecosystem.

2.4.5 Effect on Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

The project study area is almost wholly within the Maurepas Wildlife Management Area (WMA). The purpose, along with objectives and goals of this project, is to improve degrading swamp conditions within the WMA and in surrounding swamp areas. Project components at this time are not intended to affect other type areas; however if project components or plans are adjusted, they would be intended to enhance environmental conditions at these types of sites within or adjacent to the project area.

3.0 Findings of Compliance or Non Compliance with the Restrictions on Discharge

1) No significant adaptations of the guidelines were made relative to this evaluation.

2) No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.

3) The discharges of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violation of any applicable State water quality standards for waters. The discharge operations will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

4) The placement of fill materials in the project area(s) will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973.

5) The placement of fill materials will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.

4.0 Evaluation Responsibility

Evaluation Prepared By:

Jammie Favorite, Office of Coastal Protection and Restoration Authority, Plan Development Section, P.O. Box 44027, Capital Station, Baton Rouge, LA 70804-4027

Jamie M. Bartel, P.G. Project Manager, CDM Federal Programs, 6120 Perkins Road, Suite 200 Baton Rouge, LA 70808

Evaluation Reviewed By:

William P. Klein, Jr., Ed.D. U.S. Army Corps of Engineers, New Orleans District, P.O. Box 60267, New Orleans, LA 70118

The proposed plan for the project which incorporates sites for dredging and excavation and the placement of fill, complies with the requirements of guidelines and includes appropriate and practicable methods to minimize adverse effects to the aquatic ecosystem.

Date: Sept 27, 2010

Joan M Exnicios

Joan M. Exnicios, Chief
Environmental Planning and Compliance Branch

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PUBLIC NOTICE

LOUISIANA COASTAL AREA - ECOSYSTEM RESTORATION PROJECT
Small Diversion at Convent/Blind River
St. James Parish, Louisiana

Introduction. This Public Notice is issued in accordance with provisions of Title 33 CFR Parts 336.1(b)(1) and 337.1, which establish policy, practices, and procedures to be followed on federal actions involving the disposal of dredged or fill material into waters of the United States.

Project Authority. The authority for the proposed action is Title VII of the Water Resources Development Act (WRDA) 2007 authorizes the Louisiana Coastal Area (LCA) ecosystem restoration program.

Location. The proposed action is located in St. James Parish, Louisiana. The project area consists of the Maurepas Swamp and Blind River southwest of I-10 and is almost entirely located within the Maurepas Wildlife Management Area.

Project Description. The USACE proposes to construct a freshwater diversion project from the Mississippi River in the vicinity of Romeville, Louisiana to provide freshwater, nutrients, and sediments to the southeast portion of the Maurepas Swamp. Some of the project components may involve the excavation of previously dredged (spoil) or fill material during construction. Construction of the diversion structure, the transmission canal, the berm gaps, and gated control structures or culverts may require material excavation, predominantly in upland areas. There will be excavation of previously dredged material (that was used to create berms along the transmission canal) to create berm gaps. The excavated material will be placed behind the remaining berms and spread out to build up these upland areas adjacent to the swamp for natural regeneration of upland flora. Excavated material to restore existing gaps will be placed in small mounds in the swamp adjacent to the restored existing gaps. *The proposed action itself consists of measures to minimize the adverse effects of storm water erosion and thus requires no separate measures or controls for compliance with CWA Section 402(p) and LAC 33:IX.2341.B.14.j.*

Discharges by Others.

Other Information. A Draft Environmental Impact Statement (DEIS), entitled Integrated Louisiana Coastal Area - Ecosystem Restoration Project Feasibility Study and Supplemental Environmental Impact Statement for Small Diversion at Convent/Blind River St. James Parish, Louisiana, was mailed to the public for a 45-day review on May 21, 2010. The DEIS addressed the impacts associated with the construction of a proposed dredge openings in the existing Amite River Diversion Canal (ARDC) spoil banks, construct bifurcated conveyance channels.

Properties Adjacent to Disposal Sites. The proposed action is adjacent to Amite River Diversion Canal.

Status of EIS and Other Environmental Documents. Environmental compliance for the proposed action would be achieved upon: coordination of the EIS and supporting documents with appropriate agencies, 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; public review of the Section 404(b)(1) Public Notice; signature of the Section 404(b)(1) Evaluation; 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 EA; and receipt and acceptance or resolution of all NMFS Essential Fish Habitat recommendations. The draft ROD would not be signed until the proposed action achieves environmental compliance with applicable laws and regulations, as described above.

Coordination. The following is a partial list of agencies to which a copy of this notice is being sent:

U.S. Environmental Protection Agency, Region VI
U.S. Fish and Wildlife Service
National Marine Fisheries Service
U.S. Coast Guard, Eighth District
Louisiana Department of Environmental Quality
Louisiana Department of Natural Resources
Louisiana Department of Wildlife and Fisheries
Louisiana Department of Transportation and Development
Louisiana State Historic Preservation Officer

This notice is being distributed to these and other appropriate Congressional, federal, state, and local interests, environmental organizations, and other interested parties.

Evaluation Factors. Evaluation includes application of the Section 404(b)(1) guidelines promulgated by the Administrator of the U.S. Environmental Protection Agency, through 40 CFR 230.

Public Involvement. Interested parties may express their views on the disposal of material associated with the proposed action or suggest modifications. All comments postmarked on or before the expiration of the comment period for this notice will be considered.

Any person who has an interest that may be affected by deposition of excavated or dredged material may request a public hearing. The request must be submitted in writing to the District Engineer within the comment period of this notice and must clearly set forth the interest that may be affected and the manner in which the interest may be affected by the proposed action.

You are requested to communicate the information contained in this notice to any parties who may have an interest in the proposed action.

For further information regarding the proposed action, please contact Dr. Klein at (504) 862-2540. Dr. Klein's FAX number is (504) 862-2572 and his E-mail address is William .P.Klein@usace.army.mil.

1.0 **JOAN M. EXNICIOS**

Chief, Environmental Planning
and Compliance Branch

COMMENT PERIOD FOR THIS PUBLIC NOTICE EXPIRES: June 21, 2010

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APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT **OMB APPROVAL NO. 0710-003**
(33 CFR 325)

Public reporting burden for this collection of information is estimated to average 5 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Service Directorate of Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302; and to the Office of Management and Budget, Paperwork Reduction Project (0710-0003), Washington, DC 20503. Please DO NOT RETURN your form to either of those addresses. Completed applications must be submitted to the District Engineer having jurisdiction over the location of the proposed activity.

PRIVACY ACT STATEMENT

Authority: 33 USC 401, Section 10; 1413, Section 404. Principal Purpose: These laws require authorizing activities in, or affecting, navigable waters of the United States, the discharge or fill material into waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. Routine Uses: Information provided on this form will be used in evaluating the application for a permit. Disclosure: Disclosure of requested information is voluntary. If information is not provided, however, the permit application cannot be processed nor can a permit be issued.

One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned.

(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)

1. APPLICATION NO.	2. FIELD OFFICE CODE	3. DATE RECEIVED	4. DATE APPLICATION COMPLETED

(ITEMS BELOW TO BE FILLED BY APPLICANT)

5. APPLICANT'S NAME	8. AUTHORIZED AGENT'S NAME AND TITLE (an agent is not required)
US Army Corps of Engineers, New Orleans District	Not Applicable
6. APPLICANT'S ADDRESS	**9. AGENT'S ADDRESS**
CEMVN P.O. Box 60267 New Orleans, LA 70160-0267	Not Applicable
7. APPLICANT'S PHONE NOs. W/AREA CODE a. Residence b. Business 504-862-1958	10. AGENT'S PHONE NOs. W/AREA CODE a. Residence Not Applicable b. Business Not Applicable

11. STATEMENT OF AUTHORIZATION

I hereby authorize, _____ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.

_____
APPLICANT'S SIGNATURE DATE

NAME, LOCATION, AND DESCRIPTION OR PROJECT OR ACTIVITY

12. PROJECT NAME OR TITLE (see instructions)
Louisiana Coastal Area-Small Diversion at Convent/Blind River

13. NAME OF WATERBODY, IF KNOWN (if applicable)	14. PROJECT STREET ADDRESS (if applicable)
Maurepas Swamp and indirectly Blind River	Not Applicable
15. LOCATION OF PROJECT St. James Parish LA COUNTY STATE	

16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions) Section, Township, Range, Lat/Lon, and/or Accessor's Parcel Number, for example.

17. DIRECTIONS TO THE SITE

The project site extends from the Mississippi River at Romeville northeast into the Maurepas Swamp

ENG FORM 4345 EDITION OF SEP 91 IS OBSOLETE (Proponent: CECW-OR)

18. Nature of Activity (Description of project, include all features)

Features of the proposed diversion (Figure 1) include:
1) A diversion culvert: (3-10x10 feet multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44 and 3-10x10 cast iron sluice gates with motor operators on the culvert inlets, and inlet canal across the batture from the Mississippi River to the culvert inlet))
2) Transmission canal: an earthen trapezoidal channel approx. 3 miles in length, 155-foot bottom width, 250 foot top width, 4:1 side slopes, and depth of 12 feet
3) Control Structures and Berm Gaps: control structures will utilize the existing drainage canal system, the berm gaps will consist of 500-foot wide gaps along the existing banks created when the drainage canals were constructed
4) Cross culverts at Hwy 61: culvert crossings under the KCS railroad and Hwy 61 consisting of 3-3x4 feet reinforced concrete box culverts.

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

Purpose of the project is to restore hydraulic connectivity in the Maurepas Swamp (within the study area) and deliver freshwater and nutrients to it from the Mississippi River. Construction of the project as well as O&M associated with the project will create dredged material to create berms along the transmission canal, while excess can be used to enhance elevated areas within the project study area for tree growth and animal refuge during high water.

USE BLOCKS 20-22 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

The placement of material dredged to construct the drainage canals, along with pipeline canals, and logging in the area have created hydrologic barriers or impounded areas that have isolated the swamps east and west of the Blind River. This has created standing water conditions that have led to degradation of the swamp habitats and prevented the introduction of nutrients that would promote the healthy growth and regeneration of plants. The degraded swamps are in the process of transitioning to freshwater marshes and open water. Without the proposed action, this transition will continue.

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards

The material to be dredged and excavated is former swamp floor sediment. The material is primarily alluvial silt and clay that was deposited by annual flooding from the Mississippi River. It is estimated that between 10,000 and 45,000 cubic yards of material will be removed during construction; however, steps to minimize disturbance and reduce this amount will be taken. During O&M dredging of the transmission canal, dredged material will be removed on an annual basis and place in areas of the swamp that are already elevated to promote tree growth and provide refuge for animals at high water

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

No waters will be filled, all dredged material placed in the swamp will be placed on existing high elevation areas.

23. Is Any Portion of the Work Already Complete? Yes ___ No _x_ IF YES, DESCRIBE THE COMPLETED WORK

24. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (If more than can be entered here, please attach a supplemental list).

25. List of Other Certifications or Approvals/Denials Received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED
LDEQ	Water Quality Certification		TBD		

ENG FORM 4345 EDITION OF SEP 91 IS OBSOLETE (Proponent: CECW-OR)

[1] Would include but is not restricted to zoning, building, and flood plain permits

26. Application is hereby made for a permit or permits to authorize the work described in this application. I certify that the information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

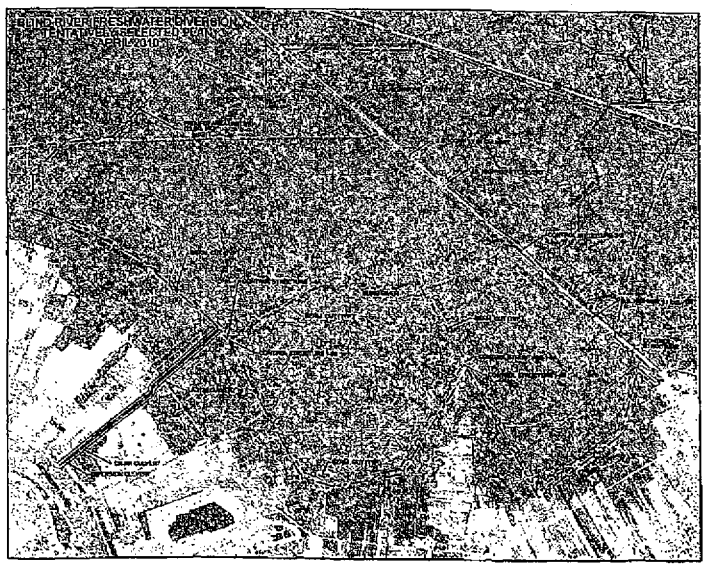
SIGNATURE OF APPLICANT | DATE | SIGNATURE OF AGENT | DATE

Sept 27 2010 | Sept 27, 2010

The application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than $10,000 or imprisoned not more than five years or both.

Figure 1:



DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

REPLY TO
ATTENTION OF:

May 21, 2010

Planning, Programs, and
Project Management Division
Environmental Planning
and Compliance Branch

Melvin C. Mitchell, Sr.
Louisiana Dept. of Env. Quality
Water Quality Certifications Section
P.O. Box 4313
Baton Rouge, LA 70821-4313

Dear Mr. Mitchell, Sr.:

An application for a State Water Quality Certificate, prepared by the U.S. Army Corps of Engineers, New Orleans District (MVN) is enclosed. MVN staff request that a water quality certification be completed, pursuant to Section 401 of the Clean Water Act of 1977, as amended (33 U.S.C., Section 1341). The draft environmental impact statement (EIS) for the LCA Convent/Blind River Diversion, Louisiana, project is enclosed for your review and comment.

The 2004 programmatic environmental impact statement (EIS) for the Louisiana Coastal Area (LCA), Louisiana, Ecosystem Restoration study identified critical projects, multiple programmatic authorizations, and ten additional required feasibility studies for the LCA. The Water Resources Development Act of 2007 included authorization, under Title VII, for the LCA Restoration Plan and specific authorization for feasibility reports on six of the ten near-term elements.

Two elements were determined to be hydrologically intertwined and the planning efforts were combined into Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock EIS Lafourche, Terrebonne, St. Mary Parish, Louisiana. The Terrebonne Basin Barrier Shoreline Restoration Study EIS (Volume V) is now being completed under a separate feasibility effort due to a need for additional alternative analysis and increasing uncertainties resulting from the Deepwater Horizon oil spill off the Louisiana coast. Consequently, only four draft EIS's and a Summary Document (Volume I) are available for public review at this time:

Amite River Diversion Canal Modification EIS (Volume II)
Convey Atchafalaya to Northern Terrebonne Marsh /
Multipurpose Operation of the Houma Navigation Lock EIS (Volume III)
Small Diversion at Convent / Blind River EIS (Volume IV)
Medium Diversion at White Ditch EIS (Volume VI)

Enclosed with this letter is Volume I and IV. A copy of the other draft EISs are available upon request.

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

Without action, the swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 21,369 acres (8,647 ha) of baldcypress-tupelo swamp projected to become marsh or open water over the 50-year period of analysis. Recent studies generally show that protecting wetlands has a net effect of lowering storm surge and wave heights compared to a future condition with extensive wetland loss. In addition to no action, twelve alternative plans to address the problems of swamp deterioration were developed and evaluated with the assistance of the U.S. Fish and Wildlife Service as a Cooperating Agency. After an iterative screening process, alternative plans were eliminated from further consideration because they did not adequately address the problems, planning goals or objectives. In addition to No Action, four alternatives were examined in detail. These four alternatives provide significant fish and wildlife habitat values and when compared to no action, contain elements that would work together to produce a greater overall benefit to restoring the swamp with limited detrimental environmental impacts to the study area.

Alternative 2, a 3,000 cfs diversion near Romeville is the Tentatively Selected Plan (TSP). It would improve and protect 21,369 acres (8,647 ha) of baldcypress-tupelo swamp, negatively impact 53 acres (21 ha) of forested wetland, and have a net value of 6,421 Average Annual Habitat Units (AAHUs) over the 50-year period of analysis. The TSP has a total estimated cost of $123,140,000. The TSP best meets the screening criteria; would accomplish the planning objectives and goals; would be consistent with the Environmental Operating Principles; and would best satisfy the Congressional mandate provided in Public Law 110-114 to reverse the trend of deterioration in the southeast part of the Maurepas Swamp.

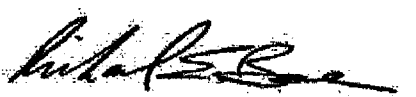
To the best of our knowledge any dredge/fill material will be free of contaminants. Please provide the public notice for publication in the Advocate of Baton Rouge to the person listed below, as soon as possible. In addition to sending us a hard copy of the public notice documents, we request that you send a complete electronic copy via E-Mail to

william.p.klein.Jr@usace.army.mil.

Please review the enclosed documents and provide comments within 45 days of the date stamped on the cover page of the EIS. Comments should be mailed to the attention of Dr. William Klein Jr.; U.S. Army Corps of Engineers; Planning, Programs, and Project Management Division; Environmental Planning and Compliance Branch; CEMVN-PM-RS; P.O. Box 60267; New Orleans, Louisiana 70160-0267.

Comments may also be provided by E-Mail to william.p.klein.Jr@usace. army.mil, or by fax to (504) 862-2088. Dr. Klein may be contacted at (504) 862-2540, if questions arise.

Sincerely,



for Joan M. Exnicios
Chief, Environmental Planning
and Compliance Branch

Enclosures

U.S. Army Corps of Engineers- New Orleans District
P.O. Box 60267
New Orleans, LA 70160-0267

Attention: Sandra Stiles

RE: Water Quality Certification (WQC 100824-01/AI 171484/CER 20100001)
Louisiana Coastal Area- Small Diversion at Convent/Blind River
St. James Parish

Dear Ms. Stiles:

We have received notice of your application for a 401 Water Quality Certification to construct a freshwater/sediment diversion canal, in the vicinity of Romeville, Louisiana. Prior to processing the certificate, this office requires:

1. **A proof of publication of the Public Notice in THE ADVOCATE of Baton Rouge.**

2. **Assurance that any excavated and fill material will be, to the best of your knowledge, free of contaminants and/or will be disposed of in an approved landfill.**

3. **A signed copy of the 404 permit application.**

4. **A list of landowners, adjacent to the project site.**

5. **A detailed description of the Best Management Practices (BMPs) and/or any other mitigating measures that will be implemented *during* the construction of the project to control stormwater runoff from the site.**

6. **Assurance that any exposed soils will be stabilized by the use of Best Management Practices (such as reseeding and revegetating the exposed area) in order to prevent potential future erosion and non-point source pollution from the site.**

Be sure to include our reference number (WQC 100824-01/AI 171484) on all responses. Please send all correspondence to the Louisiana Department of Environmental Quality to the following address:

Louisiana Department of Environmental Quality
Water Permits Division
P.O. Box 4313
Baton Rouge, LA 70821-4313
Attn: Water Quality Certifications

Enclosed is a copy of the public notice to be published by you one time in the official State Journal, THE ADVOCATE of Baton Rouge. (As provided for by LRS 30:2074 A(3), the cost of this publication is to be at your expense). PLEASE REQUEST THAT THE NEWSPAPER FURNISH US WITH PROOFS OF PUBLICATION OF THIS NOTICE TO THE FOLLOWING ADDRESS:

Louisiana Department of Environmental Quality
Water Permits Division
P.O. Box 4313
Baton Rouge, LA 70821-4313
Attn: Water Quality Certifications

A ten-day period after the date of publication will allow for public comment. After this ten-day period has expired, a decision as to whether to grant the certificate will be made in accordance with LAC 33:IX.1507.A-E and provisions of Section 401 of the Clean Water Act.

If we haven't received this information within 30 days from the date of this letter, your application will be considered inactive. If you have any questions, please call Jamie Phillippe at 225-219-3003.

Sincerely,

Tom Killeen, Environmental Scientist Manager
Municipal and General Water Permits Section

TK/jjp

PUBLIC NOTICE TO BE RUN IN

THE ADVOCATE OF BATON ROUGE
P.O. Box 588
Baton Rouge, LA 70821
Phone: 225-388-0128
Fax: 225-388-0164

Attn: Public Notices

Notice is hereby given that the Corps of Engineers- New Orleans District has applied for a 401 Water Quality Certification to construct a freshwater/sediment diversion canal, in the vicinity of Romeville, Louisiana. The applicant is applying to the Louisiana Department of Environmental Quality, Office of Environmental Services for a Water Quality Certification in accordance with statutory authority contained in the LAC 33:IX.1507.A-E and provisions of Section 401 of the Clean Water Act.

Comments concerning this application can be filed with the Water Permits Section within ten days of this notice by referencing WQC 100824-01/AI 171484 to the following address:

Louisiana Department of Environmental Quality
Water Permits Division
P.O. Box 4313
Baton Rouge, LA 70821-4313
Attn: Water Quality Certifications

A copy of the application is available for inspection and review at the LDEQ Public Records Center, on the first floor of the Galvez Building, Room 127 at 602 North Fifth Street Baton Rouge, LA 70802 from 8:00 a.m. to 4:30 p.m.

BOBBY JINDAL
GOVERNOR

PEGGY M. HATCH
SECRETARY

State of Louisiana

DEPARTMENT OF ENVIRONMENTAL QUALITY
ENVIRONMENTAL SERVICES

SEP 20 2010

U.S. Army Corps of Engineers- New Orleans District
P.O. Box 60267
New Orleans, LA 70160-0267

Attention: Sandra Stiles

RE: Water Quality Certification (WQC 100824-01/AI 171484/CER 20100001)
Louisiana Coastal Area- Small Diversion at Convent/Blind River
St. James Parish

Dear Ms. Stiles:

The Louisiana Department of Environmental Quality (the Department) has reviewed your application to construct a freshwater/sediment diversion canal, in the vicinity of Romeville, Louisiana.

Based on the information provided in the application, the Department made a determination that the requirements for a Water Quality Certification have been met and concludes that the placement of the fill material will not violate water quality standards of Louisiana as provided for in LAC 33:IX.Chapter 11. Therefore, the Department hereby issues a Water Quality Certification to the U.S. Army Corps of Engineers- New Orleans District.

Sincerely,

Melvin C. Mitchell, Sr.
Administrator
Water Permits Division

MCM/jjp

Volume IV

APPENDIX E:

Louisiana Coastal Resources Program Consistency Determination

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Volume IV

APPENDIX E:

Louisiana Coastal Resources Program Consistency Determination

CONSISTENCY DETERMINATION
LOUISIANA COASTAL ZONE MANAGEMENT PROGRAM
LCA Small Diversion at Convent/Blind River
St. James Parish and Ascension Parish, Louisiana

INTRODUCTION

Section 307 of the Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et. seq. requires that "each federal agency conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved state management programs." In accordance with Section 307, a Consistency Determination has been prepared for the proposed LCA Small Diversion at Convent/Blind River, located largely in St. James Parish and in a small portion of Ascension Parish, Louisiana. Coastal Use Guidelines were written in order to implement the policies and goals of the Louisiana Coastal Resources Program, and serve as a set of performance standards for evaluating projects. Compliance with the Louisiana Coastal Resources Program, and therefore, Section 307, requires compliance with applicable Coastal Use Guidelines.

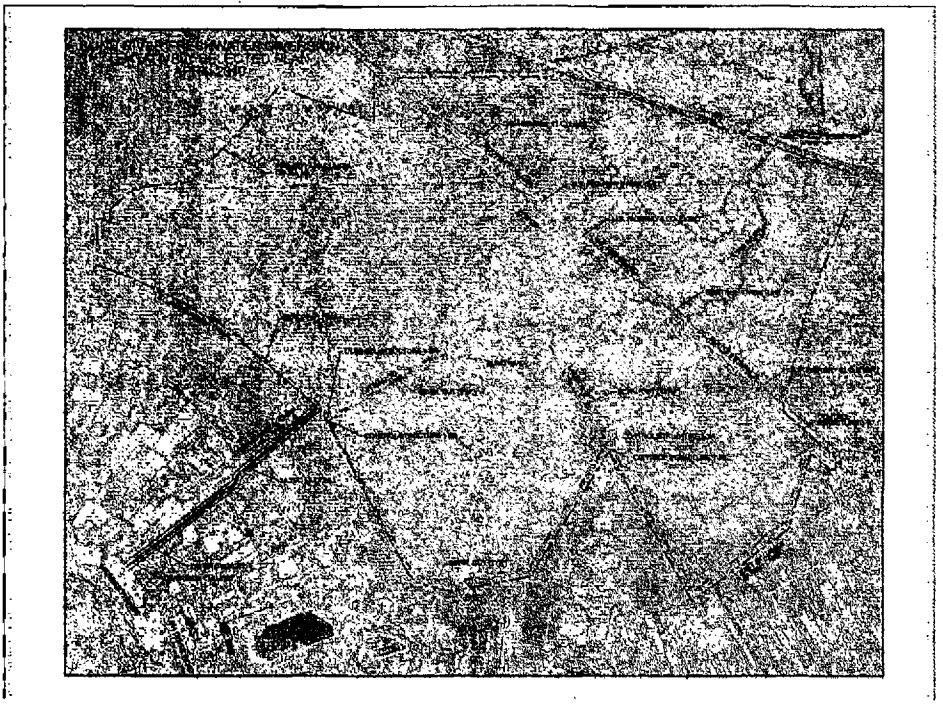
PROJECT DESCRIPTION

The main objective and goal for this project, LCA Small Diversion at Convent/Blind River, is to restore portions of the southeastern Maurepas Swamp; it is a coastal restoration project designed to reverse the trend of deterioration in the swamp and in the Blind River. The Mississippi River levee system has cut off the Maurepas Swamp (and Blind River) from the natural periodic, near annual flooding by the Mississippi River, and past construction of logging trails, drainage channels, pipe lines and other utilities, and roads through the Swamp have disrupted the natural flow and drainage patterns, and impacted the biological productivity of the Swamp. Without action, the Swamp is predicted to continue to deteriorate at the same or accelerated rates, with approximately 9,850 acres (3,991 hectares [ha]), including 6,255 acres (2,534 ha) of brackish marsh and 3,595 acres (1,456 ha) of saline marsh, projected to be lost over the 50-year period of analysis.

The main components of the tentatively selected plan (TSP), a 3,000 cfs diversion at Romeville, include a diversion from the Mississippi River consisting of three gated culverts, a 3-mile long transmission canal, five concrete drainage control structures with downward opening weir gates, thirty berm gaps approximately 500 feet wide each, and three culverts at the railroad/Hwy 61 crossing. Figure 1 shows location of the diversion, transmission canal, and structures.

The schedule to begin construction of the diversion, the transmission channel, and the in-swamp water management/control structures is dependent on final approval of the feasibility study by the Chief of Engineers (USACE HQ) and congressional authorization to use appropriated funds for construction.

Figure 1. The Project Area and TSP Feature Locations for the LCA Small Diversion at Convent Blind River.



Disposal Areas

Designated disposal sites for previously dredged or excavated materials that are generated during construction of the Blind River diversion system include areas adjacent to the diversion structure, berms adjacent to the transmission canal, and in swamp areas adjacent to control structures and berm gaps. Previously dredged material will be excavated using various types of equipment for construction of the diversion, the transmission canal, the berm gaps, and for placement of control structures. Front end loaders, backhoes, and trackhoes, as well as barge supported excavators may be used.

Material removed from structure locations near the edge of the swamp will be used to create berm areas around the structures or to enhance berms/higher elevations close to the structure locations. Material would be placed at semi-confined areas along channel banks to create a sub-aerial platform at typical wetland elevations. It is anticipated that wetland plants would colonize these areas, and that the disposal site would transform into functioning wetland. Material removed as a function of gapping along the existing drainage canals will be used in much the same manner as dredged material at structure locations.

GUIDELINES

1. **Guidelines Applicable to All Uses**

Guideline 1.1: The guidelines must be read in their entirety. Any proposed use may be subject to the requirements of more than one guideline or section of guidelines and all applicable guidelines must be complied with.

Response: Acknowledged.

Guideline 1.2: Conformance with applicable water and air quality laws, standards, and regulations, and with those other laws, standards and regulations which have been incorporated into the coastal resources program shall be deemed in conformance with the program except to the extent that these guidelines would impose additional requirements.

Response: Acknowledged.

Guideline 1.3: The guidelines include both general provisions applicable to all uses and specific provisions applicable only to certain types of uses. The general guidelines apply in all situations. The specific guidelines apply only to situations they address. Specific and general guidelines should be interpreted to be consistent with each other. In the event there is an inconsistency, the specific should prevail.

Response: Acknowledged.

Guideline 1.4: These guidelines are not intended to, nor shall they be, interpreted so as to result in an involuntary acquisition or taking of property.

Response: Acknowledged.

Guideline 1.5: No use or activity shall be carried out or conducted in such a manner as to constitute a violation of the terms of a grant or donation of any lands or water bottoms to the State or any subdivision thereof. Revocations of such grants and donations shall be avoided.

Response: The tentatively selected plan would not cause violations or revocations of such grants or donations.

Guideline 1.6: Information regarding the following general factors shall be utilized by the permitting authority in evaluating whether the proposed use is in compliance with the guidelines.

a) type, nature, and location of use.
b) elevation, soil, and water conditions and flood and storm hazard characteristics of site.
c) techniques and materials used in construction, operation, and maintenance of use.
d) existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity, and salinity; and impacts on them.
e) availability of feasible alternative sites or methods for implementing the use.
f) designation of the area for certain uses as part of a local program.
g) economic need for use and extent of impacts of use on economy of locality.
h) extent of resulting public and private benefits.
i) extent of coastal water dependency of the use.
j) existence of necessary infrastructure to support the use and public costs resulting from the use.
k) extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited.
l) proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands.
m) the extent to which regional, state, and national interests are served including the national interest in resources and the siting of facilities in the coastal zones as identified in the coastal resources program.
n) proximity to, and extent of, impacts on special areas, particular areas, or other areas of particular concern of the state program or local programs.
o) likelihood of, and extent of impacts, resulting secondary impacts and cumulative impacts.
p) proximity to, and extent of, impacts on public lands or works, or historic, recreational or cultural resources.
q) extent of impacts on navigation, fishing, public access, and recreational opportunities.
r) extent of compatibility with natural and cultural setting.
s) extent of long-term benefits or adverse impacts.

Response: All of the above are acknowledged

Guideline 1.7: It is the policy of the coastal resources program to avoid the following adverse impacts. To this end, all users and activities shall be planned, sited, designed, and constructed, operated, and maintained to avoid to the maximum extent practicable significant:

a) reductions in the natural supply of sediment and nutrients to the coastal system by alterations of freshwater flow.

Response: The effect of the proposed new channel alignment and increased channel depths on the natural supply of sediment and nutrients entering the eastern portion of the Gulf of Mexico is expected to be minimal because of rapid dilution in the receiving

water body as has historically been the case.

b) adverse economic impacts on the locality of the use and affected governmental bodies.

Response: Long-term economic benefits to the region and nation are anticipated as a result of project implementation. Improved habitat for fish and wildlife, reduction in conversion of swamp to marsh and open water, reduction in storm surge, and improved recreational benefits would result upon project completion.

c) detrimental discharges of inorganic nutrient compounds into coastal waters.

Response: There would be a temporary increase in the concentration of inorganic nutrient compounds near the dredging/clearing and/or construction locations due to resuspension of sediments during dredging operations. Any effects are expected to be minor and would only occur during actual dredging and construction operations.

d) alterations in the natural concentration of oxygen in coastal waters.

Response: Oxygen concentrations in the canal waters near dredging site(s) would have a tendency to be reduced during dredging operations. Ambient oxygen concentrations would return once dredging operations were completed.

e) destruction or adverse alterations of streams, wetland, tidal passes, inshore waters and water bottoms, beaches, dunes, barrier islands, and other natural biologically valuable areas or protective coastal features.

Response: No adverse effects to the stream and canals interior to the swamp are expected. No tidal passes, beaches, dunes, barrier islands, or protective coastal features would be affected. Impacts associated with dredging access and floatation channels are unavoidable and would result in a brief variation in bottom topography.

f) adverse disruption of existing social patterns.

Response: The area is remote, accessible only by boat or aircraft, and uninhabited. Adverse social impacts might occur temporarily from the rerouting of recreational boat traffic near dredging operations. However, any disruptions would be short-term and are not expected to disrupt existing social patterns.

g) alterations of the natural temperature regime of coastal waters.

Response: Project construction would not cause a measurable change in the natural temperature regime of coastal waters, effecting only canals and bayous internal to the swamp area. Temporary and localized increases in water temperatures might occur with increased turbidity during dredging operations; however, temperatures would return to ambient levels following completion of dredging operations.

h) detrimental changes in existing salinity regimes.

Response: No measurable change in existing salinity regimes would occur.

i) detrimental changes in littoral and sediment transport processes.

Response: This plan would not affect littoral or sediment transport processes.

j) adverse effects of cumulative impacts.

Response: There would be no adverse cumulative impacts from the proposed action.

k) detrimental discharges of suspended solids into coastal waters, including turbidity resulting from dredging.

Response: Coastal water would not be affected. This project would cause only a minor, temporary increase in the suspended sediment load within canals and bayous in the Maurepas Swamp area. The bulk of the material would rapidly settle to the bottom and become part of the bed load. Increased turbidity would be detectable for only a short distance downstream of dredge operations and are expected to return to ambient conditions once dredging is completed.

l) reductions or blockage of water flow or natural circulation patterns within or into an estuarine system or wetland forest.

Response: Circulation patterns would not be altered for any estuarine systems; however, the point of this project is to achieve a hydroperiod conducive to growth in wetland forests (baldcypress-tupelo).

m) discharges of pathogens or toxic substances into coastal waters.

Response: No pathogens would be discharged.

n) adverse alteration or destruction of archaeological, historical, or other cultural resources.

Response: No cultural resources will be adversely impacted or destroyed-no archaeological sites exist within the project area where construction or disruption of surface features will occur.

o) fostering of detrimental secondary impacts in undisturbed or biologically highly productive wetland areas.

Response: No detrimental secondary impacts are expected in undisturbed or biologically highly productive wetlands.

p) adverse alteration or destruction of unique or valuable habitats, critical habitat for endangered species, important wildlife or fishery breeding or nursery areas, designated wildlife management or sanctuary areas, or forest lands.

Response: No critical habitat for endangered species, nor any wildlife management or sanctuary areas would be adversely altered or destroyed by the proposed project. There could be temporary displacement of wildlife and aquatic organisms away from dredging and disposal sites due to turbidity and physical disturbance by construction equipment; however, the project would ultimately increase the quantity and quality of available habitats for terrestrial and aquatic organisms to utilize.

q) adverse alteration or destruction of public parks, shoreline access points, public works, designated recreation areas, scenic rivers, or other areas of public use and concern.

Response: No such areas would be adversely impacted.

r) adverse disruptions of coastal wildlife and fishery migratory patterns.

Response: No adverse disruptions of wildlife and fishery migratory patterns would occur. There could be temporary displacement of wildlife and fishery organisms away from dredging and disposal sites due to turbidity and physical disturbance by construction equipment. However, any such impacts would be minimally disruptive since most fish and wildlife in the area are mobile and would move to adjacent undisturbed areas during construction activities.

s) land loss, erosion, and subsidence.

Response: No land loss, erosion, or subsidence would result from the proposed project. The net effect from this project would be a net gain in wetland habitat.

t) increases in the potential for flood, hurricane, or other storm damage, or increases in the likelihood that damage will occur from such hazards.

Response: The proposed project would not increase flooding potential.

u) reductions in the long-term biological productivity of the coastal ecosystem.

Response: The proposed project would not result in long-term reduction of biological productivity; to the contrary, the project is intended to increase biological productivity.

Guideline 1.8: In those in which the modifier "maximum extent practicable" is used, the proposed use is in compliance with the guideline if the standard modified by the term is complied with. If the modified standard is not complied with, the use will be in compliance with the guideline if the permitting authority finds, after a systematic consideration of all pertinent information regarding the use, the site, and the impacts of the use as set forth in Guideline 1.6,

and a balancing of their relative significance, that the benefits resulting from the proposed use would clearly outweigh the adverse impacts resulting from noncompliance with the modified standard and there are no feasible and practical alternative locations, methods, and practices for the use that are in compliance with the modified standard and:

a) significant public benefits will result from the use, or;
b) the use would serve important regional, state, or national interests, including the national interest in resources and the sitting of facilities in the coastal zone identified in the coastal resources program, or;
c) the use is coastal water dependent.

The systematic consideration process shall also result in a determination of those conditions necessary for the use to be in compliance with the guideline. Those conditions shall assure that the use is carried out utilizing those locations, methods, and practices which maximize conformance to the modified standard; are technically, economically, environmentally, socially, and legally feasible and practical and minimize or offset those adverse impacts listed in guideline 1.7 and in the guideline at issue.

Response: Acknowledged.

Guideline 1.9: Uses shall, to the maximum extent practicable, be designed and carried out to permit multiple concurrent uses which are appropriate for the location and to avoid unnecessary conflicts with other uses of the vicinity.

Response: The purpose of the proposed project is for improved habitat (fish and wildlife) and recreational use. After construction, recreational pursuits would be encouraged to the maximum extent practicable.

Guideline 1.10: These guidelines are not intended to be, nor shall they be, interpreted to allow expansion of governmental authority beyond that established by La. R.S. 49:213.1 through 213.21, as amended; nor shall these guidelines be interpreted so as to require permits for specific uses legally commenced or established prior to the effective date of the coastal use permit program nor to normal maintenance or repair of such uses.

Response: Acknowledged.

2. Guidelines for Levees

Guideline 2.1: The leveeing of unmodified or biologically productive wetlands shall be avoided to the maximum extent practicable.

Response: No levees will be constructed that would disrupt biologically productive wetlands. The berm associated with the transmission canal will be constructed on lands currently used for agricultural purposes.

Guideline 2.2: Levees shall be planned and sited to avoid segmentation of wetland areas and

systems to the maximum extent practicable.

Response: No wetland areas or system would be segmented; the intent of the project is to improve hydrologic connectivity between areas of the swamp that have been impounded as a result of anthropogenic changes in years past.

Guideline 2.3: Levees constructed for the purpose of developing or otherwise changing the use of a wetland area shall be avoided to the maximum extent practicable.

Response: No levees associated with this project would encourage or cause development or change the use of wetlands.

Guideline 2.4: Hurricane and flood protection levees shall be located at the wetland/non-wetland interface or landward to the maximum extent practicable.

Response: The project does not include construction of hurricane or flood protection levees.

Guideline 2.5: Impoundment levees shall only be constructed in wetland areas as part of approved water or marsh management projects or to prevent release of pollutants.

Response: No impoundment levees will be constructed in the wetland areas. Excavated material from berm gaps will be placed behind the remaining berms and spread out to increase exiting uplands.

Guideline 2.6: Hurricane or flood protection levee systems shall be designed, built, and thereafter operated and maintained utilizing best practical techniques to minimize disruptions of existing hydrologic patterns, and the interchange of water, beneficial nutrients and aquatic organisms between enclosed wetlands and those outside the levee system.

Response: The project area does not include construction of hurricane or flood protection levees.

3. Guidelines for Linear Facilities

Guideline 3.1: Linear use alignments shall be planned to avoid adverse impacts on areas of high biological productivity or irreplaceable resource areas.

Response: No linear use alignments will be used.

Guideline 3.2: Linear facilities involving the use of dredging or filling shall be avoided in wetland and estuarine areas to the maximum extent practicable.

Response: No linear use alignments will be used in wetland or estuarine areas.

Guideline 3.3: Linear facilities involving dredging shall be of the minimum size and length.

Response: Not applicable to this project.

Guideline 3.4: To the maximum extent practicable, pipelines shall be installed through the "push ditch" method and the ditch backfilled.

Response: Acknowledged.

Guideline 3.5: Existing corridors, right-of-way, canals, and streams shall be utilized to the maximum extent practicable for linear facilities.

Response: Acknowledged.

Guideline 3.6: Linear facilities and alignments shall be, to the maximum extent practicable, designed and constructed to permit multiple uses consistent with the nature of the facility.

Response: Temporary disruption to multiple uses of the project area may occur during dredging operations, but would be restored following project completion.

Guideline 3.7: Linear facilities involving dredging shall not traverse or adversely affect any barrier island.

Response: No barrier islands would be affected. The proposed project does not occur on or near any barrier islands.

Guideline 3.8: Linear facilities involving dredging shall not traverse beaches, tidal passes, protective reefs or other natural gulf shoreline unless no other alternative exists. If a beach, tidal pass, reef or other natural gulf shoreline must be traversed for a non-navigation canal, they shall be restored at least to their natural condition immediately upon completion of construction. Tidal passes shall not be permanently widened or deepened except when necessary to conduct the use. The best available restoration techniques which improve the traversed area's ability to serve as a shoreline shall be used.

Response: No such areas would be affected.

Guideline 3.9: Linear facilities shall be planned, designed, located, and built using the best practical techniques to minimize disruption of natural hydrologic and sediment transport patterns, sheet flow, and water quality, and to minimize adverse impacts on wetlands.

Response: Acknowledged.

Guideline 3.10: Linear facilities shall be planned, designed, and built using the best practical techniques to prevent bank slumping and erosion, saltwater intrusion, and to minimize the potential for inland movement of storm-generated surges. Consideration shall be given to the use of locks in navigation canals and channels which connect more saline areas with fresher areas.

Response: Acknowledged.

Guideline 3.11: All non-navigation channels, canals and ditches which connect more saline areas with fresher areas shall be plugged at all waterway crossings and at intervals between crossings in order to compartmentalize them. The plugs shall be properly maintained.

Response: The proposed project may affect downstream salinity patterns with the introduction and flow of freshwater through the swamp and toward Lake Maurepas; this is not considered an adverse impact as more saline water has spiked the area during storm surge and is gradually doing more harm to existing wetlands.

Guideline 3.12: The multiple use of existing canals, directional drilling and other practical techniques shall be utilized to the maximum extent practicable to minimize the number and size of access canals, to minimize changes of natural systems and to minimize adverse impacts on natural areas and wildlife and fisheries habitats.

Response: Acknowledged.

Guideline 3.13: All pipelines shall be constructed in accordance with parts 191, 192, and 195 of Title 49 of the Code of Federal Regulations, as amended, and in conformance with the Commissioner of Conservation's Pipeline Safety Rules and Regulations and those safety requirements established by LA R.S. 45:408, whichever would require higher standards.

Response: Acknowledged.

Guideline 3.14: Areas dredged for linear facilities shall be backfilled or otherwise restored to the pre-existing conditions upon cessation of use for navigation purposes to the maximum extent practicable.

Response: Acknowledged.

Guideline 3.15: The best practical techniques for site restoration and re-vegetation shall be utilized for all linear facilities.

Response: Acknowledged.

Guideline 3.16: Confined and dead end canals shall be avoided to the maximum extent practicable. Approved canals must be designed and constructed using the best practical techniques to avoid water stagnation and eutrophication.

Response: The proposed project would not construct confined or dead end canals.

4. Guidelines for Dredged Spoil Deposition

Guideline 4.1: Spoil shall be deposited utilizing the best practical techniques to avoid disruption of water movement, flow, circulation, and quality.

Response: Acknowledged. Excavated or previously dredged material for canal spoil banks and wetland restoration/berm expansion will be generated during construction of the diversion, the transmission canal, the berm gaps, and several types of control structures as well as from O&M activities to maintain integrity of the transmission canal, berms, and structures. This material will be excavated from areas not located in any waterway, wetland or waterbody, but from upland areas.

Guideline 4.2: Spoil shall be used beneficially to the maximum extent practicable to improve productivity or create new habitat, reduce or compensate for environmental damage done by dredging activities, or prevent environmental damage. Otherwise, existing spoil disposal areas or upland disposal shall be utilized to the maximum extent practicable rather than creating new disposal areas.

Response: Acknowledged. Designated disposal sites for previously dredged or excavated materials that are generated during construction of the Blind River diversion system include areas adjacent to the diversion structure, berms adjacent to the transmission canal, and in swamp areas adjacent to control structures and berm gaps.

Guideline 4.3: Spoil shall not be disposed of in a manner which could result in the impounding or draining of wetlands or the creation of development sites unless spoil deposition is part of an approved levee or land surface alteration project.

Response: No dredged material would be deposited in a manner that would create adverse impacts as a result of impoundment; however, the control structures and material placement resulting from installation of the structures and the berm gaps will be placed in such a way as to encourage hydrologic connectivity and flow through the swamp, including drainage that would encourage dry-out periods for cypress propagation. The problem in the swamp is improper drainage, and the project and dredge material will be used in all ways to improve swamp conditions.

Guideline 4.4: Spoil shall not be disposed of on marsh, known oyster or clam reefs, or in areas of submerged vegetation to the maximum extent practicable.

Response: Dredged material used to renourish/build upon existing marsh could result in disruption to submersed vegetation. However, recolonization of submerged vegetation is expected to occur once the project is completed. No dredged material will be placed on known oyster or clam reefs.

Guideline 4.5: Spoil shall not be disposed of in such a manner as to create a hindrance to

navigation or fishing, or hinder timber growth.

Response: No hindrance to navigation, fishing, and timber growth would occur. The project area may be unavailable for fishing activities during construction; however, alternative fishing areas exist nearby and fishing access would be restored after construction.

Guideline 4.6: Spoil disposal areas shall be designed and constructed and maintained using the best practicable techniques to retain the spoil at the site, reduce turbidity, and reduce shoreline erosion when appropriate.

Response: Acknowledged.

Guideline 4.7: The alienation of state-owned property shall not result from spoil deposition activities without the consent of the Department of Natural Resources.

Response: No state-owned properties would be alienated by deposition of dredged material.

5. Guidelines for Shoreline Modification

Guideline 5.1: Non structural methods of shoreline protection shall be utilized to the maximum extent practicable.

Response: Acknowledged.

Guideline 5.2: Shoreline modification structures shall be designed and built using best practical techniques to minimize adverse impacts.

Response: Acknowledged

Guideline 5.3: Shoreline modification structures shall be lighted or marked in accordance with U.S. Coast Guard regulations, to not interfere with navigation, and they should foster fishing, other recreational opportunities, and public access.

Response: Acknowledged.

Guideline 5.4: Shoreline modification structures shall be built using best practical techniques to avoid the introduction of pollutants and toxic substances into coastal waters.

Response: Acknowledged.

Guideline 5.5: Piers and docks and other harbor structures shall be designed and built using best practical techniques to avoid obstruction of water circulation.

Response: The proposed action would not construct any piers, docks or other harbor structures.

Guideline 5.6: Marinas and similar commercial and recreational developments shall to the maximum extent practicable not be located so as to result in adverse impacts on open productive oyster beds, or submerged grass beds.

Response: The proposed action would not construct any marinas or similar commercial or recreational developments.

Guideline 5.7: Neglected or abandoned shoreline modification structures, piers, docks, mooring and other harbor structures shall be removed at the owner's expense, when appropriate.

Response: Acknowledged.

Guideline 5.8: Shoreline stabilization structures shall not be built for the purpose of creating fill areas for development unless part of an approved surface alteration use.

Response: Acknowledged.

Guideline 5.9: Jetties, groins, breakwaters and similar structures shall be planned, designed and constructed so as to avoid to the maximum extent practicable downstream land loss and erosion.

Response: Acknowledged.

6. Guidelines for Surface Alterations

Guideline 6.1: Industrial, commercial, urban, residential, and recreational uses are necessary to provide adequate economic growth and development. To this end, such uses will be encouraged in those areas of the coastal zone that are suitable for development. Those uses shall be consistent with the other guidelines and shall, to the maximum extent practicable, take place only:
a) on lands five feet or more above sea level or within fast lands; or
b) on lands which have foundation conditions sufficiently stable to support the use, and where flood and storm hazards are minimal or where protection from these hazards can be reasonably well achieved, and where the public safety would not be unreasonably endangered; and
1) the land is already in high intensity of development use, or
2) there is adequate supporting infrastructure, or
3) the vicinity has a tradition of use for similar habitation or development.

Response: Acknowledged.

Guideline 6.2: Public and private works projects such as levees, drainage improvements, roads,

airports, ports, and public utilities are necessary to protect and support needed development and shall be encouraged. Such projects shall, to the maximum extent practicable, take place only when:

a) they protect or serve those areas suitable for development pursuant to Guideline 6.1; and
b) they are consistent with other guidelines; and
c) they are consistent with all relevant adopted state, local, and regional plans.

Response: Acknowledged.

Guideline 6.3: Blank (Deleted by LA Department of Natural Resources).

Guideline 6.4: To the maximum extent practicable, wetland areas shall not be drained or filled. Any approved drain or fill project shall be designed and constructed using best practical techniques to minimize present and future property damage and adverse environmental impacts.

Response: No wetlands shall be filled or drained. Rather the proposed project would create/nourish and rehabilitate wetlands, create upland areas and encourage a hydroperiod to nurture baldcypress and tupelo propagation.

Guideline 6.5: Coastal water-dependent uses shall be given special consideration in permitting because of their reduced choice of alternatives.

Response: Acknowledged.

Guideline 6.6: Areas modified by surface alteration activities shall, to the maximum extent practicable, be revegetated, refilled, cleaned, and restored to their pre-development condition upon termination of the use.

Response: The proposed action would utilize dredged material to enhance the marsh. These areas are expected to revegetate naturally within 9-12 months following construction.

Guideline 6.7: Site clearing shall, to the maximum extent practicable, be limited to those areas immediately required for physical development.

Response: Acknowledged.

Guideline 6.8: Surface alterations shall, to the maximum extent practicable, be located away from critical wildlife areas and vegetation areas. Alterations in wildlife preserves and management areas shall be conducted in strict accord with the requirements of the wildlife management body.

Response: After construction, the upland areas created with excavated or previously dredged material would be allowed to vegetate naturally. The proposed action has been coordinated with US Fish and Wildlife, LA Department of Wildlife and Fisheries, and

National Marine Fisheries Service. No critical wildlife or vegetation areas would be impacted by the proposed project. No alterations of wildlife preserves or management areas would occur.

Guideline 6.9: Surface alterations which have high adverse impacts on natural functions shall not occur, to the maximum extent practicable, on barrier islands and beaches, isolated cheniers, isolated natural ridges or levees, or in wildlife and aquatic species breeding or spawning areas, or in important migratory routes.

Response: The proposed action has been coordinated with the US Fish and Wildlife Services and the National Marine Fisheries Service to minimize impacts to threatened and endangered species and their critical habitat. Although the proposed action would involve activities in the habitat of the Gulf and Pallid sturgeon and the West Indian manatee, the scope of these activities is not likely to adversely impact these species. No sturgeon breeding or spawning areas, or manatee foraging areas, would be impacted. Benthic organisms upon which Gulf sturgeon feed may be temporarily impacted by dredging actions; however, the benthic organisms would quickly re-establish, and dredging windows would be used to minimize the potential to affect individuals.

Guideline 6.10: The creation of low dissolved oxygen conditions in the water or traps for heavy metals shall be avoided to the maximum extent practicable.

Response: Low dissolved oxygen conditions may occur during dredging operations and as a result of increased turbidity. However, any such conditions would be of short duration and would return to ambient conditions after construction activities were completed.

Guideline 6.11: Surface mining and shell dredging shall be carried out utilizing the best practical techniques to minimize adverse environmental impacts.

Response: Not applicable.

Guideline 6.12: The creation of underwater obstructions which adversely affect fishing or navigation shall be avoided to the maximum extent practicable.

Response: No underwater obstructions would be created.

Guideline 6.13: Surface alteration sites and facilities shall be designed, constructed, and operated using the best practical techniques to prevent the release of pollutants or toxic substances into the environment and minimize other adverse impacts.

Response: Acknowledged.

Guideline 6.14: To the maximum extent practicable, only material that is free of contaminants and compatible with the environmental setting shall be used as fill.

Response: The excavated and previously dredged material will be used to enhance surrounding upland areas. The excavated and previously dredged material is expected to be free of contaminants, based on the HTRW survey for the project area.

7. Guidelines for Hydrologic and Sediment Transport Modifications

Guideline 7.1: The controlled diversion of sediment laden waters to initiate new cycles of wetland building and sediment nourishment shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the outfall area. Such diversions shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Response: The proposed project is a controlled diversion to direct Mississippi River water into a portion of the Maurepas Swamp for the purpose enhancing swamp productivity.. An adaptive management plan, as well as water quality monitoring, are included in the plan for this project.

Guideline 7.2: Sediment deposition systems may be used to offset land loss, to create or restore wetland areas or enhance building characteristics of a development site. Such systems shall only be utilized as part of an approved plan. Sediment from these systems shall only be discharged in the area that the proposed use is to be accomplished.

Response: The river diversion includes sediment reintroduction to the southeastern Maurepas Swamp to restore wetland areas and enhance vertical accretion in conjunction with increased swamp productivity.

Guideline 7.3: Undesirable deposition of sediments in sensitive habitat or navigation areas shall be avoided through the use of the best preventive techniques.

Response: Acknowledged.

Guideline 7.4: The diversion of freshwater through siphons and controlled conduits and channels, and overland flow to offset saltwater intrusion and to introduce sediment and nutrients into wetlands shall be encouraged and utilized whenever such diversion will enhance the viability and productivity of the outfall area. Such diversions shall incorporate a plan for monitoring and reduction and/or amelioration of the effects of pollutants present in the freshwater source.

Response: The proposed action will reintroduce water flow and increase nutrient delivery. See also response to Guideline 7.2.

Guideline 7.5: Water or swamp management plans shall result in an overall benefit to the productivity of the area.

Response: Acknowledged.

Guideline 7.6: Water control structures shall be assessed separately based on their individual merits and impacts and in relation to their overall water or marsh management plan of which they are a part.

Response: Acknowledged. Intensive modeling (HEC-RAS and EFDC models) have been applied to the project study area to assess the best possible placement of structures and overall water distribution and flow into the swamp.

Guideline 7.7: Weirs and similar water control structures shall be designed and built using the best practical techniques to prevent "cut arounds," permit tidal exchange in tidal areas, and minimize obstruction to the migration of aquatic organisms.

Response: Acknowledged.

Guideline 7.8: Impoundments which prevent normal tidal exchange and/or the migration of aquatic organisms shall not be constructed in brackish and saline areas to the maximum extent practicable.

Response: The proposed project does not include any impoundments that prevent normal tidal exchange.

Guideline 7.9: Withdrawal of surface and ground water shall not result in saltwater intrusion or land subsidence to the maximum extent practicable.

Response: Not applicable.

8. Guidelines for the Disposal of Wastes

Response: The proposed action would not involve the disposal of wastes and, therefore, these guidelines are not applicable.

9. Guidelines for Uses That Result in the Alteration of Waters Draining into Coastal Waters

Response: The proposed action would not involve the alterations of waters draining into coastal waters, and, therefore, these guidelines are not applicable.

10. Guidelines for Oil, Gas, and Other Mineral Activities

Response: The proposed action would not involve oil, gas, or other mineral activities, and, therefore, these guidelines are not applicable.

CONSISTENCY DETERMINATION

Based on this evaluation, it is proposed that implementation of the Tentatively Selected Plan (Freshwater Diversion from Mississippi River located at Romeville, 3,000 cfs), would be consistent, to the maximum extent practicable, with the State of Louisiana's approved Coastal Resources Program.

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BOBBY JINDAL
GOVERNOR

ROBERT D. HARPER
SECRETARY

State of Louisiana

DEPARTMENT OF NATURAL RESOURCES
OFFICE OF COASTAL MANAGEMENT

July 22, 2010

Joan Exnicios
Chief, Environmental Branch
Corps of Engineers- New Orleans District
P.O. Box 60267
New Orleans, LA 70160-0267

RE: **C20100165,** Coastal Zone Consistency
New Orleans District, Corps of Engineers
Direct Federal Action
LCA Convent/Blind River Diversion Project, **St. James Parish, Louisiana**

Dear Ms. Exnicios:

This office has received the above referenced federal application for consistency review with the approved Louisiana Coastal Resources Program in accordance with Section 307(c) of the Federal Coastal Zone Management Act of 1972, as amended. NOAA Regulations on Federal Consistency, at 15 CFR '930.41(a), allow 60 days for the review of Direct Federal Activities, and at '930.41(b) allow an additional 15 days with appropriate applicant notification. Please be advised that, by this letter, Interagency Affairs/Field Services Division is requesting the 15 day time extension.

A final determination will be made within the authorized time period ending August 9, 2010. Please refer to the above Consistency Application number when responding to this letter. If you have any questions please call Brian Marcks of the Consistency Section at (225) 342-7591 or 1(800) 267-4019.

Sincerely yours,

Gregory J. DuCote
Administrator
Interagency Affairs/Field Services Division

GJD/bgm

Cc: William Klein, Jr., COE-NOD

BOBBY JINDAL
GOVERNOR

ROBERT D. HARPER
SECRETARY

State of Louisiana

DEPARTMENT OF NATURAL RESOURCES
OFFICE OF COASTAL MANAGEMENT

August 5, 2010

Joan Exnicios
Chief, Environmental Branch
Corps of Engineers- New Orleans District
P.O. Box 60267
New Orleans, LA 70160-0267

RE: **C20100165,** Coastal Zone Consistency
New Orleans District, Corps of Engineers
Direct Federal Action
LCA Small Diversion at Convent/Blind River, **St. James Parish, Louisiana**

Dear Ms. Exnicios:

The above referenced project has been reviewed for consistency with the Louisiana Coastal Resources Program in accordance with Section 307 (c) of the Coastal Zone Management Act of 1972, as amended. The project, as proposed in this application, is consistent with the LCRP, provided the Corps complies with the LDWF stipulations with which your agency concurred by email of July 28, 2010.

If you have any questions concerning this determination please contact Brian Marcks of the Consistency Section at (225) 342-7939 or 1-800-267-4019.

Sincerely yours,

Karl L Mosz for

Gregory J. DuCote
Administrator
Interagency Affairs/Field Services Division

GJD/JDH/bgm

cc: William Klein, COE-NOD
Bren Haase, OCPR
Dave Butler, LDWF
Chuck Spears, OCM FI
Jody Chenier, St. James Parish

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Volume IV

APPENDIX F:

State Historic Preservation Officer Coordination Letter

Included herein are the following:

-Initiation Letters for:

a. SHPO

b. Various Local American Indian Tribes

-Programmatic Agreement

-Advisory Council on Historic Preservation Letter

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

APRIL 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Mr. Scott Hutcheson
State Historic Preservation Officer
Office of Cultural Development
Department of Culture, Recreation and Tourism
P.O. Box 4427
Baton Rouge, Louisiana 70804

Dear Mr. Hutcheson:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The study of the diversion at Convent/Blind River restoration project is evaluating a small hydraulic diversion (less than 5,000 cfs) from the Mississippi River into Maurepas Swamp. Alternative locations for the proposed control structure in the vicinity of Convent, St. James Parish, Louisiana, located at Mississippi River mile 159 are being investigated. The project will be for the restoration of a portion of the swamp in the headwaters of the Blind River watershed. At this time the project is identifying reasonable alternatives and screening the alternatives down to a recommended plan. The Blind River headwaters are located in St. James Parish, approximately 23 miles north of the east bank of the Mississippi River at Convent. The Blind River flows north then east through Ascension and St. John the Baptist parishes before emptying into Lake Maurepas.

Two maps are attached to this letter. The first is a small scale map showing the Convent/Blind River project, area, marked in green, in relation to Hope Canal Diversion project, marked in yellow and the Amite River Diversion project marked in Red. The second attachment is a large scale map showing only the Convent/Blind River Diversion project area.
Records the Louisiana Division of Archaeology indicate that six know sites are located within the proposed project area. The site forms for these cultural resources are attached to this letter.

16SJ39, the Romeville/Convent site, a historic period artifact scatter is reported to be mostly destroyed and has been recommended as not eligible to the National Register of Historic Places.

16AN31, the Monroe Plantation consists in the salve quarters area, sugar house, machine shop, cemetery and the big house. This plantation dates to the mid 19th century to the mid 20th century. It has not been evaluated for inclusion to the National Register of Historic Places.

16AN39, the site of the fort and town of Galveztown is affiliated with the 18th – 19th century Spanish, Canary Islanders and French settlers. When last recorded in 1989, there was apparently no evidence of standing architecture; however there were numerous surface artifacts. According to a local informant the site has eroded 30 ft. into the river. 16AN39 has not been evaluated for inclusion to the National Register of Historic Places.

16AN50, the Bayou Conway Site, is a prehistoric period site along Bayou Conway. Artifacts from dredge material contained several decorated pot sherds dating to the Troyville-Coles Creek periods.

16SJ20, the Wilton Plantation, is an 18th century plantation near Romeville, Louisiana. Cultural features include the slave quarter area, sugar house ruins, a tenant farmer community and the ruins of the big house. It has not been evaluated for inclusion to the National Register of Historic Places.

16SJ21, the Helvetia Plantation, is a 19th and 20th century sugar plantation located near Romeville, Louisiana. Cultural features present are the sugar mill, two intact slave quarter houses, the remains of the big house and two Creole style overseer's houses. It has not been evaluated for inclusion to the National Register of Historic Places.

In accordance with 36 CFR Part 800.4(a)(3) we request that you review the attached maps and identify any cultural properties that may be of interest to the State of Louisiana. If so please inform Mr. DeMarcay at (504 862-2039.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

for Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

w/attachments
cc: John Burns, CDM w/attachments

ALABAMA-COUSHATTA TRIBE OF TEXAS
571 State Park Rd 56 • Livingston, Texas 77351 • (936) 563-1100

May 8, 2009

Gary DeMarcay
U.S. Army Corps of Engineers
CEMVN-PM-RN
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Mr. DeMarcay:

On behalf of Chief Oscola Clayton Sylestine and the Alabama-Coushatta Tribe, our appreciation is expressed on your efforts to consult us regarding the Blind River Small Diversion Canal in St. James, St. John the Baptist, and Ascension Parishes.

Our Tribe maintains ancestral associations within the state of Louisiana despite the absence of written records to completely identify Tribal activities, villages, trails, or grave sites. It is our objective to ensure any significances of Native American ancestry including the Alabama-Coushatta Tribe are administered with the utmost attention.

Upon review of the April 20, 2009 documents submitted to our Tribe, a determination of immediate impact to religious, cultural, or historical assets of the Alabama-Coushatta Tribe of Texas could not be ascertained. The proposed location exists in proximity to migratory routes and temporary habitation sites utilized by ancestral members of the Alabama and Coushatta Tribes. We have no objections to the proceeding of this proposal provided precautionary measures are utilized to minimize impacts to ground contents.

In the event of inadvertent discovery of human remains and/or archaeological artifacts, activity in proximity to the location must cease and appropriate authorities, including this office, notified without delay. Should you require additional assistance, please do not hesitate to contact us.

Respectfully submitted,

Bryant J. Celestine
Historic Preservation Officer

Telephone: 936 – 563 – 1181 celestine.bryant@actribe.org Fax: 936 – 563 – 1183

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chairperson LaRue Parker
Caddo Nation of Oklahoma
P.O. Box 487
Binger, OK 73009

Dear Chairperson Parker:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Caddo Nation of Oklahoma Tribal Historic Preservation Officer Mr. Robert Cast. If you wish to view the attachment please contact Mr.Cast, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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Two maps are attached to this letter. The first is a small scale map showing the Convent/Blind River project, area, marked in green, in relation to Hope Canal Diversion project, marked in yellow and the Amite River Diversion project marked in Red. The second attachment is a large scale map showing only the Convent/Blind River Diversion project area.

Records the Louisiana Division of Archaeology indicate that six know sites are located within the proposed project area. The site forms for these cultural resources are attached to this letter.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Caddo Nation of Oklahoma. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

For Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Robert Cast, Historic Preservation Officer
w/attachments
John Burns, CDM w/attachments

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chairman Lonnie L. Martin
Chitimacha Tribe of Louisiana
P.O. Box 661
Charenton, LA 70523

Dear Chairman Martin:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Chitimacha Tribe of Louisiana Cultural Director Ms. Kimberly Walden. If you wish to view the attachment please contact Ms. Walden, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Chitimacha Tribe of Louisiana. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Kimberly S. Walden, Cultural Director w/attachments
John Burns, CDM w/attachments

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chief Gregory E. Pyle
Choctaw Nation of Oklahoma
P.O. Box Drawer 1210
Durant, OK 74701

Dear Chief Pyle:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Choctaw Nation of Oklahoma Tribal Historic Preservation Officer Mr. Terry Cole. If you wish to view the attachment please contact Mr. Cole, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Choctaw Nation of Oklahoma. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

For Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Terry D. Cole, Director/THPO w/attachments
John Burns, CDM w/attachments

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chief Kevin Sickey
Coushatta Tribe of Louisiana
P.O. Box 818
Elton, LA 70532

Dear Chief Sickey:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Coushatta Tribe of Louisiana Cultural Contacts Bertney and Linda Langely. If you wish to view the attachment please contact Mr. or Ms. Langely, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Coushatta Tribe of Louisiana. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

For Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Bertney and Linda Langley, Cultural Contacts
w/attachments
John Burns, CDM w/attachments

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Principal Chief Christine Norris
Jena Band of the Choctaw Indians
P.O. Box 14
Jena, LA 71342

Dear Chief Norris:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Jena Band of Choctaw Indians Environmental Director Ms. Lillie McCormick. If you wish to view the attachment please contact Ms. McCormick, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Jena Band of Choctaw Indians. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

Cc: Lillie McCormick, Environmental Director
w/attachments
John Burns, CDM w/attachments

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

APRIL 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chief Beasley Denson
Mississippi Band of Choctaw Indians
P.O. Box 6257
Choctaw, MS 39350

Dear Chief Denson:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Mississippi Band of Choctaw Indians Tribal Historic Preservation Officer Mr. Kenneth Carleton. If you wish to view the attachment please contact Mr. Carleton, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

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Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

For Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Kenneth H. Carleton, Historic Preservation Officer
w/attachments
John Burns, CDM w/attachments

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chairman John Berrey
Quapaw Tribe of Oklahoma
P.O. Box 765
Quapaw, OK 74363

Dear Chairman Berrey:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Quapaw Tribe of Oklahoma Historic Preservation Officer, Ms. Carrie Wilson. If you wish to view the attachment please contact Ms.Wilson, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The study of the diversion at Convent/Blind River restoration project is evaluating a small hydraulic diversion (less than 5,000 cfs) from the Mississippi River into Maurepas Swamp. Alternative locations for the proposed control structure in the vicinity of Convent, St. James Parish, Louisiana, located at Mississippi River mile 159 are being investigated. The project will be for the restoration of a portion of the swamp in the headwaters of the Blind River watershed. At this time the project is identifying reasonable alternatives and screening the alternatives down to a recommended plan. The Blind River headwaters are located in St. James Parish, approximately 23 miles north of the east bank of the Mississippi River at Convent. The Blind River flows north then east through Ascension and St. John the Baptist parishes before emptying into Lake Maurepas.

Two maps are attached to this letter. The first is a small scale map showing the Convent/Blind River project, area, marked in green, in relation to Hope Canal Diversion project, marked in yellow and the Amite River Diversion project marked in Red. The second attachment is a large scale map showing only the Convent/Blind River Diversion project area.

Records the Louisiana Division of Archaeology indicate that six know sites are located within the proposed project area. The site forms for these cultural resources are attached to this letter.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Quapaw Tribe of Oklahoma. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Carrie V. Wilson, Historic Preservation Officer
w/attachments
John Burns, CDM w/attachments

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chairman Mitchell Cypress
Seminole Tribe of Florida
6300 Sterling Rd.
Hollywood, FL 33024

Dear Chairman Cypress:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Seminole Tribe of Florida Tribal Historic Preservation Officer Mr. Willard Steele and the Compliance Review supervisor Ms. Dawn Hutchins. If you wish to view the attachment please contact Mr. Steele or Ms. Hutchins, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Seminole Tribe of Florida. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Willard S. Steele, Tribal Historic Preservation Officer
Dawn Hutchins, Compliance Review Supervisor
w/attachments
John Burns, CDM w/attachments

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Principal Chief Enoch Kelley Haney
Seminole Nation of Oklahoma
P.O. Box 1498
Wewoka, OK 74884

Dear Chief Haney:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Seminole Nation of Oklahoma Tribal Historic Preservation Officer Ms. Natalie Deere. If you wish to view the attachment please contact Ms. Deere, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Seminole Nation of Oklahoma. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

for Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Natalie Deere Tribal Historic Preservation Officer
w/attachments
John Burns, CDM w/attachments

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DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P.O. BOX 60267
NEW ORLEANS, LOUISIANA 70160-0267

April 20, 2009

Planning, Programs, and
Project Management Division
Environmental Planning
And Compliance Branch
Attn: CEMVN-PM-RN

Chairman Earl J. Barbry, Sr.
Tunica-Biloxi Tribe of Louisiana
P.O. Box 1589
Marksville, LA 71351

Dear Chairman Barbry:

RE: Small Diversion at Convent/Blind River, St. James, St. John the Baptist and Ascension Parishes, Louisiana.

A copy of this letter and the attachments are being sent to the Tunica-Biloxi Tribe of Louisiana Cultural Director Mr. Earl Barbry, Jr.. If you wish to view the attachment please Mr. Barbry, or, if you wish, you may contact Mr. Gary DeMarcay of my staff at (504) 862-2039.

A small diversion at Convent/Blind River is proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Hope Canal and Amite River Diversion Canal modification projects to bring Mississippi River water, sediment and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

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In accordance with 36 CFR Part 800.4(a)(4) we request that you review the attached maps and identify any cultural properties that may be of interest to the Tunica-Biloxi Tribe of Louisiana. If so please inform either the Louisiana State Historic Preservation Office at (225) 342-8170 or Mr. DeMarcay at the number above.

Thank you for your help with this project. If you have any questions or require additional information, please contact Mr. DeMarcay.

Sincerely,

for Joan Exnicios, Acting
Chief, Environmental Planning
And Compliance Branch

cc: Earl Barbry, Jr. Cultural Director
w/attachments
John Burns, CDM w/attachments

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Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

WHEREAS, the United States Army Corps of Engineers (USACE), in cooperation with the Coastal Protection and Restoration Authority of Louisiana (CPRA), has been working to reverse the current trend of coastal degradation; and

WHEREAS, the Louisiana Coastal Area Plan (LCA Plan) is the recommended plan resulting from the Louisiana Coastal Area Ecosystem Restoration Study, completed in November 2004 and recommended to the Congress by a Chief of Engineers report dated January 31, 2005; and

WHEREAS, Section 7006 of the Water Resources Development Act (WRDA) of 2007 (Public Law 110-114) includes conditional authorization for the LCA Plan; and

WHEREAS, the LCA Plan calls for a coordinated, feasible solution to the identified critical water resource problems and opportunities in coastal Louisiana and includes fifteen (15) near-term critical restoration features (Undertakings); and

WHEREAS, the USACE has determined that the restoration features are undertakings as defined in the regulations of the Advisory Council on Historic Preservation (ACHP) implementing Section 106 of the National Historic Preservation Act (36 CFR § 800) that may affect properties included in or eligible for inclusion in the National Register of Historic Places (NRHP); and

WHEREAS, the USACE has consulted with the ACHP and the Louisiana State Historic Preservation Officer (SHPO) to develop this Programmatic Agreement (Agreement) pursuant to 36 CFR § 800.14(b)(1) of the ACHP's regulations implementing Section 106; and

WHEREAS, Section 7006(e)(3) of WRDA 2007 requires submittal of additional feasibility reports on the following six (6) of the fifteen (15) near-term critical restoration features identified in the 2004 LCA Study: (1) Multipurpose Operation of Houma Navigation Canal Lock, (2) Terrebonne Basin Barrier Shoreline Restoration, (3) Small Diversion at Convent/Blind River, (4) Amite River Diversion Canal Modification, (5) Medium Diversion at White's Ditch, and (6) Convey Atchafalaya River Water to Northern Terrebonne Marshes; and authorizes construction of those six features substantially in accordance with the recommendations presented in a final report of the

Chief of Engineers if a favorable report of the Chief is completed by not later than December 31, 2010; and

WHEREAS, Section 7006(e)(1) of WRDA 2007 requires submittal of feasibility reports on the following four (4) of the fifteen (15) near-term critical restoration features identified in the 2004 LCA Study: (1) Land Bridge between Caillou Lake and the Gulf of Mexico, (2) Gulf Shoreline at Point au Fer Island, (3) Modification of Caernarvon Diversion, and (4) Modification of Davis Pond Diversion; and authorizes construction of those four features if the Secretary of the Army determines that the projects are feasible; and

WHEREAS, Section 7006(c) of WRDA 2007 requires submittal of construction reports on the following five (5) of the fifteen (15) near-term critical restoration features identified in the 2004 LCA Study: (1) Mississippi River-Gulf Outlet Environmental Restoration, (2) Small Diversion at Hope Canal, (3) Barataria Basin Barrier Shoreline Restoration, (4) Small Bayou Lafourche Reintroduction, and (5) Medium Diversion at Myrtle Grove; and authorizes construction of those five features substantially in accordance with the report of the Chief of Engineers dated January 31, 2005; and

WHEREAS, the USACE has elected to fulfill its obligations under Section 106 of the National Historic Preservation Act of 1966, as amended, through the execution and implementation of this Agreement as provided in 36 CFR § 800; and

WHEREAS, the Undertakings, including stipulations of the Agreement, are subject to provisions of the Antideficiency Act (31 U.S.C. § 1341), the unavailability of funds shall not relieve the USACE from its obligation to perform those Section 106 responsibilities set forth in the Agreement; and

WHEREAS, the USACE, ACHP, SHPO, and Indian tribes as defined in 36 CFR § 800.16(m), representatives of local governments, and other appropriate parties have consulted to develop this Agreement to define efficient and cost effective processes and protocols for taking into consideration the effects of the Undertakings upon historic properties pursuant to 36 CFR § 800.14(b)(1); and

WHEREAS, the USACE acknowledges Indian tribes as sovereign nations which have a unique government-to-government relationship with the federal government and its agencies; the USACE further acknowledges its Trust Responsibility to those recognized Indian tribes; and

WHEREAS, the USACE has notified affected Indian tribes and shall fulfill its tribal consultation responsibilities through ongoing consultation with Indian tribes that attach religious and cultural significance to historic properties that may be affected by the Undertakings; and

WHEREAS, the USACE has decided that it will invite any interested Indian tribe to sign this Agreement as a concurring party; and

WHEREAS, the CPRA has been invited to be a signatory to this Agreement; and

WHEREAS, the USACE, in coordination with the SHPO, has taken appropriate measures to identify other consulting parties and to invite such parties to participate in the development and execution of this Agreement; and

WHEREAS, the USACE has requested the participation of local governments and the public by mail during the development of this Agreement and will take appropriate steps to involve and notify those parties, as appropriate, during the implementation of the terms of this Agreement; and

NOW, THEREFORE, the USACE, ACHP, and SHPO agree that the implementation of the following stipulations will evidence that the USACE has taken into account the effects of the Undertakings upon historic properties.

STIPULATIONS

The USACE shall adhere to the process and protocols set forth in this Agreement and shall ensure the following stipulations are carried out.

I. Tribal Consultation

A. The USACE shall conduct government-to-government consultation with Indian tribes that attach religious and cultural significance to historic properties that may be affected by the Undertakings.

B. The USACE will develop protocols with Indian tribes with cultural, religious, and/or ancestral ties to the Gulf Coast region to facilitate tribal consultation regarding the potential effect of the Undertakings on properties with tribal cultural or religious significance. The USACE shall provide Indian tribes with copies of all plans, determinations, and findings provided to the SHPO to assist the Indian tribes in identifying activities that may be of interest.

C. Pursuant to this Agreement, the USACE will develop consultation protocols with each Indian tribe, as requested, within ninety (90) days of the execution of this Agreement unless that timeframe is modified by written agreement.

D. The USACE has invited the Alabama Coushatta Tribe of Texas, the Caddo Nation of Oklahoma, the Chitimacha Tribe of Louisiana, the Choctaw Nation of Oklahoma, the Coushatta Tribe of Louisiana, the Jena Band of Choctaw Indians, the Mississippi Band of Choctaw Indians, the Quapaw Tribe of Oklahoma, the Seminole Nation of Oklahoma, the Seminole Tribe of Florida, and the Tunica-Biloxi Tribe

of Louisiana to consult in the development of the Agreement. The Alabama-Coushatta Tribe of Texas and the Mississippi Band of Choctaw Indians have participated in the development of the Agreement and will each sign the Agreement as a concurring party. The USACE will provide all invited Indian tribes with a copy of the Programmatic Agreement and will invite them to sign the Agreement as concurring parties.

II. Public Involvement

A. The USACE, in coordination with the SHPO, shall identify and provide members of the public likely to be interested in the effects of the Undertakings upon historic properties with a description of the restoration features and the provisions of the Agreement.

B. The USACE will involve the public through the National Environmental Policy Act (NEPA) process, which affords all persons, organizations and government agencies the right to review and comment on proposed major federal actions that are evaluated by a NEPA document. This is known as the "scoping process." The scoping process is the initial step in the preparation of a NEPA document and will help identify (1) the range of actions (project, procedural changes), (2) alternatives (both those to be rigorously explored and evaluated and those that may be eliminated), and (3) the range of environmental resources considered in the evaluation of environmental impacts.

C. The USACE will release a draft of the NEPA document for each of the Undertakings to the public for a review period. A public meeting soliciting comments on the proposed action presented in each draft NEPA document will be held during the public comment period. Comments from this review period will be incorporated into each final NEPA document.

D. To the extent permitted under applicable federal laws and regulations, the USACE will release to the public documents developed pursuant to this Agreement, including protocols, effects determinations, and Interim Progress Reports.

III. Other Consulting Parties

A. The USACE, in coordination with the SHPO, will continue efforts during the duration of this Agreement to identify other parties with demonstrated interests in preservation issues and invite them to participate as consulting parties.

B. The USACE will document the consulting parties in the consultation process for each of the Undertakings and maintain it as part of the administrative record.

C. If any dispute arises about the right to be recognized as a consulting party, the USACE will contact the ACHP and provide all appropriate documentation. The ACHP will participate in the resolution of the issue.

IV. Identification, Evaluation, and Assessment of Effects Determinations

A. In coordination with the SHPO and Indian tribes, the USACE will develop protocols for the identification and evaluation of historic properties covered under the terms of this Agreement. Such protocols also will address applicable professional standards, documentation requirements for SHPO submissions, review procedures, and the involvement of consulting parties. Identification and evaluation protocols will be developed within ninety (90) days of the execution of this Agreement unless that timeframe is modified by written agreement.

B. The USACE, in consultation with the SHPO and Indian tribes, will define and document the area of potential effects (APE) for each of the Undertakings based on the nature of the proposed construction, existing information on the presence or absence of historic properties, the types of historic properties expected to be encountered, the physical characteristics of the APE, and the religious and cultural significance of the APE to Indian tribes. The APE associated with each restoration feature will anticipate the potential for direct, indirect, and cumulative effects upon historic properties. Identification and evaluation efforts will be limited to the APE once that APE is approved by the SHPO and Indian tribes who have signed this Agreement.

C. In the event of disagreement between the USACE, SHPO, and/or Indian tribes on the eligibility of a property for listing in the National Register of Historic Places under 36 CFR § 60, the USACE shall request a formal determination of eligibility for that property from the Keeper of the National Register of Historic Places (Keeper). The determination by the Keeper will serve as the final decision regarding the National Register eligibility of the property.

D. All standard response timeframes established under 36 CFR § 800 will apply during the interim period between the execution of this Agreement and the adoption of identification and evaluation protocols, unless otherwise agreed by the SHPO and Indian tribes. The USACE may request expedited review by the SHPO and Indian tribes on a case by case basis during the interim period.

V. Coordination of Effects Determinations

A. The USACE shall evaluate effects of each of the Undertakings on historic properties in a holistic manner. In the event the USACE determines that any aspect of an Undertaking will have an effect or adverse effect on a historic property within the restoration feature's APE, the entire restoration feature will be reviewed accordingly.

B. In the absence of alternative response timeframes identified in approved protocols developed pursuant to this Agreement, consultation under this Agreement will be concluded for USACE findings of *no historic properties affected* when the SHPO and Indian tribes have reviewed the written documentation and concur with the USACE finding or do not object within thirty (30) days of receipt of an adequately documented finding.

C. Following submission of written documentation to the SHPO and Indian tribes, the USACE may propose a finding of *no adverse effect with conditions*, as appropriate. Such conditions may include, but are not limited to:

1. Avoidance and/or preservation in-place of historic properties;

2. Unavoidable visual effects to historic properties in cases where reasonable and practicable efforts to screen views are considered and implemented; and

3. Modifications or conditions to ensure consistency with the Secretary of Interior's *Standards for the Treatment of Historic Properties* and applicable guidelines.

D. In the absence of alternative response timeframes identified in approved protocols developed pursuant to this Agreement, consultation under this Agreement will be concluded for USACE findings of *no adverse effect* or *no adverse effect with conditions* when the SHPO and Indian tribes have reviewed the written documentation and concur with the USACE finding or do not object within thirty (30) days of receipt of an adequately documented finding. The public shall also be afforded an opportunity to comment.

E. Should the SHPO and/or Indian tribes object to USACE's findings of *no historic properties affected*, findings of *no adverse effect with conditions*, findings of *no adverse effect*, or should the USACE determine that it cannot accept conditions requested by the SHPO and/or Indian tribes, the USACE shall seek to resolve such objection through consultation in accordance with Stipulation IX of this Agreement.

VI. Resolution of Adverse Effects

A. In the event that the USACE, in consultation with the SHPO and Indian tribes, determines that the implementation of an Undertaking may result in an adverse effect upon historic properties as defined in 36 CFR § 800.5(a)(1) and (2) of the ACHP's regulations, the USACE shall notify the ACHP, SHPO, Indian tribes, other consulting parties, and the public. If the project activity will affect a National Historic Landmark, the USACE shall also notify the National Park Service (NPS). The adverse effect notification shall include the documentation specified in 36 CFR § 800.11(e), subject to the confidentiality provisions of 36 CFR § 800.11(c).

B. In the absence of alternative response timeframes identified in approved protocols developed pursuant to this Agreement, the ACHP, SHPO, Indian tribes, consulting parties, including NPS, as appropriate, and the public shall be afforded an opportunity to review and comment on the adverse effect notification for a period of thirty (30) days after receipt of the adverse effect notification.

C. The USACE, in consultation with the SHPO, Indian tribes, other consulting parties, and the ACHP if they notify the parties of their participation pursuant to 36 CFR 800.6(a)(1)(iii), will develop treatment plans for the resolution of adverse effects to historic properties within sixty (60) days of the receipt of the adverse effect notification. Such treatment plans will address measures to avoid, minimize, or mitigate adverse effects on historic properties. Standard mitigation measures will be tailored to the significance of the historic property, and may address the following:

1. Public Interpretation;

2. Documentation consistent with the Level II Standards of the Historic American Building Survey/ Historic American Engineering Record (HABS/HAER);

3. Historical, Architectural or Archaeological Monographs;

4. Rehabilitation of historic buildings in accordance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (36 CFR § 68);

5. Off-site mitigation, including acquisition of property or preservation easements on property, as appropriate, containing threatened resources of comparable significance in

circumstances where there is an imminent need to proceed with construction activity and it is in the public interest;

6. Ethnographic studies;

7. Studies of traditional cultural properties;

8. Relocation of historic properties to sites approved by the SHPO as possessing similar overall character; and

9. Data recovery for archeological properties.

D. Once the consulting parties agree to a treatment plan for the resolution of adverse effects on historic properties, the parties will execute a memorandum of agreement.

E. Should the USACE, SHPO, and/or Indian tribes disagree on the proposed mitigation measures, the USACE shall seek to resolve such objection through consultation in accordance with Stipulation IX of this Agreement.

F. As specified in Section 7(a) of Public Law 86-523, as amended by Public Law 93-291 (16 U.S.C. 469c(a)), the USACE may not incur costs for data recovery activities that exceed one percent of the total amount authorized to be appropriated for the critical restoration feature, unless and until the Assistant Secretary of the Army (Civil Works) has waived that limit and the Secretary of the Interior has concurred in the waiver in accordance with Section 208(3) of Public Law 96-515, as amended (16 U.S.C. 469c-2(3)).

VII. Unanticipated Discoveries and Effects

A. In the event that the USACE discovers a previously unidentified historic property, including archeological sites, human remains, and properties of traditional religious and cultural significance to Indian tribes, during the execution of any of the Undertakings, the USACE immediately shall secure the jobsite and suspend work in the vicinity of the affected resource. The USACE shall immediately notify the SHPO, Indian tribes consistent with tribal protocols, and other consulting parties, as appropriate, should the proposed work adversely affect a previously unidentified historic property or will adversely affect a known historic property in an unanticipated manner. In accordance with Stipulation VI of this Agreement, the USACE, in coordination with the ACHP, SHPO, Indian tribes, and other consulting parties, as appropriate, will develop standard mitigation measures. The USACE will implement the standard

mitigation measures once approved by the ACHP, SHPO, Indian tribes, and consulting parties, as appropriate.

B. In the event that the USACE discovers a previously unidentified burial, including burial sites, human skeletal remains, or burial artifacts, on private or state land during the execution of any of the Undertakings, the USACE will follow procedures established in the Louisiana Unmarked Human Burial Sites Preservation Act (R.S. 8:671-681).

C. In the event that the USACE discovers a previously unidentified burial, including burial sites, human remains or funerary objects, on federal or tribal land during the execution of any of the Undertakings, the USACE will follow procedures established by the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 and the regulations that allow for its implementation (43 CFR § 10) and the Archaeological Resources Protection Act of 1979 (Public Law 96-95; 16 U.S.C. 470aa-mm), as amended, and implementing regulations (32 CFR § 229).

D. The USACE shall insure that all contractors are made aware of the requirements of this Agreement by way of its inclusion with solicitation and award documentation. In the event that a contractor discovers a previously unidentified historic property, the contractor shall immediately notify the USACE, refrain from further project activities within the immediate vicinity of the discovery, and take reasonable efforts to avoid and minimize harm to the historic property. The USACE shall implement additional measures to secure the historic property for safety and security concerns, as appropriate.

E. In the event that previously unidentified direct adverse effects to historic properties are identified following the completion of work within an activity area, any party may provide the USACE with evidence of such effects for a period of twelve (12) months from the completion of the affecting work. The USACE, in consultation with the SHPO, Indian tribes, and ACHP, as appropriate, will review the effect in accordance with the provisions of this Agreement.

F. In the event that previously unidentified direct adverse effects to structural historic properties are identified following the completion of work within an activity area, owners of such affected properties may provide the USACE with evidence of such effects for a period of twelve (12) months from the completion of the affecting work. The USACE, in consultation with the SHPO, Indian tribes, as appropriate, and the ACHP, as appropriate, will review the effect in accordance with the provisions of this Agreement.

G. If the USACE, SHPO, Indian tribes, consulting parties, or member of the public, as appropriate, cannot agree on an appropriate course of action to address the discovery situation, the USACE shall initiate the dispute resolution process set forth in Stipulation IX of this Agreement.

H. If, during performance of any relocations, construction of any improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material, or performance of any operation, maintenance, repair, rehabilitation and replacement (OMRR&R) activities required for a critical restoration feature, the CPRA discovers a previously unidentified historic property, including archeological sites, human remains, and properties of traditional religious and cultural significance to Indian tribes, the CPRA shall immediately notify the USACE, refrain from further project activities within the immediate vicinity of the discovery, and take reasonable efforts to avoid and minimize harm to the historic property. The CPRA, in coordination with the USACE, shall follow the procedures discussed in paragraphs A. through C. of this Stipulation, as applicable. The CPRA shall not proceed with performance of any relocation or construction of any improvement that is related to such a discovery until the USACE provides written notice to the CPRA that it should proceed with such work.

I. The CPRA shall insure that its contractors are made aware of the requirements of this Agreement by way of its inclusion with solicitation and award documentation for activities related to performance of relocations, construction of improvements, or OMRR&R activities required for a critical restoration feature. In the event that a contractor discovers a previously unidentified historic property, the contractor shall immediately notify the CPRA, refrain from further project activities within the immediate vicinity of the discovery, and take reasonable efforts to avoid and minimize harm to the historic property. The CPRA shall implement additional measures to secure the historic property for safety and security concerns, as appropriate.

VIII. Treatment of Human Remains

A. Pursuant to this Agreement, the USACE, in consultation with the SHPO and Indian tribes will develop protocols within ninety (90) days of the execution of this Agreement that take into account all applicable laws and regulations for the treatment of human remains that may be encountered during any ground disturbing activities related to the Undertakings.

B. For human remains that are determined to be Native American, the USACE will develop a subset of the treatment protocols in consultation with the SHPO and Indian tribes.

C. The USACE or the CPRA, as applicable, will implement the approved treatment protocols, in consultation with the SHPO and Indian tribes, in the event human remains are encountered during any ground disturbing activities related to the Undertakings.

IX. Dispute Resolution

A. Except for the resolution of eligibility issues, as set forth in Stipulation IV.C. of this Agreement, should the SHPO, Indian tribes, or member of the public disagree on the implementation of the provisions of this Agreement, they will notify the USACE, who will seek to resolve such objection through consultation.

B. If the dispute cannot be resolved through consultation, the USACE shall forward all documentation relevant to the dispute to the ACHP, including any proposed resolution identified during consultation. Within seven days after receipt of all pertinent documentation, the ACHP may:

1. Provide the USACE with recommendations to take into account in reaching final decision regarding the dispute; or

2. Notify the USACE that it will comment pursuant to 36 CFR § 800.7(c) and provide formal comments within twenty-one (21) days.

C. Any recommendation or comment provided by the ACHP will be understood to pertain only to the subject of the dispute, and the USACE's responsibilities to fulfill all actions that are not subject of the dispute will remain unchanged.

D. If the ACHP does not provide the USACE with recommendations or notification of its intent to provide formal comments within seven (7) days, the USACE may assume that the ACHP does not object to its recommended approach and it will proceed accordingly.

X. Administration and Duration of this Agreement

A. This Agreement will become effective upon the date of execution by the final signatory. The refusal of any party invited to concur in the Agreement will not invalidate the Agreement.

B. This Agreement will remain in effect for fifteen (15) years from the date of execution, unless extended for a five-year period by written agreement negotiated by all signatories by July 2025.

C. The USACE shall provide all signatories with annual Interim Progress Reports, which will be submitted every twelve (12) months from the execution date of this Agreement.

D. The consulting parties to this Agreement shall meet annually, or as needed, to evaluate the effectiveness of this Agreement.

XI. Amendment and Termination

A. Notwithstanding any provision of this Agreement, the signatories may request that it may be amended, whereupon the signatories will consult to consider such amendment. The USACE will facilitate such consultation, including Indian tribes, within thirty (30) days of the request from one of the signatory parties. Any amendment will be in writing and will be signed by the USACE, ACHP, SHPO, and CPRA, and shall be effective on the date of the final signatory.

B. This Agreement may be terminated at the request of any of the signatory parties within thirty (30) days following written notification to all parties. In the event of termination, the USACE shall comply with 36 CFR § 800 on a case by case basis for all activities covered by the Agreement.

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Execution of this Programmatic Agreement and implementation of its terms evidences that the USACE has taken into account the effects of the LCA Plan upon historic properties and has afforded the ACHP an opportunity to comment.

Signatory:

United States Army Corps of Engineers

By: _____ Date: 28 July 2010
Colonel Edward R. Fleming
District Commander
U.S. Army Corps of Engineers, New Orleans District

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Execution of this Programmatic Agreement and implementation of its terms evidences that the USACE has taken into account the effects of the LCA Plan upon historic properties and has afforded the ACHP an opportunity to comment.

Signatory:

Coastal Protection and Restoration Authority of Louisiana

By: _____ Date: 7/27/10
Garret Graves
Chairman
Coastal Protection and Restoration Authority of Louisiana

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Execution of this Programmatic Agreement and implementation of its terms evidences that the USACE has taken into account the effects of the LCA Plan upon historic properties and has afforded the ACHP an opportunity to comment.

Signatory:

Louisiana State Historic Preservation Officer

By: Phil Boggan (by Jennifer Hokan Morris) Date: 7/27/10
Phil Boggan
Deputy Louisiana State Historic Preservation Officer
Louisiana Office of Cultural Development

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Execution of this Programmatic Agreement and implementation of its terms evidences that the USACE has taken into account the effects of the LCA Plan upon historic properties and has afforded the ACHP an opportunity to comment.

Signatory:

Advisory Council on Historic Preservation

By: _____ Date: 7/29/10
John M. Fowler
Executive Director
Advisory Council on Historic Preservation

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Alabama Coushatta Tribe of Texas

By:_____ Date:_____
Carlos Bullock, Tribal Council Chairman

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Mississippi Band of the Choctaw Indians

By:_____ Date:_____
Beasley Denson, Chief

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Caddo Nation of Oklahoma

By:_____ Date:_____
Brenda Shemayme Edwards, Chairperson

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Chitimacha Tribe of Louisiana

By:_____ Date:_____
John Paul Darden, Chairman

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Choctaw Nation of Oklahoma

By:_____ Date:_____
Gregory E. Pyle, Chief

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Coushatta Tribe of Louisiana

By:_____ Date:_____
Kevin Sickey, Chief

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Jena Band of the Choctaw Indians

By:_____ Date:_____
Christine Norris, Principal Chief

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Quapaw Tribe of Oklahoma

By:_____ Date:_____
John Berrey, Chairman

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Seminole Nation of Oklahoma

By:_____ Date:_____
Enoch Kelley Haney, Principal Chief

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Seminole Tribe of Florida

By:_____ Date:_____
Mitchell Cypress, Chairman

Programmatic Agreement
among
the United States Army Corps of Engineers,
the Coastal Protection and Restoration Authority of Louisiana,
the Louisiana State Historic Preservation Officer,
and
the Advisory Council on Historic Preservation,
Regarding the
Louisiana Coastal Area Ecosystem Restoration Plan (LCA Plan)

Concurring Party:

Tunica-Biloxi Tribe of Louisiana

By:_____ Date:_____
Earl J. Barbry Sr., Chairman

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Preserving America's Heritage

July 29, 2010

Ms. Joan M. Exnicios
Chief, New Orleans Environmental Branch
New Orleans District
Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160-0267

REF: Louisiana Coastal Area Ecosystem Restoration Plan
Louisiana

Dear Ms. Exnicios:

The Advisory Council on Historic Preservation (ACHP) has signed the enclosed Programmatic Agreement (PA) for the referenced undertaking. Our signature completes the requirements of Section 106 of the National Historic Preservation Act (NHPA) and the ACHP's regulations at 36 CFR Part 800. As requested we have signed six original signature pages which we will return to you. Please provide us with an original, fully-executed copy of this Agreement, which is being signed in counterparts by the signatories. The original copy of the Agreement will be retained for our files. As discussed, the Corps of Engineers (Corps) should provide an original of the executed PA to each of the signatories and a copy to each concurring party.

We commend the Corps for working closely with the ACHP, and the Louisiana State Historic Preservation Officer, the Coastal Protection and Restoration Authority of Louisiana, interested Indian tribes, and other consulting parties toward resolution of adverse effects for this important environmental restoration project.

If you have any questions or need further assistance, please contact Dr. John Eddins at 202-606-8553, or by email at jeddins@achp.gov.

Sincerely,

Caroline D. Hall
Assistant Director
Federal Property Management Section
Office of Federal Agency Programs

Enclosures

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Volume IV

APPENDIX G:

Response to Public Comments

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FW DEQ WQ DRAFT EIS - LCA - Vol IV.txt
From: Klein, William P Jr MVN [William.P.Klein.Jr@usace.army.mil]
Sent: Thursday, July 08, 2010 2:43 PM
To: Boudreaux, Michelle MVN-Contractor; Hicks, Billy J MVN; Jamie Favorite; Burkel, Jamie M.; John Burns
Subject: FW: DEQ SOV: 100603/1025 USACE DRAFT EIS - LCA - Vol. IV

Please include below email from LDEQ as official comment on the LCA Convent/Blind River Diversion and include in the comment/response appendix.

Thank you,

William P. Klein, Jr., Ed.D.
U.S. Army Corps of Engineers
New Orleans District
P.O. Box 60267
New Orleans, LA 70116
504-862-2540
william.p.klein.jr@usace.army.mil

-----Original Message-----
From: Diane Merritt [mailto:Diane.Merritt@LA.GOV]
Sent: Thursday, July 08, 2010 2:35 PM
To: Klein, William P Jr MVN
Subject: DEQ SOV: 100603/1025 USACE DRAFT EIS - LCA - Vol. IV

July 8, 2010

Joan M. Exnicios, Chief

USACE Environ.Planning Branch

P.O. Box 60267

New Orleans, LA 70160-0267

william.p.klein.jr@usace.army.mil <mailto:william.p.klein.jr@usace.army.mil>

RE:

100603/1025

USACE DRAFT EIS - LCA - Vol. IV

(on disk)

Small Diversion at Convent/Blind Riv.

St. James Parish

Dear Ms. Exnicios:

The Department of Environmental Quality (LDEQ), Offices of Environmental Services and Environmental Compliance have received your request for comments on the above referenced project. Please take any necessary steps to obtain and/or update all necessary approvals and environmental permits regarding this

979

proposed project.

There were no objections based on the information in the document submitted to us. However, the following comments have been included below. Should you encounter a problem during the implementation of this project, please notify LDEQ's Single-Point-of-Contact (SPOC) at (225) 219-3640.

The Office of Environmental Services/Permits Division recommends that you investigate the following requirements that may influence your proposed project:

* If your project results in a discharge to waters of the state, submittal of a Louisiana Pollutant Discharge Elimination System (LPDES) application may be necessary.
* If the project results in a discharge of wastewater to an existing wastewater treatment system, that wastewater treatment system may need to modify its LPDES permit before accepting the additional wastewater.
* LDEQ has stormwater general permits for construction areas equal to or greater than one acre. It is recommended that you contact the LDEQ Water Permit Division at (225) 219-3181 to determine if your proposed improvements require one of these permits.
* All precautions should be observed to control nonpoint source pollution from construction activities.
* If any of the proposed work is located in wetlands or other areas subject to the jurisdiction of the U.S. Army Corps of Engineers, you should contact the Corps directly to inquire about the possible necessity for permits. If a Corps permit is required, part of the application process may involve a water quality certification from LDEQ.
* All precautions should be observed to protect the groundwater of the region.
* Please be advised that water softeners generate wastewaters that may require special limitations depending on local water quality considerations. Therefore if your water system improvements include water softeners, you are advised to contact the LDEQ Water Permits to determine if special water quality-based limitations will be necessary.
* Any renovation or remodeling must comply with LAC 33:XXX.Chapter 28.Lead-Based Paint Activities, LAC 33:III.Chapter 27.Asbestos-Containing Materials in Schools and State Buildings (includes all training and accreditation), and LAC 33:III.5151.Emission Standard for Asbestos for any renovations or demolitions.
* If any solid or hazardous wastes, or soils and/or groundwater contaminated with hazardous constituents are encountered during the project, notification to LDEQ's Single-Point-of-Contact (SPOC) at (225) 219-3640 is required. Additionally, precautions should be taken to protect workers from these hazardous constituents.

Acknowledged. All above requirements and considerations will be recognized and complied with during PED phase and into construction of the project.

Currently, St. James Parish is classified as an attainment parish with the National Ambient Air Quality Standards.

Please forward all future requests to Ms. Diane Hewitt, LDEQ/Performance Management/ P.O. Box 4301, Baton Rouge, LA 70821-4301, and your request will be processed as quickly as possible.

Page 2

086

FW DEQ MQ DRAFT EIS - LCA - Vol IV.txt

If you have any questions, please feel free to contact me at (225) 219-4079 or by email at diane.hewitt@la.gov <mailto:diane.hewitt@la.gov> . Permitting questions should be directed to the Office of Environmental Services at (225) 219-3181.

Sincerely,

Diane Hewitt
Performance Management
LDEQ/Community and Industry Relations
Business and Community Outreach Division
Office of the Secretary
P.O. Box 4301 (602 N. 5th Street)
Baton Rouge, LA 70821-4301
Phone: 225-219-4079
Fax 225-325-8208
E-mail: diane.hewitt@la.gov

Page 3

Louisiana Department of Environmental Quality (LDEQ) comments regarding the Corps of Engineers' draft supplemental environmental impact statement for the LCA-Small Diversion at Convent/Blind River, LA, May 2010

General Comments:

1. LDEQ supports the Corps' efforts to restore the wetland habitat of the Maurepas Swamp and its surrounding areas. Overall, the project will be beneficial to the area.

2. LDEQ is aware that the LCA is investigating other projects in the area. One of these projects, Amite River Diversion Canal Modification, is related to the Blind River project. The Amite River Diversion Canal flows into the Blind River. In addition, as part of LDEQ's Dissolved Oxygen TMDL for the Lower Amite River, LDEQ has recommended that the weir on the Amite River Diversion Canal be repaired to establish more flow down the Lower Amite River. This should result in improved water quality in the Lower Amite River. In addition, repairing the weir may provide a route to input nutrients along the northern rim of the Maurepas Swamp. The cumulative effects of the two projects proposed by the Corps and the repair of the weir should be evaluated. LDEQ may be able to provide assistance with the evaluation or projection of water quality produced as a result of these projects.

← Acknowledged.

Bobby Jindal
Governor

State of Louisiana
Department of Wildlife & Fisheries

Robert J. Barham
Secretary

July 14, 2010

Gregory J. Ducote, Administrator
Louisiana Department of Natural Resources
Coastal Management Division
P.O. Box 44487
Baton Rouge, LA 70804-4487

RE: *Consistency Number: C20100163*
Applicant: Corps of Engineers - New Orleans District
Notice Date: June 7, 2010

Dear Mr. Ducote:

The professional staff of the Louisiana Department of Wildlife and Fisheries (LDWF) has reviewed the notice referenced above. The following recommendations have been provided by the appropriate biologist(s):

Ecological Studies:
This project is located in the vicinity of the Blind River, a Louisiana designated Natural and Scenic River. The applicant must obtain authorization from the Louisiana Department of Wildlife and Fisheries, Scenic Rivers Program prior to initiating any of the proposed activities within or adjacent to the banks of the Blind River. Scenic Rivers Coordinator Keith Cascio can be contacted at 318-343-4045.

Portions of the proposed activity are within Maurepas Swamp Wildlife Management Area. No activities shall occur on any LDWF Wildlife Management Area or Refuge without obtaining a Special Use Permit from LDWF. The applicant shall contact Vaughan McDonald at (504) 284-5267 for more information.

Ecological Studies and Office of Fisheries have been involved with several planning and development team meetings concerning this project and generally, we support its implementation. In regard to project specifics, we offer the following:

- Ecological Studies believes that operational flexibility should be incorporated into the operation plan and that the plan be modified as needed in response to monitoring and recommendations of regulatory and resource agencies.

Both the feasibility level OMRR&R and monitoring and adaptive management plans will be revised in the preconstruction, engineering, and design (PED) phase. The monitoring and adaptive management plan revision will outline how each monitored variable can direct an adaptive management action. In addition, the monitoring and adaptive management plan revision will propose more concrete and formalized communication mechanisms for the exchange of information to inform operational decisions. Also, the flexibility in the operations and control plan allow for delivering the appropriate volumes of water necessary to restore the hydrologic cycles for a healthy swamp and will include a dry out period every 3-5 years.

P.O. BOX 98000 - BATON ROUGE, LOUISIANA 70898-9000 - PHONE (225) 765-2800
AN EQUAL OPPORTUNITY EMPLOYER

Page 2
Application Number: C20100165
July 14, 2010

- The operation plan should allow for a drawdown or dry out period every 3-5 years to promote woody species regeneration. This period should coincide with naturally dries years and lower ambient water levels (as they are identified) to maximize the likelihood of a successful draw down.
- Office of Fisheries recommends that the control structures in the swamp be designed to allow for fish passage.
- Within current reports, we have not seen mention of the potential to introduce invasive aquatic species from the Mississippi River. This is less of an issue since the Bonnet Carre Spillway would also provide a way of introducing species, but the pathway should be noted.

The Louisiana Department of Wildlife and Fisheries appreciates the opportunity to review and provide recommendations to you regarding this proposed activity. Please do not hesitate to contact LDWF Permits Coordinator Dave Butler at 225-763-3595 should you need further assistance.

Sincerely,

Kyle F. Balkum
Biologist Program Manager

mw/rb

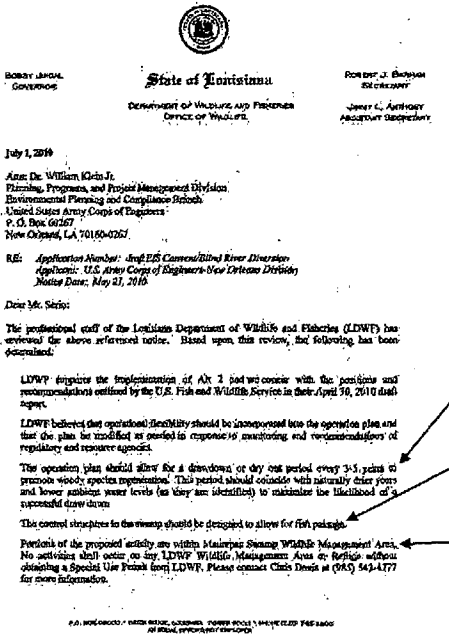
c: Matthew Weigel, Biologist
Rob Bourgeois, Biologist
Keith Cascio, Scenic Rivers Coordinator
Vaughan McDonald, Biologist

Both the feasibility level OMRR&R and monitoring and adaptive management plans will be revised in the preconstruction, engineering, and design (PED) phase. The monitoring and adaptive management plan revision will outline how each monitored variable can direct an adaptive management action. In addition, the monitoring and adaptive management plan revision will propose more concrete and formalized communication mechanisms for the exchange of information to inform operational decisions. Also, the flexibility in the operations and control plan allow for delivering the appropriate volumes of water necessary to restore the hydrologic cycles for a healthy swamp and will include a dry out period every 3-5 years.

The fish passage will be included in the final design. The exact design of the control structures will be part of the value engineering process in both preliminary and final design. The function of the control structures is to limit short circuiting to the Blind River, but some direct flows will be allowed to keep the canals supplied with fresh water and to allow aquatic life to pass freely throughout the system as it currently exists.

The plan currently has a bar screen structure in the program to stop large debris and large fish and aquatic life from entering the diversion canal. There will be opportunity for smaller aquatic life to move from the Mississippi River into the Blind River Lake Maurepas area. Since there have been historic overflows from the Mississippi river to the project area the species in both fresh water areas should be similar. The most recent overflow of Mississippi river water was through the Nita Crevasse which apparently occurred in March 1890. The pathway will be noted in the report.

984



BOBBY JINDAL
GOVERNOR

State of Louisiana

DEPARTMENT OF WILDLIFE AND FISHERIES
OFFICE OF WILDLIFE

ROBERT J. BARHAM
SECRETARY

JAMES C. ANTHONY
ASSISTANT SECRETARY

July 1, 2010

Attn: Dr. William Klein Jr.
Planning, Programs, and Project Management Division
Environmental Planning and Compliance Branch
United States Army Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160-0267

RE: *Application Number: draft EIS Convent/Blind River Diversion*
Applicant: U.S. Army Corps of Engineers-New Orleans Division
Notice Date: May 21, 2010

Dear Mr. Serio:

The professional staff of the Louisiana Department of Wildlife and Fisheries (LDWF) has reviewed the above referenced notice. Based upon this review, the following has been determined:

LDWF supports the implementation of Alt 2 and we concur with the positions and recommendations outlined by the U.S. Fish and Wildlife Service in their April 30, 2010 draft report.

LDWF believes that operational flexibility should be incorporated into the operation plan and that the plan be modified as needed in response to monitoring and recommendations of regulatory and resource agencies.

The operation plan should allow for a drawdown or dry out period every 3-5 years to promote woody species regeneration. This period should coincide with naturally drier years and lower outflow years levels (as they are identified) to minimize the likelihood of a successful draw down.

The control structures in the swamp should be designed to allow for fish passage.

Portions of the proposed activity are within Maurepas Swamp Wildlife Management Area. No activities shall occur on any LDWF Wildlife Management Area or Refuge without obtaining a Special Use Permit from LDWF. Please contact Chris Davis at (985) 543-4777 for more information.

P.O. BOX 98000 • BATON ROUGE, LOUISIANA 70898-9000 PHONE (225) 765-2800
AN EQUAL OPPORTUNITY EMPLOYER

Both the feasibility level OMRR&R and monitoring and adaptive management plans will be revised in the preconstruction, engineering, and design (PED) phase. The monitoring and adaptive management plan revision will outline how each monitored variable can direct an adaptive management action. In addition, the monitoring and adaptive management plan revision will propose more concrete and formalized communication mechanisms for the exchange of information to inform operational decisions. Also, the flexibility in the operations and control plan allow for delivering the appropriate volumes of water necessary to restore the hydrologic cycles for a healthy swamp and will include a dry out period every 3-5 years.

The fish passage will be included in the final design. The exact design of the control structures will be part of the value engineering process in both preliminary and final design. The function of the control structures is to limit short circuiting to the Blind River, but some direct flows will be allowed to keep the canals supplied with fresh water and to allow aquatic life to pass freely throughout the system as it currently exists.

Acknowledged. Prior to conducting any additional activities for the project and within the WMA, a Special Use Permit will be requested.

985

This project is located in the vicinity of the Blind River, a Louisiana designated Natural and Scenic River. The applicant must obtain authorization from the Louisiana Department of Wildlife and Fisheries, Scenic Rivers Program, prior to initiating any of the proposed activities within or adjacent to the banks of the Blind River. Scenic Rivers Coordinator, Keith Caskie can be contacted at 318-343-4015.

The Louisiana Department of Wildlife and Fisheries appreciates the opportunity to review and provide recommendations to you regarding this proposed activity. Please do not hesitate to contact Habitat Section biologist Matthew Weigel at 225-763-3587 should you need further assistance.

Sincerely,

Kyle F. Balkum
Biologist Program Manager

KFB

cc Matthew Weigel, Biologist
Chris Davis, Biologist
Keith Caskie, Scenic Rivers Coordinator
ERA, Marine & Wetlands Section
USFWS Ecological Services

Acknowledged. Prior to conducting any additional activities for the project and within the WMA, authorization from the Scenic Rivers Program will be requested.

986



July 6, 2010

Colonel Alvin Lee
Commander
New Orleans District U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160
Re: LCA Draft Feasibility Reports and Draft Environmental Impact Statements

Dear Colonel Lee:

Thank you for the opportunity to review and comment on the LCA Draft Feasibility Reports and Draft Environmental Impact Statements. Section 7006(e)(3) of the 2007 WRDA identifies six near-term restoration projects that Congress has authorized for construction subject to, among other things, completion of feasibility studies and a Chief's Report before December 31, 2010. The draft Feasibility Report covers five of those six projects:

? Medium Diversion at White Ditch
? Convey Atchafalaya to Northern Terrebonne Marsh/Multipurpose Operation of the Houma Navigation Canal (HNC) Lock (two projects merged)
? Small Diversion at Convent/Blind River
? Amite River Diversion Canal (ARDC) Modification

Although we were disappointed that the initial deadline of December 31, 2008 was missed, we commend the U.S. Army Corps of Engineers and the State of Louisiana in working diligently to meet the December 31, 2010 as directed by WRDA. It is imperative that these projects are constructed as quickly as possible and our organizations are available to assist to ensure the urgency of these projects is understood in Washington, D.C. and in the State.

We understand the need for additional analysis and the increasing uncertainty of the Terrebonne Basin Barrier Shoreline Project considering the Deepwater Horizon oil spill. However, the Deepwater Horizon oil spill has also shown the urgent need to restore and maintain our barrier island chains to protect the interior marshes from multiple threats, including massive oil spills and hurricanes. We request the USACE to distribute an updated timeline for completion to the public and that timeline ensures that this feasibility report is completed at the earliest possible time with the understanding that some details may have to be modified during the engineering, design and construction phase. We request that the Chief's Report also address an extended deadline for the

Terrebonne Basin Barrier Shoreline project that will not be meeting the required WRDA deadline due to these extraordinary circumstances.

We also applaud the USACE and the State of Louisiana for incorporating Monitoring and Adaptive Management Plans at the feasibility stage of project planning. We support the use of project funding to conduct monitoring and expand research and development on these restoration projects to provide lessons learned and flexibility in operations and management. We offer our assistance as the Monitoring and Adaptive Management Plans continue to develop.

Two of the four projects (ARDC Modifications and Atchafalaya to Terrebonne/HNC Lock) were restricted from providing large scale benefits due to the cost constraints authorized in WRDA 2007. The USACE and State of Louisiana boldly expanded the Medium Diversion at White Ditch beyond its cost authorization to adequately address the sustainability of the study area. We commend the USACE and State for this action. We would have liked to see the same initiative to address the concerns of the Maurepas and Terrebonne Basins. Many large-scale restoration measures were considered in these studies, but dismissed due to costs. The ARDC Modification Project only addressed one of the four identified degraded hydrologic units and the Atchafalaya to Terrebonne/HNC Lock Project only reduces the land loss rate by 10 percent over the 50 year period. Much larger scale restoration in these basins is needed. In these instances, the project did not truly meet the objectives of the project in the entire study area. A phased approach to project implementation should be provided that evaluates all needed restoration measures to meet the full objectives of the study without any cost constraints, identifies the critical first steps, and identifies phased project implementation based on available funding.

It is imperative that the USACE complete the Feasibility Reports and the Chief's Report for these LCA projects before the end of the year. Specific comments on each project are enclosed. We believe these comments could be addressed during the engineering, design, construction or adaptive management phases of the projects and will not delay the process.

The undersigned groups welcome the opportunity to discuss our recommendations at any time.

Sincerely,

Coalition to Restore Coastal Louisiana
Steven Peyronnin Natalie Snider
Executive Director Science Director

Lake Pontchartrain Basin Foundation
John Lopez, Ph.D.
Director of Coastal Sustainability

Environmental Defense
Jim Tripp Angelina Freeman, Ph.D.
General Counsel Coastal Scientist

National Audubon Society
G. Paul Kemp, Ph.D.
Vice President, Gulf Coast Initiative

National Wildlife Federation
Karla Raettig
National Campaign Director

cc: Garret Graves, Coastal Protection and Restoration Authority
Steve Mathies, Louisiana Office of Coastal Protection and Restoration
Timothy Axtman, U.S. Army Corps of Engineers



Medium Diversion at White Ditch
LCA Draft Feasibility Report

A key component to restoration of Louisiana's coastal landscape is to reconnect the Mississippi River to the wetlands by mimicking natural processes that use the power of the Mississippi River to build land and maintain ecological integrity including habitats, communities, and storm buffering capacity. We strongly support the Medium Diversion at White Ditch and its objectives to provide freshwater, nutrients and sediments designed to restore degraded habitat and sustain a larger coastal ecosystem to support and protect the environment, economy, and culture of southern Louisiana.

Much has been learned recently about the design and operation of diversions in the Lower Mississippi River for coastal restoration, including the advantages of using pulsing as an operational strategy to maximize sediment capture (Allison and Meselhe, 2010). With rising sea levels and predictions for increased storm frequency/intensity; it is imperative that restoration projects are designed to maximize potential for offsetting projected land loss. Therefore, we commend and support the Tentatively Selected Plan (TSP) incorporating pulsing at 35,000 cfs (cubic feet per second) at high river flows to maximize sediment capture in the planning and operation of the diversion. The minimal amount of shoaling in the river expected from operation of the diversion in a pulsed fashion (1,000 cfs diversion that is pulsed at 35,000 cfs at the beginning of spring flood when suspended sediment concentrations are significantly elevated) is an additional advantage to this operational regime. Designing flexibility into this diversion project by providing pulsing capacity allows adaptation to unforeseen circumstances, as demonstrated by the Deepwater Horizon oil spill where river diversions were used to keep oil at bay. We applaud the Corps for evaluating a pulsed diversion in the analysis, and agree that the pulsed operation of the TSP maintains the medium diversion category authorization.

The sediment concentrations in the Mississippi River can vary significantly according to location, and a thorough analysis of site specific data and modeling would improve prediction of sediment efficiency and land building potential relative to diversion locations. Extensive sediment data collection and modeling is being undertaken in the White Ditch reach of the river in support of the Myrtle Grove Land Building Diversion. Using this type of data and modeling results in the benefits and drawbacks of location selection would provide a more robust analysis. We suggest incorporation of this additional data in Planning, Engineering, and Design.

The conveyance channel for the TSP accounts for almost half the total cost for the project. We agree that amending language from House/Senate subcommittees that

adjusts the project as authorized in WRDA 2007 for the increase in construction cost is warranted. However, we recommend reevaluating the conveyance channel and whether natural channel formation can be effectively utilized allowing the engineering to be scaled back (thereby reducing cost) to be investigated in Planning, Engineering, and Design. Natural channel formation could be incorporated into the Monitoring and Adaptive Management Plan and funding for channel modifications could be acquired on an as needed basis as a part of Operations and Maintenance.

References

Allison, M.A. and Meselhe, E.A., 2010. The use of large water and sediment diversions in the lower Mississippi River (Louisiana) for coastal restoration. Journal of Hydrology 387, 346-360.



Convey Atchafalaya to Northern Terrebonne Marsh/
Multipurpose Operation of the Houma Navigation Canal (HNC) Lock
LCA Draft Feasibility Report

In contrast to the robustness of the Medium Diversion at White Ditch project, the narrowing of ambition in the design of the Convey Atchafalaya to Northern Terrebonne Marsh/Multipurpose Operation of the Houma Navigation Canal (HNC) Lock is striking.
As stated in the Draft Feasibility Report:
The purpose of the project is to reverse the current trend of marsh degradation in the project area resulting from subsidence, erosion, saltwater intrusion, and lack of sediment and nutrient deposition. The project proposes to accomplish this by utilizing fresh water, sediments, and nutrients from the Atchafalaya River and the Gulf Intracoastal Waterway (GIWW).

The report goes further to define the objectives of the project to include:

? Prevent, reduce, and/or reverse future wetland loss
? Achieve and maintain characteristics of sustainable marsh hydrology
? Reduce salinity levels in project area
? Increase sediment and nutrient load to surrounding wetlands
? Increase residence time of fresh water
? Sustain productive fish and wildlife habitat

We do not feel that the alternatives developed for this project meet the objectives of the project. Alternative 2 was selected as the Tentatively Selected Plan. However, the TSP will reduce land loss rates by a mere 10 percent over the 50-year project period and this benefit will be lost with intermediate or high relative sea level rise. The Draft Feasibility Report states that modeling of Alternative 3 under Intermediate RSLR would reduce the effectiveness of the project by 87 percent and effectiveness of the other alternatives, including the TSP, would be similar. None of the alternatives would prevent marsh collapse at the high RSLR rate.

Although none of the alternatives meet the full objectives of the project, there are benefits to be realized from the project. Based on the description of the eight alternatives available, we feel that Alternative 3 has additional benefits over Alternative 2 and should be selected as the Tentatively Selected Plan (TSP). Alternative 3 includes all the measures in Alternative 2 plus two additional measures in the West -- Bayou Penchant Area. To increase flows from the Atchafalaya River, water will be moved from Bayou Shaffer to the Avoca Island Cutoff/Bayou Chene. This will be accomplished by creating an opening through the Avoca Island levee and installing a large gated diversion structure

(WS4) in the opening. The remaining measure (WC2) would place stone along the shore of Bayou Chene and Avoca Island Cutoff to protect from increased flows. Alternative 3 would prevent 10,308 acres of emergent marsh soils from being converted to open water over the 50-year period of analysis and would generate 3,325 AAHUs.

Alternative 2, the TSP, does not make any change to the Avoca Island Levee, one of the root causes for problems in this area that this project is designed to address. The northern and central Terrebonne Basin is in dire need to additional freshwater and sediment inputs. While even Alternatives 3 would provide only modest amounts of water and sediment into this deteriorating basin, they would represent a net addition of water and sediment above current levels. We would therefore urge further consideration of a gate diversion structure in a new Avoca Island levee opening, a structure that would return the hydrology of this part of the coast more to the distribution of flows that existing prior to construction of the levee.



Small Diversion at Convent/Blind River
LCA Draft Feasibility Report

A key component to restoration of Louisiana's coastal landscape is to reconnect the Mississippi River to the wetlands by mimicking natural processing that use the power of the Mississippi River to build land and maintain ecological integrity including habitats, communities, and storm buffering capacity. We strongly support the Small Diversion at Convent/Blind River and its objectives to provide freshwater, nutrients and sediments designed to restore and sustain degraded forest ecosystem to support and protect the environment, economy, and culture of southern Louisiana.

We support the selection of Alternative 2, a 3,000-cfs gated culvert diversion structure at Romeville, Louisiana, as the TSP for the Small Diversion at Convent/Blind River. Alternative 2 is also the NER Plan. Although we typically support larger flow rates, we understand the constraints of the receiving area and the need to provide both wet and dry periods for natural regeneration of the forest. We also support the robust monitoring plan to be utilized to adaptively manage the structure operations including optimal pulsing periods and various flow rate impacts.

We are concerned about the requirements for Operations, Maintenance, Repair, Rehabilitation and Replacement (OMRR&R). The Feasibility Report estimates that the total annual cost will be $2,754,000. Over the 50 year lifetime of the project, that equates to $137,700,000 in OMRR&R. Most of this cost is associated with dredging in the Transmission Canal ($2,700,000 per year). There was no discussion of alternatives to dredging, such as modification to the canal to limit sedimentation. Although the material will be used beneficially and "discharged into the swamp in a controlled manner to supplement land-building", there is no detailed discussion on how this will be accomplished.

In addition, the deposition of 150,000 cubic yards of material annually appears to be an estimate based on multiple assumptions. With the uncertainty involved, the Monitoring and Adaptive Management Plan should monitor impacts to the Transmission Canal and recommend dredging on an as needed basis. The adaptive management plan should also evaluate structure operation and pulsing that maximizes impacts and minimizes dredging requirements.

Lastly, Appendix L: Engineering Appendix states that material dredged during the construction of the Transmission Canal can be sold as excess spoil by the contractor or used to widen/raise the adjacent berm. There appears to be no discussion of alternatives to use the material beneficially.

Estimates for OMRR&R were based on the preliminary design for a feasibility-level study. Additional considerations will be given in the PED phase for the reduction of OMRR&R associated costs. Adaptive management measures over the life of the project also are expected to contribute to cost-reducing practices to minimize these costs.

Concur. Language below on flexibility was added to section 7.2 of Monitoring and Adaptive Management Plan: "Some potential adaptive management actions for this project may include modifying the operation of the diversion structure or modifying operations of outfall management features and to allow operational flexibility, such as pulsing, based on monitoring results. The monitoring and assessment teams should continue to evaluate operations to maximize benefits and minimize dredging requirements.

Use of the dredged material will be a function of its suitability for various purposes, such as berm building, or distribution in the swamp and it is intended that all dredged material will be considered for beneficial use first, prior to other considerations and in accordance with Coastal Zone Consistency Determination; however, in the event the dredged material is not suitable for beneficial use in the immediate area of the project study area, it may be sold by the contractor.

694



Amite River Diversion Canal Modifications
LCA Draft Feasibility Report

The study area for the Amite River Diversion Canal Modifications Project is within one of the largest remaining tracts of coastal freshwater swamps in Louisiana. Some of the study area is degrading to marsh or open water. The continued degradation of these areas will lead to loss of ecological function, storm surge protection values, and a unique habitat. We strongly support the Amite River Diversion Canal Modifications and its objectives to provide freshwater, nutrients and sediments into these degraded forest ecosystems to support and protect the environment, economy, and culture of southern Louisiana.

Alternatives
The Amite River Diversion Canal Modification is the only project included in the Draft Feasibility Reports where the National Ecosystem Restoration (NER) Plan, Alternative 39, was not selected as the Tentatively Selected Plan (TSP). Alterative 33 was ranked as the 4th best performing plan but was selected as the TSP due to cost constraints under the current WRDA 2007 authorization. However, the acreage of benefits for Alternative 39 provides double the benefits of the TSP over the 50 year study period and impacts all of the critical, degrading hydrologic units identified within the study.

Although the TSP, Alternative 33, meets the objectives of the study, it only meets those objectives in the most critical hydrologic unit, NE-2. The other three degraded hydrologic units (NE-1, SE-1 and SE-2) are also in critical need for hydrologic restoration and the TSP does not meet the project objectives in these units of the study area. We must keep in mind that these areas will continue to degrade, increasing the difficulty and cost of restoring these areas in the future. The maximum cost allowance in WRDA 2007 is $10,760,000 and the NER Plan total cost is estimated at $13,600,000. The difference of $2,840,000 is a small cost difference in order to double the acres benefited from this project and restore hydrologic function to all four critical hydrologic units.

The Chiefs Report should acknowledge that the environmentally-preferred and cost-effective alternative was not selected due to authorization constraints. Additional authorization should be sought to authorize the NER Plan for completion under the same Feasibility Study and Environmental Impact Statement.

We fully support the State of Louisiana's position on this project:

CPRA supports the NER plan (Alternative 39) since this plan includes all of the most critical areas within the Maurepas Swamp basin, establishes the greatest amount of hydrologic connectivity of all of the alternatives, is cost-effective while providing the most benefits, and is a best-buy plan. However, due to authorized cost limitations in WRDA 2007, CPRA supports Alternative 33 as the TSP. CPRA believes the project warrants additional Congressional authorization to increase funding and allow the implementation of the NER plan (Alternative 39) to fully address the Maurepas Swamp's ecosystem needs identified in this report.

Monitoring and Adaptive Management Plan
We certainly understand the need to incorporate adaptive management into the LCA projects. However, the Feasibility Report states that there are minimal active adaptive management opportunities for the Amite River Diversion Canal project and that the lessons learned would not likely apply to other coastal Louisiana restoration projects. The Monitoring and Adaptive Management Plan states that the Amite River Diversion Canal project will not be adaptively managed.

The Feasibility Study analyzed the need for restoration throughout the study area and identified four hydrologic units in a degraded state. Hydrologic restoration will only occur in the NS-2, however it is still imperative to understand the impacts of this decision on the other degrading hydrologic units. Although the Monitoring and Adaptive Management Plan, includes the monitoring objectives for the entire study area, which includes the four most critical hydrologic units, the monitoring procedures are described for within the project area, which only includes one of the critical units, NE-2. Thus, it is unclear if the Monitoring and Adaptive Management Plan intends to monitor ecological variables in the entire study area or just the project area.

It is our recommendation that the Monitoring and Adaptive Management Plan collect monitoring data on the entire study area, or at least the four degraded hydrologic units, to not only understand the outcomes of the project construction but to also understand the outcomes of project decision-making.

We are also concerned with the cost estimates associated with Alternative 33, specifically the costs to monitor the project outcomes ($2,971,200). This cost is nearly 40 percent of the total project cost and we assume will only cover monitoring within the project construction area. For the NER Plan, Alternative 39, monitoring is only 26.9 percent of the total project cost.

Although monitoring and research is one of the most important aspects of project performance and future planning, and those costs should be incorporated into the total project costs, we should be very aware of the need to balance monitoring and the overall project costs. In addition, these monitoring costs would be more reasonable if monitoring was being conducted on the entire study area instead of just one of the hydrologic units.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue, South
St. Petersburg, Florida 33701

June 18, 2010

FFER4/MM

727/551-5608

Mr. Jon Porthos, Chief
Environmental Planning and Compliance Branch
New Orleans District, U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Porthos:

Acknowledge this letter as NMFS is preparing comments

NOAA's National Marine Fisheries Service (NMFS) has reviewed the four public notices dated May 21, 2010, pertaining to the Louisiana Coastal Area – Ecosystem Restoration Projects. The 4 public notices are variously titled:

1. Amite River Diversion Canal Modification Project, Livingston and Ascension Parishes, Louisiana.
2. Small Diversion at Convent/Blind River, St. James Parish, Louisiana.
3. Medium Diversion at White Ditch, Plaquemines Parish, Louisiana.
4. Central Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock

NMFS is presently reviewing Supplemental Environmental Impact Statements for each of the above identified projects. While we have significant recommendations pertaining to needed revisions to these documents, we do not expect to object to authorization or implementation of any of the above identified projects. As such, NMFS has no comments to provide on the public notices for any of the projects identified above.

We appreciate the opportunity to review and comment on these projects.

Sincerely,

for

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc:
FWS, Lafayette, Walther
EPA, Dallas, Mack
LA DNR, Castellanos, Nassar
F/SER32, Swafford
File

997

SEMINOLE TRIBE OF FLORIDA
TRIBAL HISTORIC PRESERVATION OFFICE

Dr. William Klein Jr.
U.S. Army Corps of Engineers
Planning, Programs, and Project Management Division
Environmental Planning and Compliance Branch
CEMVN-PM-ES
P.O. Box 60267
New Orleans, LA 70160-0267

THPO#: 006201

June 22, 2010

Subject: LCA Convent Blind River Diversion, Louisiana

Dear Mr. Klein,

The Seminole Tribe of Florida Tribal Historic Preservation Office (STOF-THPO) has received the New Orleans District Corps of Engineers' project notification for the above-referenced project. Due to the fact that the project area is within the geographic area considered by the Seminole Tribe of Florida to be ancestral, aboriginal, or ceded (NHPA 1966, Section 01, and 36 CFR, Section 800.2), the STOF-THPO would like to request a copy of the Environmental Impact Statement for review prior to making any further comment. We thank you for the notification of this proposed project. Please reference *THPO-006201* in any future documentation about this project.

Sincerely,

Direct routine inquiries to:

Willard Steele,
Tribal Historic Preservation Officer
Seminole Tribe of Florida

Anne Mahrer
Compliance Review Supervisor
annemahrer@semtribe.com

No response required other than to acknowledge letter and send them a copy of the report (USACE doing this)

866

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701

July 1, 2010 F/SER46:KC/jk
225/389-0508

Ms. Joan M. Exnicios, Chief
Environmental Planning and Compliance Branch
Planning, Programs, and Management Division
New Orleans District, U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Ms. Ehnicios:

NOAA's National Marine Fisheries Service (NMFS) has reviewed the Draft Integrated Feasibility Study and Supplemental Environmental Impact Statement for the Louisiana Coastal Area Small Diversion at Convent/Blind River, in St. James Parish, Louisiana. The document was transmitted for our review by your letter dated May 21, 2010. Your letter indicates that submittal of the document to NMFS initiates essential fish habitat consultation as required by provisions of the Magnuson-Stevens Fishery Conservation and Management Act. It should be noted that NMFS has agreed to serve as a cooperating agency on this project under provisions of the National Environmental Policy Act.

The overall study area is located in the vicinity of Romeville, Louisiana. The tentatively selected plan (Alternative 2) calls for construction of a water diversion system, near Romeville, with the capacity to divert 3,000 cubic feet per second of Mississippi River water into Maurepas Swamp to facilitate maintenance and rebuilding of the swamp's ecosystem. Specific components of the project include a gated culvert system and transfer canal, restoration and improvement of 160 existing berm cuts, addition of 10 new 300-foot-wide berm cuts, construction of up to six water control structures at strategic locations in the swamp, and addition of three new culverts under U.S. Highway 61. The tentatively selected plan is estimated to improve and protect 21,369 acres of bald cypress-tupelo swamp projected to be lost over the 50-year period of analysis, including: 1) 3,300 acres of bald cypress-tupelo swamp that would convert to marsh in 20 to 30 years; 2) 7,900 acres of bald cypress-tupelo swamp that would convert to marsh in 30 to 50 years; and 3) 10,140 acres of bald cypress-tupelo swamp that would convert to marsh in more than 50 years. The project would negatively impact 59 acres of forested wetland and is estimated to have a net value of 6,421 Average Annual Habitat Units over the 50-year period of analysis.

The enclosed comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) and 600.920 of the Magnuson-Stevens Fishery Conservation and Management Act.

Related correspondence should be directed to the attention of Mr. Richard Hartman at the NMFS Southeast Region, Habitat Conservation Division office at: c/o LSU, Baton Rouge, Louisiana 70803-7535. He may be contacted by telephone at (225) 389-0508, ext. 203 or by e-mail at richard.hartman@noaa.gov. The NMFS Protected Resources Division is responsible for issues pertaining to threatened and endangered species and marine mammals. The contact person for that Division is Mr. David Bernhart. He may be contacted at the letterhead address, by telephone at (727) 824-5312, or by e-mail at david.bernhart@noaa.gov.

Sincerely,

Miles M. Croom

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

Enclosure

cc:
FWS, Lafayette, Walther
EPA, Dallas, Ettinger
LA DNR, Consistency, Duffy
F/SER46, Swafford
F/SER4, Dale
NOAA PPL Reid
Files

1000

NOAA's National Marine Fisheries Service (NMFS) Comments on the Draft Supplemental Environmental Impact Statement (SEIS) for the Louisiana Coastal Area (LCA)
Small Diversion at Convent/Blind River, St. James Parish, Louisiana
Authorized under the 2007 Water Resources Development Act

Essential Fish Habitat (EFH) Consultation

Based on our review of the SEIS, NMFS has determined the document and related coordination with the NMFS fulfills consultation requirements contained in section 600.920 of the essential fish habitat (EFH) rules and regulations of the Magnuson-Stevens Fishery Conservation and Management Act.

According to the SEIS, Lake Maurepas, which adjoins the project area, is designated EFH for red drum (*Sciaenops ocellatus*) and white shrimp (*Litopenaeus setiferus*). Although Lake Maurepas is technically located outside of the study area, the SEIS notes that some shift and possible decrease in "optimal habitat" for red drum and white shrimp is possible with the tentatively selected plan. The SEIS indicates the level of change and adverse impact, if any, to EFH would be minor; while considerable benefit to EFH is possible since ongoing conversion of wetlands to open water would be reduced. Best management practices, environmental monitoring, and adaptive management would be implemented with the preferred plan.

Based on the preceding, NMFS has no EFH conservation recommendations to offer at this time. Provided that the project is completed and operated as proposed, no further consultation is required.

General comments

The SEIS for the proposed action is generally well written and sufficiently describes the affected environment and environmental impacts. The information presented supports the determination that the selected plan is environmentally acceptable and would promote the long-term recovery and health of one of Louisiana's largest tracts of freshwater swamp and a major ecological component of the Lake Pontchartrain Basin.

Specific comments

SECTION 1.0 STUDY INFORMATION
1.5 Prior Reports and Existing Projects
1.5.2 Existing Water Projects
1.5.3.3 Coastal Restoration Projects

Page 1-15, lines 37-42. According to this section, the LCA Small Diversion at Hope Canal consists of diverting approximately 1,500 cubic feet per second from the

This information is available, but similar to the Blind River project the exact diversion flow rates for the Hope Canal project are open to adaptive management and the flow will vary depending on natural conditions. The most current report has a flow rate that varies from 1500 to 2000 cubic feet per second. Language from the Hope Canal report on diversion strategy, if available, will be included in this report.

1001

Mississippi River into the Hope Canal at Carville, Louisiana. Information is needed concerning the duration and seasonal timing of the diversion period.

SECTION 3.0 ALTERNATIVES
3.3 Preliminary Alternatives Plans
3.3.1 Development of Preliminary Alternative Plans
CB-6 Obtain Total Maximum Daily Load (TMDL) waiver for diversion into Blind River

Page 3-27, lines 36-39 According to this section, the overall project has an extensive monitoring plan and includes costs for adaptive management "to assure that the overall water quality in the Blind River is not degraded." Also, as noted in section 3.7.7 (page 3-104, line 28) water quality impairment is a potential risk endpoint of the project. NMFS recommends that both the final SEIS and the Monitoring and Adaptive Management Plan (MAMP) (Appendix I) clearly state that water quality in Blind River and Lake Maurepas will be monitored and that management measures will be implemented when needed to remedy project-related water quality degradation.

Also according to this section: "The State agencies will work together to monitor the diversion operation to assist with the overall environmental improvement of the Blind River." This section should be modified to note that federal resource agencies, including the NMFS and U.S. Fish and Wildlife Service (FWS), would be consulted with regard to environmental monitoring and adaptive management measures needed to protect and restore fish and wildlife resources and habitat, including EFH in Lake Maurepas.

3.7 Plan Selection – Tentatively Selected Plan
3.7.3 Components

Page 3-95, lines 12-17 NMFS recommends the description for the control structures in the selected plan include a map of the project area illustrating the expected locations of the various features including the control structures. NMFS recommends the map be accompanied by a diagram depicted the design plans and specifications of the control structures, as well as a detailed operational scheme.

3.7.6 Operations and Maintenance Considerations

Page 3-99, lines 15-33 NMFS understands the need to provide access to the maintenance canal; however, the final SEIS should address the possibility that mowing be limited to one side of the canal and shrubs and trees be allowed to grow on the unmowed bank. Establishment of trees along one side of the canal would reduce maintenance and disturbance, lessen water temperature increases in summer, and provide cover for wildlife.

Page 3-100, lines 24-25 The diversion flow period (six to nine months per year) should be identified and discussed, as appropriate, throughout the final SEIS. Currently, the diversion flow period is not mentioned elsewhere in the document.

The Monitoring and Adaptive Management Plan does clearly state that stage, velocity, turbidity, dissolved oxygen, salinity, nutrients, and TSS measurements will be conducted at 5 locations on Blind River. During PED the Adaptive management and monitoring plan will be revised based on the final project designs. At this time the water quality elements will be revisited and revised as necessary in coordination with agencies to ensure that the appropriate level and location of monitoring and adaptive management actions are in place.

Section 1.3 of Appendix I states the intention of the USACE to engage NOAA/NMFS and other federal resource agencies as participants in the adaptive management program for this project. "As part of the LCA Program communication structure for implementation of adaptive management (Figure 3), an LCA Adaptive Management Planning Team will be established. This team will be led jointly by a Senior Planner from the USACE and a counterpart from the OCPR. Other team members include USACE and State support staff and representatives from USFWS, NOAA, Natural Resources Conservation Service (NRCS), and Louisiana Department of Wildlife and Fisheries (LDWF). These members will be selected on the basis of their knowledge of ecosystem restoration, coastal Louisiana ecosystems and adaptive management. Other resources and expertise will be brought in as needed. This team will be responsible for recommending project and program adaptive management actions to the LCA Management Team."

1002

A map to illustrate location of the TSP plan features will be included in Section 3.0 "TSP Features" of the report. The preliminary plans and specs for the control structures, as presented in the feasibility phase are included in Appendix L, Annex L-4 to L-6. A detailed operational scheme for these structures will be developed in the PED phase of this project.

The addition of tree and shrub growth along the maintenance canal is a good consideration and will be further explored in the PED phase of the project.

As additional modeling will be completed during the PED phase of the project, the diversion flow period will be refined.

Page 3-101, lines 6-10. NMFS recommends this section be modified to note that planned maintenance excavation within the intracoastal canal will be coordinated with state and Federal resource agencies. Coordination should address beneficial use of excavated material, excavation and disposal methodologies, timing, and other considerations as needed to protect fish and wildlife.

Acknowledged. Text will be added on coordination with other state and Federal resource agencies.

3.7.7 Monitoring Plan and Adaptive Management

Pages 3-101 through 3-104. The MAMP is an essential component of the project. Environmental monitoring is needed to assess project related impacts and establish operational changes needed to protect and restore EFH and other habitat and resources. By letter dated April 7, 2010, the FWS, in consultation with NMFS, provided detailed comments concerning needed changes in the project's MAMP. NMFS recommends the MAMP be modified in accordance with FWS and NMFS recommendations. Also, as noted below (see "APPENDIX I"), the MAMP should be modified to include performance measures that call for water quality monitoring and adaptive management to remedy water quality problems in Blind River if they should occur.

AM plan was revised based on April 7, 2010 USFWS comments. Responses to the specific the USFWS comments are included in this appendix on page 55 The Monitoring and Adaptive Management Plan does recommend stage, velocity, turbidity, dissolved oxygen, salinity, nutrients, and TSS measurements to be conducted at 5 locations on Blind River. During PED the Adaptive management and monitoring plan will be revised based on the final project designs. At this time the water quality elements will be revisited and revised as necessary in coordination with agencies to ensure that the appropriate level of monitoring and adaptive management actions are in place to identify any water quality issues and remedy them if they should occur. Assessment of water quality monitoring data will indicate if any operational changes in the diversion or outfall management features are needed to address water quality impairment. Water quality impairment in Blind River is identified in the adaptive management and monitoring plan and will be measured as a risk end point and not specifically as a performance measure since improving water quality is not a stated objective of the Blind River project. The developed Risk endpoint is incorporated in the Adaptive management plan to measure and identify potential undesirable outcomes of the project and will be a trigger for adaptive management.

The MAMP also should include water quality monitoring and adaptive management as needed to remedy potential water quality problems in Lake Maurepas if such problems occur. Depending on the amount and rate of nutrient assimilation by wetlands after repeated or long term nutrient loading, NMFS is concerned the proposed diversion of river water could create algal blooms in and eutrophication of waterways in the project area. The MAMP should identify sampling locations, frequency, and duration for measuring dissolved oxygen levels in Lake Maurepas, which is designated as EFH for red drum and white shrimp, with particular emphasis on collecting data during the summer months. Potential adverse impacts to EFH in Lake Maurepas also include displacement of these designated fishery species from the area due to extreme turbidity and salinity changes, as well as colder water temperatures. These water quality parameters should be included in the MAMP for the lake.

The Risk Endpoint under Objective 4 has been changed to include Lake Maurepas in addition to Blind River.

Page 3-101, line 27. The feasibility level MAMP is provided in Appendix I (not Appendix J, as stated).

Concur. This correction was made in the report.

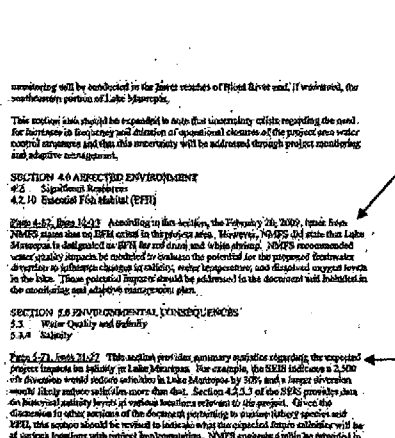
3.8 Risk and Uncertainty
3.8.2 Environmental Uncertainties

Page 3-113, lines 9-21. This section should be expanded to note that uncertainty exists regarding salinity change and nutrient input into Blind River and other downstream waters and that this uncertainty will be addressed through project monitoring and adaptive management.

Language was added in Appendix I, section 7.2 regarding flexibility of operations. The AM Framework Team does not interpret project operations as an "uncertainty". We believe the relevant uncertainty is amount, duration, and timing of water flow and the ecological response to the changed hydrology.

Page 3-114, lines 19-24. NMFS supports plans to conduct salinity monitoring. As noted in comments below (APPENDIX I), the final SEIS should acknowledge that salinity

1003



monitoring will be conducted in the lower reaches of Hope Canal and, if warranted, the southeastern portion of Lake Maurepas.

This section also should be expanded to note that uncertainty exists regarding the need for increases in frequency and duration of operational closures of the project area water control structures and that this uncertainty will be addressed through project monitoring and adaptive management.

SECTION 4.0 AFFECTED ENVIRONMENT
4.5 Significant Resources
4.5.10 Essential Fish Habitat (EFH)

Page 4-57, lines 34-43 According to this section, the February 26, 2009, letter from NMFS states that no EFH exists in the project area. However, NMFS did state that Lake Maurepas is designated as EFH for red drum and white shrimp. NMFS recommended water quality impacts be modeled to evaluate the potential for the proposed freshwater diversion to influence changes in salinity, water temperature, and dissolved oxygen levels in the lake. These potential impacts should be addressed in the document with habitats in the monitoring and adaptive management plan.

SECTION 5.0 ENVIRONMENTAL CONSEQUENCES
5.3 Water Quality and Salinity
5.3.4 Salinity

Page 5-71, lines 21-27 This section provides summary statistics regarding the expected project impacts on salinity in Lake Maurepas. For example, the SEIS indicates a 2,500 cfs diversion would reduce salinities in Lake Maurepas by 30% and a larger diversion would likely reduce salinities more than that. Section 4.2.2.3 of the SEIS provides data on historical salinity levels at various locations relevant to the project. Given the discussion in other portions of the document pertaining to shrimp/fishery species and EFH, this section should be revised to indicate what the expected future salinities will be at various locations with project implementation. NMFS suggests a table be provided in the final SEIS identifying mean and maximum historic salinities at various locations in the project area and what the modeled salinities would be at those locations with project implementation.

5.10 Essential Fish Habitat (EFH)

Page 5-119, lines 11-30 The first sentence in this section (lines 13-14) is confusing and should be rewritten to clarify where and to what extent salinity might decrease and how this might affect "optimal habitat" for red drum and white shrimp. NMFS recommends the final SEIS indicate that any reduction in salinity in Lake Maurepas would represent improvement in the direction of historical conditions that existed prior to anthropogenic alteration (diversion) of water flow into the Maurepas Swamp.

Previous studies have noted that Lake Maurepas is a freshwater lake (<2.5 parts per thousand salinity) Only during extreme drought periods does the Lake become slightly brackish (2 to 4 parts per thousand salinity). Modeling of Lake Maurepas involves input from several sources other than Blind River. As discussed in the report section 5.3.4
The Blind River project will improve the water quality of the Blind River throughout its course which will discharge to Lake Maurepas. During PED hydrology and water quality will be further modeled for the project at the necessary locations to address any remaining uncertainties in Lake Maurepas. The additional project modeling in addition to the future efforts such as the LCA Hope Canal project would further provide the necessary information to determine if there would be any potential impacts to EFH.

Studies of Lake Maurepas indicate the lake is a freshwater lake. Normal salinity levels are less than 2 parts per thousand, as indicated in several reports on the Lake. Then the 30% reduction will result in salinities less than 1.4 In either case the Lake remains a freshwater lake. There are times during extreme drought (last was 1999) when the salinity was near 4 parts per thousand which made the lake temporarily brackish. The Blind River and Hope Canal diversions will keep the lake fresher during drought periods and in those cases should exceed the 30% reduction and keep the lake fresh with salinities less than 2 parts per thousand. It should always be noted that during tropical storm surge events the salinity will exceed the level for freshwater. The diversions will be able to flush the Lake and swamp areas around the lake to preserve the freshwater vegetative and aquatic species by shortening the duration of the saline inundation. Any salinity reduction in the Lake Maurepas due to the operation of the project will not cause environmental impacts since the lake is already a freshwater lake. However, while some uncertainty of change in water quality exists, water quality monitoring stations installed within the swamp and along Blind River as part of the feasibility phase will result in more substantial water quality and salinity data that will be used to refine water quality modeling during the PED phase. Additionally, as data and further analysis on other projects in the Maurepas Swamp area, such as Hope Canal, are available, the cumulative effects of all projects on water quality will be examined more fully.

Any salinity reduction in the Lake Maurepas due to the operation of the project will not cause environmental impacts since the lake is already a freshwater lake. However, while some uncertainty of change in water quality exists, water quality monitoring stations installed within the swamp and along Blind River as part of the feasibility phase will result in more substantial water quality and salinity data that will be used to refine water quality modeling during the PED phase. Additionally, as data and further analysis on other projects in the Maurepas Swamp area, such as Hope Canal, are available, the cumulative effects of all projects on water quality will be examined more fully.

1004

Salinity monitoring as called for in section 3.8.2.1 (page 3-114; Line 19) is vital to a determination of the level of habitat alteration in Lake Maurepas. As such, NMFS recommends this section be modified to note that while the consequences of salinity modifications are expected to be negligible, salinity and water quality monitoring are planned, as well as the implementation of adaptive management, as needed, to preclude significant adverse impacts to EFH.

APPENDIX I

Page 10: Objective 4: Improve fish and wildlife habitat in the swamp and in Blind River

According to the Alternatives Analysis (page 3-27; lines 28-30) "The overall project has an extensive monitoring plan and includes costs for adaptive management to ensure that the overall water quality in the Blind River is not degraded." Despite this statement, the MAMP performance measures contain no parameters associated with water quality monitoring the nearest hypoxic or mobilization of dissolved oxygen and salinity. NMFS recommends this be addressed in the SEIS and that the MAMP be modified to specifically state that water quality monitoring for nutrients, salinity, and dissolved oxygen will be undertaken and adaptive management will be implemented, if needed, to remedy water quality problems in the Blind River. As noted in preceding comments concerning page 3-25 lines 26-29, NMFS further recommends the SEIS and MAMP be modified to state that federal resource agencies, including NMFS and FWS, will be consulted with regard to environmental monitoring and adaptive measures needed to protect and restore fish and wildlife resources and habitat in the study area, including EFH in Lake Maurepas.

Improving water quality is not a stated objective of the Blind River project; therefore, there is no performance measure, only a risk endpoint, for water quality. As a risk endpoint, it is proposed to be monitoring at 5 stations in the Blind River. Additional monitoring may occur if LDEQ TMDL threshold is exceeded. Section 1.3 of Appendix I states the intention of the USACE to engage NOAA/NMFS and other federal resource agencies as participants in the adaptive management program for this project.

1005

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
2738 Government Street
Alexandria, LA 71302

(318) 473-7751
Fax: (318) 473-7626

June 21, 2010

Ms. Joan M. Exnicios
Chief, Environmental Planning & Compliance Branch
Department of the Army, New Orleans District, COE
P.O. Box 60267
New Orleans, Louisiana 70160-0267

RE: Pre-Decisional Draft, Integrated Feasibility Study and Supplemental Environmental Impact Statement for the Louisiana Coastal Area (LCA) Small Diversion at Convent/Blind River, St. James Parish, Louisiana

Dear Ms. Exnicios:

As requested in your public notice correspondence of May 21, 2010, referenced above, the Natural Resources Conservation Service (NRCS) has reviewed the information and offers the following comments:

NRCS supports the tentatively selected plan (TSP), Alternative 2, a 3000 cfs diversion of Mississippi River water to aid in reversing the trend of deterioration in the southeast part of the Maurepas Swamp. NRCS agrees with providing the operational flexibility to establish a hydroperiod and marsh/water hydropattern fluctuations to improve seedling germination and survival. NRCS agrees that the TSP will reverse the deterioration of both the swamp and Blind River by utilizing the natural swamp building and assimilation processes.

NRCS appreciates the opportunity to offer comments. If you have questions or need additional information, please call Mike Richard at (318) 473-7698.

Respectfully,

Kevin D. Norton
State Conservationist

cc: W. Britt Paul, ASTC/WR; SO, NRCS, Alexandria, LA
Mike Nichols, WB, SO, NRCS, Alexandria, LA

Helping People Help the Land
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No response required other than to acknowledge receipt of their letter and agreement with the TSP

1006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

JUL 0 1 2010

Colonel Alvin B. Lee
New Orleans District
U.S. Army Corps of Engineers
P.O. Box, 60267
New Orleans, LA 70160-0267

Dear Colonel Lee:

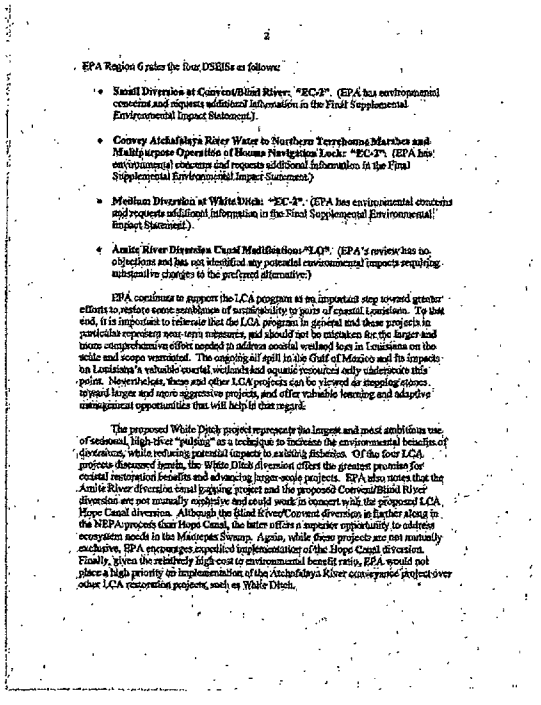
In accordance with the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, the Environmental Protection Agency (EPA) Region 6 has reviewed the Corps of Engineers (Corps) May 2010, draft Supplemental Environmental Impact Statements (DSEISs) for the following four Louisiana Coastal Area (LCA) projects: Small Diversion at Convent/Blind River; Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock; Medium Diversion at White Ditch; and Amite River Diversion Canal Modification. With this letter and enclosed Detailed Comments, EPA offers integrated ratings, comments, and recommendations on these DSEISs.

EPA greatly appreciates the Corps' ongoing interagency collaboration on the LCA program. Such teamwork is essential for leveraging and maximizing the resources available to address the pressing coastal issues facing Louisiana. EPA fully recognizes that the Congressionally-mandated timelines for the subject LCA studies, combined with the many other priority projects the Corps is engaged in place pressure on personnel and resources available for data gathering and analysis. While these factors have affected the rigor of analysis for the LCA studies, such shortcomings are to some extent mitigated by the fact that the subject projects flow from planning and analysis in the LCA programmatic EIS (2004) and in related coastal restoration efforts such as the Coastal Wetlands Planning, Protection, and Restoration Act.

EPA's comments are intended to help address remaining information gaps while striking a balance with the need to move forward expeditiously with coastal restoration projects in Louisiana. EPA is cognizant that uncertainty with major variables (particularly future relative sea level rise) hampers the ability to accurately predict the impacts and effectiveness of these and other coastal restoration projects. Robust monitoring and adaptive management programs are, therefore, essential. EPA also notes that unlike a new cross-basin levee or other large-scale artificial manipulation of the coastal landscape, these restoration projects generally attempt to mimic natural processes. Thus, the potential environmental downsides of proceeding with coastal restoration projects based on imperfect knowledge are generally more acceptable than would be the case for projects that pose significant potential adverse environmental impacts.

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EPA Region 6 rates the four DSEISs as follows:

- **Small Diversion at Convent/Blind River: "EC-2".** (EPA has environmental concerns and requests additional information in the Final Supplemental Environmental Impact Statement.).

- **Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multi-purpose Operation of Houma Navigation Lock: "EC-2".** (EPA has environmental concerns and requests additional information in the Final Supplemental Environmental Impact Statement.)

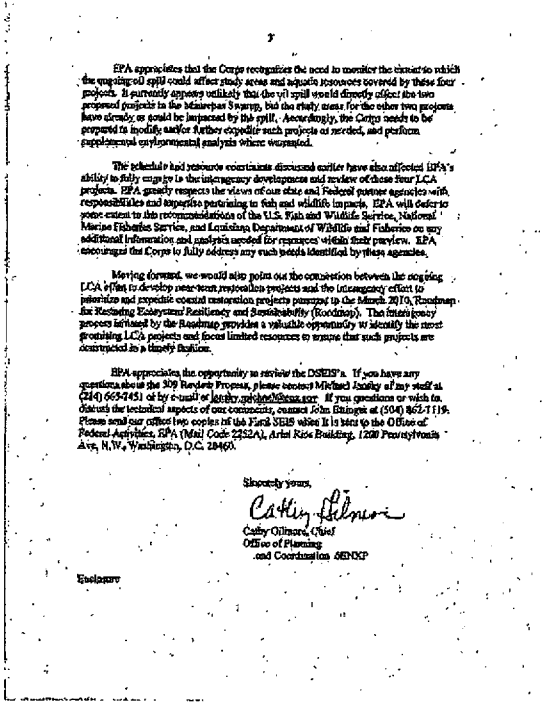
- **Medium Diversion at White Ditch: "EC-2".** (EPA has environmental concerns and requests additional information in the Final Supplemental Environmental Impact Statement.).

- **Amite River Diversion Canal Modification: "LO".** (EPA's review has no objections and has not identified any potential environmental impacts requiring substantive changes to the preferred alternative.)

EPA continues to support the LCA program as an important step toward greater efforts to restore some semblance of sustainability to parts of coastal Louisiana. To that end, it is important to reiterate that the LCA program in general and these projects in particular represent near-term measures, and should not be mistaken for the larger and more comprehensive effort needed to address coastal wetland loss in Louisiana on the scale and scope warranted. The ongoing oil spill in the Gulf of Mexico and its impacts on Louisiana's valuable coastal wetlands and aquatic resources only underscore this point. Nevertheless, these and other LCA projects can be viewed as stepping stones toward larger and more aggressive projects, and offer valuable learning and adaptive management opportunities that will help in that regard.

The proposed White Ditch project represents the largest and most ambitious use of seasonal, high-river "pulsing" as a technique to increase the environmental benefits of diversions, while reducing potential impacts to existing fisheries. Of the four LCA projects discussed herein, the White Ditch diversion offers the greatest promise for coastal restoration benefits and advancing larger-scale projects. EPA also notes that the Amite River diversion canal dredging project and the proposed Convent/Blind River diversion are not mutually exclusive and could work in concert with the proposed LCA Hope Canal diversion. Although the Blind River/Convent diversion is farther along in the NEPA process than Hope Canal, the latter offers a superior opportunity to address ecosystem needs in the Maurepas Swamp. Again, while these projects are not mutually exclusive, EPA encourages expedited implementation of the Hope Canal diversion. Finally, given the relatively high cost to environmental benefit ratio, EPA would not place a high priority on implementation of the Atchafalaya River conveyance project over other LCA restoration projects, such as White Ditch.

1008



EPA appreciates that the Corps recognizes the need to monitor the extent to which the ongoing oil spill could affect study areas and aquatic resources covered by these four projects. It currently appears unlikely that the oil spill would directly affect the two proposed projects in the Manchac Swamp, but the study areas for the other two projects have already or could be impacted by the spill. Accordingly, the Corps needs to be prepared to modify and/or further expedite such projects as needed, and perform supplemental environmental analysis where warranted.

The schedule and resource constraints discussed earlier have also affected EPA's ability to fully engage in the interagency development and review of these four LCA projects. EPA greatly respects the views of our state and Federal partner agencies with responsibilities and expertise pertaining to fish and wildlife impacts. EPA will defer to some extent to the recommendations of the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and Louisiana Department of Wildlife and Fisheries on any additional information and analysis needed for resources within their purview. EPA encourages the Corps to fully address any such needs identified by these agencies.

Moving forward, we would also point out the connection between the ongoing LCA effort to develop near-term restoration projects and the interagency effort to prioritize and expedite coastal restoration projects pursuant to the March 2010, Roadmap for Restoring Ecosystem Resiliency and Sustainability (Roadmap). The interagency process initiated by the Roadmap provides a valuable opportunity to identify the most promising LCA projects and focus limited resources to ensure that such projects are constructed in a timely fashion.

EPA appreciates the opportunity to review the DSEIS's. If you have any questions about the 309 Review Process, please contact Michael Jeansky of my staff at (214) 665-7451 or by e-mail at jeansky.michael@epa.gov. If you questions or wish to discuss the technical aspects of our comments, contact John Ettinger at (504) 862-1119. Please send our office two copies of the Final SEIS when it is sent to the Office of Federal Activities, EPA (Mail Code 2252A), Ariel Rios Building, 1200 Pennsylvania Ave, N.W., Washington, D.C. 20460.

Sincerely yours,

Cathy Gilmore

Cathy Gilmore, Chief
Office of Planning
and Coordination (6EN-XP

Enclosure

1009

DETAILED COMMENTS

ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENTS FOR THE SMALL DIVERSION AT CONVENT/BLIND RIVER; CONVEY ATCHAFALAYA RIVER WATER TO NORTHERN TERREBONNE MARSHES AND MULTIPURPOSE OPERATION OF BOUMA NAVIGATION LOCK; MEDIUM DIVERSION AT WHITE DITCH, AND AMITE RIVER DIVERSION CANAL MODIFICATIONS FOR THE LOUISIANA COASTAL AREA

COMMENTS

1. Small Diversion at Convent/Blind River DSEIS, May 2010

In general, additional freshwater and sediments to Maurepas Swamp provided by the proposed diversion is positive for the swamp. A potential downside to diverting existing surface waters and sediments is pollutants in the diverted water could impact the Blind River and Lake Maurepas. While such concerns are mitigatable, EPA would recommend additional information and analysis pertaining to water quality.

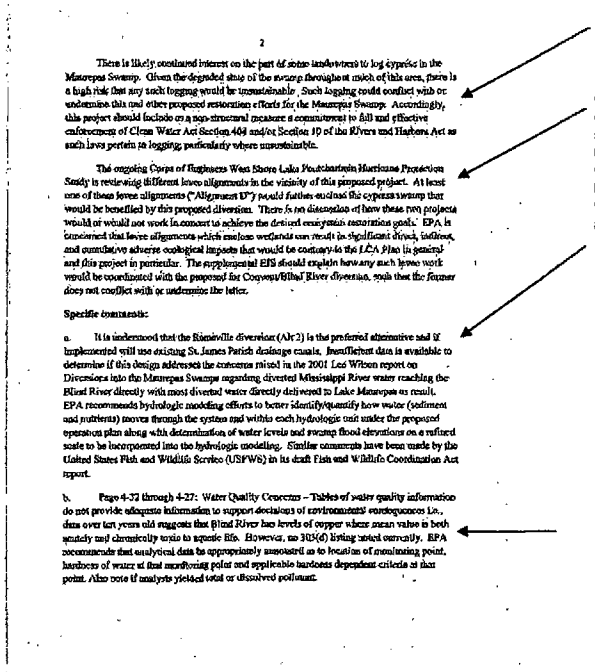
The 2001 Diversion into the Maurepas Swamp pre study, by Lee Wilson & Associates, as well as Bard Jr's Assessments of Ecological Risks of Contaminants from a Proposed Reintroduction of Mississippi River Water into Maurepas Swamp (Phase I and II, 2003 and 2008, respectively), are cited as support that long-term adverse impacts to water quality in the Maurepas Swamp, the Blind River, and Lake Maurepas are not anticipated. Unfortunately, the study area for these documents appears limited to the LCA Small Diversion at Hope Canal project area. While these assumptions may be applicable to a single 1500 cfs diversion, the application of these assumptions to a project diverting twice the amount of water (as in Small Diversion at Convent/Blind River) must account for the differences in scope. EPA notes, however, that if the diverted water flows through the swamp rather than directly to the Blind River and Lake Maurepas, and if the area of swamp is sufficient to reduce pollutants adequately, then this may not be a significant concern.

The LCA Ecosystem Restoration Study Programmatic EIS (2004) recognizes these concerns and suggests that the LCA Plan needs to consider other activities, initiate an aggressive coordination plan with the stakeholders involved, and ensure that all activities including the LCA Plan complement each other. EPA recommends that use of studies for support of these projects acknowledge the limitations and applicability. Additionally, it is suggested that cumulative effects determinations clarify if the assumptions used are applicable to its tabular timeline with no Maurepas Swamp projects other than the single proposed project, or that the cumulative effect includes the additive effects of all related Maurepas Swamp projects.

Concur. All available data and data updates on water quality in the Mississippi River will be evaluated during PED. The Monitoring and Adaptive Management Plan (Appendix I) also proposes a rigorous plan for water quality monitoring.

Cumulative impacts resulting from incremental impacts of the past, present and future actions such as the proposed Hope Canal and LCA ARDC project were included in the analysis. The cumulative impacts dialogue for each subsection throughout Section 5.0 of the report states "Cumulative impacts would be the synergistic effects of implementing the No Action Alternative combined with the beneficial impacts of other Federal, state, local and private restoration efforts as detailed in Section 5.1.2 and refers to Hope Canal, and LCA ARDC. As the project moves into PED there will be continued and increased coordination between projects and with agencies and stakeholders.

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There is likely continued interest on the part of some landowners to log cypress in the Maurepas Swamp. Given the degraded state of the swamp throughout much of this area, there is a high risk that any such logging would be unsustainable. Such logging could conflict with or undermine this and other proposed restoration efforts for the Maurepas Swamp. Accordingly, this project should include on a non-structural measure a commitment to full and effective enforcement of Clean Water Act Section 404 and/or Section 10 of the Rivers and Harbors Act as such laws pertain to logging, particularly where unsustainable.

The ongoing Corps of Engineers West Shore Lake Pontchartrain Hurricane Protection Study is reviewing different levee alignments in the vicinity of this proposed project. At least one of these levee alignments ("Alignment D") would further enclose the cypress swamp that would be benefited by this proposed diversion. There is no discussion of how these two projects would or would not work in concert to achieve the desired ecosystem restoration goals. EPA is concerned that levee alignments which enclose wetlands can result in significant direct, indirect, and cumulative adverse ecological impacts that would be contrary to the *LCA Plan* in general and this project in particular. The supplemental EIS should explain how any such levee work would be coordinated with the proposed for Convent/Blind River diversion, goals that the former does not conflict with or undermine the latter.

Specific comments:

a. It is understood that the Romeville diversion (Alt 2) is the preferred alternative and if implemented will use existing St. James Parish drainage canals. Insufficient data is available to determine if this design addresses the concerns raised in the 2001 Lee Wilson report on Diversions into the Maurepas Swamp regarding diverted Mississippi River water reaching the Blind River directly with most diverted water directly delivered to Lake Maurepas as result. EPA recommends hydrologic modeling efforts to better identify/quantify how water (sediment and nutrients) moves through the system and within each hydrologic unit under the proposed operation plan along with determination of water levels and swamp flood elevations on a refined scale to be incorporated into the hydrologic modeling. Similar comments have been made by the United States Fish and Wildlife Service (USFWS) in its draft Fish and Wildlife Coordination Act report.

b. Page 4-32 through 4-37: Water Quality Concerns – Tables of water quality information do not provide adequate information to support decisions of environmental consequences (i.e., data over ten years old suggests that Blind River has levels of copper where mean value is both acutely and chronically toxic to aquatic life. However, no 303(d) listing noted currently. EPA recommends that analytical data be appropriately annotated as to location of monitoring point, hardness of water at that monitoring point and applicable hardness dependent criteria at that point. Also note if analysis yielded total or dissolved pollutant.

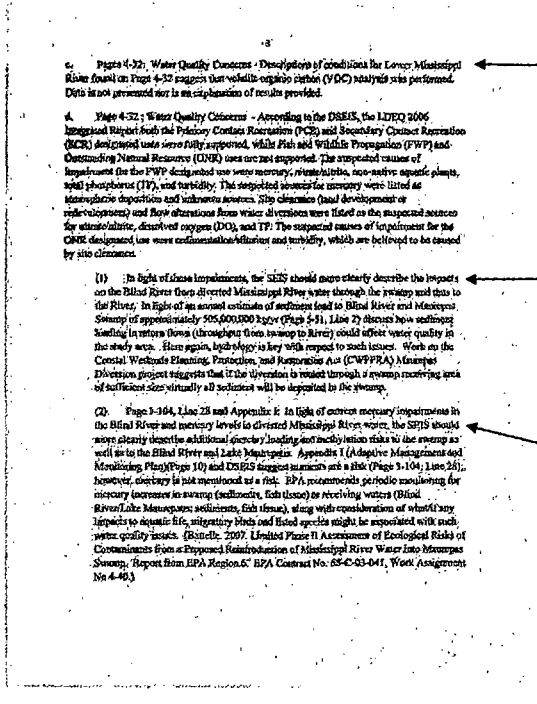
Concur. The majority of the study area is a state owned Wildlife Management Area. Activity on the state lands will be regulated. Activities on the small portion of the study area that is privately owned would also require a permit or other form of consent or authorization from the Louisiana Department of Natural Resources, U.S. Army Corps of Engineers, or the Environmental Protection Agency.

Concur. Coordination and collaboration with the Pontchartrain Levee District was initiated and will continue into the PED phase of the project to ensure project design features will consider the selected levee alignment plan. Both projects will work toward the mutual benefits of each project to avoid opposing features. WSLP is not a currently authorized project and is not part of the future without project condition however coordination with this effort indicates construction of the hurricane and storm risk reduction features would not likely adversely impact the project. As the WLSP project moves forward the team will coordinate with them to incorporate the LCA Blind River authorized plan into their efforts.

Concur. Additional modeling will be completed during the PED which will better depict water, nutrient, and sediment flow through the system. The additional modeling results will also influence revisions to the feasibility-level monitoring and the adaptive management plan that are in place to better determine habitat impact analysis and accretion rates

Location of the monitoring points for which data is presented is described either in the text and/or in the table headers. The water quality data presented in this section are what was available to date for use in this study and include hardness as a parameter. Limited data sets relevant to the project study area are available.

1011



c. Pages 4-32; Water Quality Concerns - Description of conditions for Lower Mississippi River found on Page 4-32 suggest that volatile organic carbon (VOC) analysis was performed. Data is not presented nor is an explanation of results provided.

d. Page 4-32 ; Water Quality Concerns - According to the DSEIS, the LDEQ 2006 Integrated Report lists the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) designated uses *were fully supported*, while Fish and Wildlife Propagation (FWP) and Outstanding Natural Resource (ONR) uses are not supported. The suspected causes of impairment for the FWP designated use were mercury, nitrate/nitrite, non-native aquatic plants, total phosphorus (TP), and turbidity. The suspected sources for mercury were listed as atmospheric deposition and unknown sources. Site clearance (land development or redevelopment) and flow alterations from water diversions were listed as the suspected sources for nitrate/nitrite, dissolved oxygen (DO), and TP. The suspected causes of impairment for the ONR designated use were sedimentation/siltation and turbidity, which are believed to be caused by site clearance.

(1) In light of these impairments, the SEIS should more clearly describe the impacts on the Blind River from diverted Mississippi River water through the swamp and into to the River. In light of an annual estimate of sediment load to Blind River and Maurepas Swamp of approximately 505,000,000 kg/yr (Page 5-31, Line 2) discuss how sediment loading in return flows (throughput from swamp to River) could affect water quality in the study area. Here again, hydrology is key with respect to such issues. Work on the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Maurepas Diversion project suggests that if the diversion is routed through a swamp receiving area of sufficient size virtually all sediment will be deposited in the swamp.

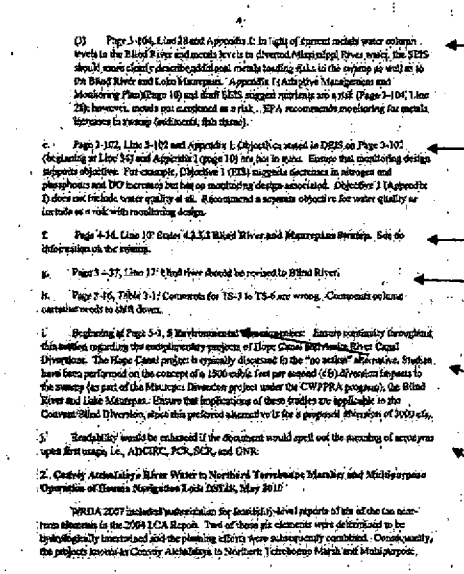
(2). Page 3-104, Line 28 and Appendix I: In light of current mercury impairments in the Blind River and mercury levels in diverted Mississippi River water, the SEIS should more clearly describe additional mercury loading and methylation risks to the swamp as well as to the Blind River and Lake Maurepas. Appendix I (Adaptive Management and Monitoring Plan)(Page 10) and DSEIS suggest nutrients are a risk (Page 3-104; Line 28); however, mercury is not mentioned as a risk. EPA recommends periodic monitoring for mercury (increases in swamp (sediments, fish tissue) as receiving waters (Blind River/Lake Maurepas; sediments, fish tissue), along with consideration of whether any impacts to aquatic life, migratory birds and listed species might be associated with such water quality issues. (Rainelle. 2007. Limited Phase II Assessment of Ecological Risks of Contaminants from a Proposed Reintroduction of Mississippi River Water into Maurepas Swamp. Report from EPA Region 6." EPA Contract No. 68-C-03-045, Work Assignment No 4-40.)

It is presumed that since no VOCs were reported in the data set, that no detections were present above the analytical detection limits. While this is an assumption based on the data available, it is highly unlikely that VOCs listed would be present in the Mississippi River unless a spill of some kind had occurred.

Modeling of the diversion and delivery system indicated that most of the sediment load in the Mississippi River water would be deposited within the transmission canal before flows reach the swamp interior, only a fraction of the suspended load (very fine particulates) will be transported to the swamp perimeter accounting for very little sediment deposition in the swamp. The primary purpose of this project which incorporates berm gapping and control structures is to reverse the problems caused by the construction of drainage canals which eliminated water passage through the swamp. This project reverses that hydrologic regime and reintroduces local drainage and diversion water to the swamp which in an area of laminar flow will remove sediment, nutrients and other contaminants that will be absorbed into the vegetative mass of the swamp. The project is reversing the environmental issues caused by the construction of the drainage canal system.

The concern for mercury is noted. During PED the Adaptive management and monitoring plan will be revised based on the final project designs. At this time the water quality elements will be revisited and revised as necessary in coordination with agencies to ensure that the appropriate level of monitoring and adaptive management actions are in place to identify any water quality issues and remedy them if they should occur.

1012



(3) Page 3-104, Line 28 and Appendix E: In light of current nickels water column levels in the Blind River and metals levels in diverted Mississippi River water, the SEIS should more clearly describe additional metals loading risks to the swamp as well as to the Blind River and Lake Maurepas. Appendix F (Adaptive Management and Monitoring Plan)(Page 10) and draft SEIS suggest nutrients are a risk (Page 3-104, Line 28); however, metals are considered as a risk. EPA recommends monitoring for metals increases in swamp (sediment, fish tissue).

c. Page 3-102, Line 3-102 and Appendix I: Objectives stated in DEIS on Page 3-102 (beginning at Line 34) and Appendix I (page 10) are not in sync. Ensure that monitoring design supports objectives. For example, Objective 1 (EIS) suggests decreases in nitrogen and phosphorus and DO increases but has no monitoring design associated. Objective 3 (Appendix I) does not include water quality at all. Recommend a separate objective for water quality or include as a risk with monitoring design.

f. Page 4-14, Line 10 Under 4.3.1.1 Blind River and Maurepas Swamp. See do information on the swamp.

g. Page 3-37, Line 17: Lloyd Hwy should be revised to Blind River.

h. Page 3-16, Table 3-1: Comments for TS-3 to TS-6 are wrong. Comments on last column needs to shift down.

i. Beginning at Page 5-3, 5 Environmental Consequences: Ensure continuity throughout this section regarding the complementary projects of Hope Canal Diversion, River Canal Diversions. The Hope Canal project is typically discussed in the "no action" alternative. Studies have been performed on the concept of a 1500 cubic feet per second (cfs) diversion (separate to the swamp (as part of the Maurepas Diversion project under the CWPPRA program), the Blind River and Lake Maurepas. Ensure that implications of these studies are applicable in the Convent/Blind Diversion, since this preferred alternative is for a proposed diversion of 3000 cfs.

j. Readability would be enhanced if the document would spell out the meaning of acronyms upon first usage, i.e., ADCIRC, PCR, SCR, and GNR.

2. Entergy Acadiana's River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock (HNLC, May 2010

WRDA 2007 included authorization for feasibility-level reports of ten of the ten near-term elements in the 2004 LCA Report. Two of these six elements were determined to be hydrologically interrelated and the planning efforts were subsequently combined. Consequently, the projects known as Convey Atchafalaya to Northern Terrebonne Marsh and Multipurpose,

The concern for metals is noted. During PED the Adaptive management and monitoring plan will be revised based on the final project designs. At this time the water quality elements will be revisited and revised as necessary in coordination with agencies to ensure that the appropriate level of monitoring and adaptive management actions are in place to identify any water quality issues and remedy them if they should occur.

Goals and objectives in the Monitoring and Adaptive Management Plan are not significantly different than stated elsewhere in the report (section 2.4). The Adaptive Management Framework Team added more detail to the objectives to better relate them to monitoring components. The Adaptive Management Framework Team believes that each monitoring design does support its objective. Water Quality has been included as a risk with a monitoring design.

The section discusses and presents water quality information from LDEQ station 0117 as that data pertains to the project study area of the swamp and also Blind River. (?)

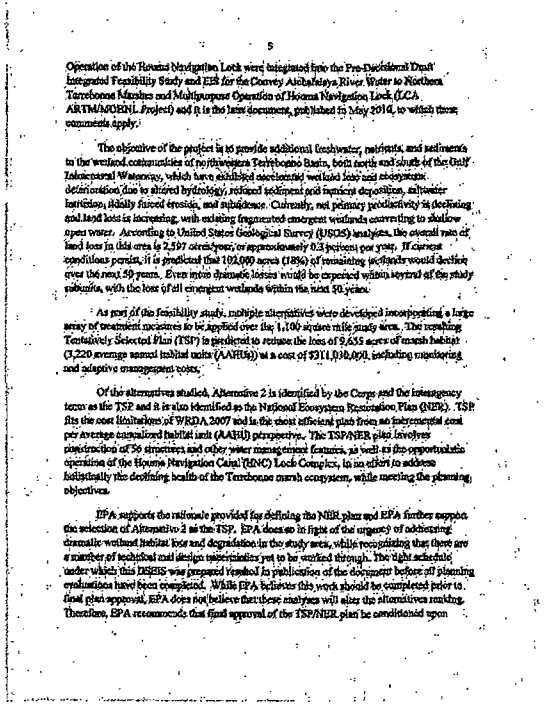
This will be corrected in the final report.

This will be corrected in the final report.

The final report will ensure that the Hope Canal and Amite projects are discussed appropriately in the no action section.

The final report will spell out acronyms upon first usage. Please note that an acronym list is included in Section 9.0

1013



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Operation of the Houma Navigation Lock were integrated into the Pre-Decisional Draft Integrated Feasibility Study and EIS for the Convey Atchafalaya River Water to Northern Terrebonne Marshes and Multipurpose Operation of Houma Navigation Lock (LCA ARTM/MOHNL Project) and it is the later document, published in May 2014, to which these comments apply.

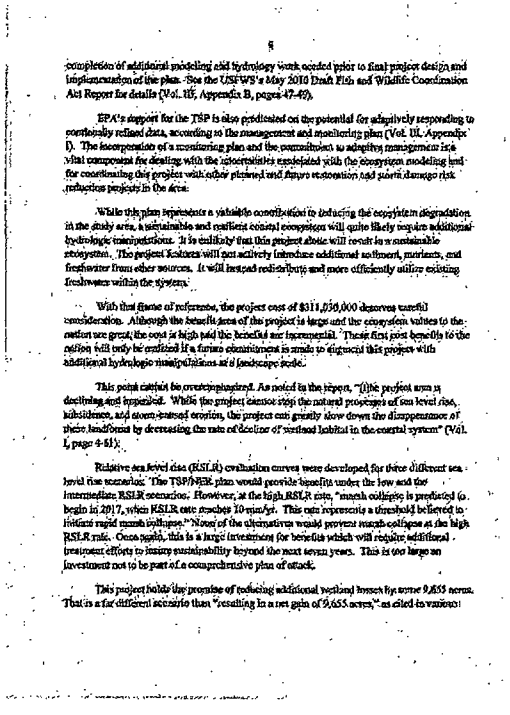
The objective of the project is to provide additional freshwater, nutrients, and sediments to the wetland communities of northwestern Terrebonne Basin, both north and south of the Gulf Intracoastal Waterway, which have exhibited accelerated wetland loss and ecosystem deterioration due to altered hydrology, reduced sediment and nutrient deposition, saltwater intrusion, tidally forced erosion, and subsidence. Currently, net primary productivity is declining and land loss is increasing, with existing fragmented emergent wetlands converting to shallow open water. According to United States Geological Survey (USGS) analyses, the overall rate of land loss in this area is 2,597 acres/year, or approximately 0.3 percent per year. If current conditions persist, it is predicted that 102,000 acres (18%) of remaining wetlands would decline over the next 50 years. Even more dramatic losses would be expected within several of the study subunits, with the loss of all emergent wetlands within the next 50 years.

As part of the feasibility study, multiple alternatives were developed incorporating a large array of treatment measures to be applied over the 1,100 square mile study area. The resulting Tentatively Selected Plan (TSP) is predicted to reduce the loss of 9,655 acres of marsh habitat (3,220 average annual habitat units (AAHUs)) at a cost of $311,030,000, including monitoring and adaptive management costs.

Of the alternatives studied, Alternative 2 is identified by the Corps and the interagency team as the TSP and it is also identified as the National Ecosystem Restoration Plan (NER). TSP fits the cost limitations of WRDA 2007 and is the most efficient plan from an environmental cost per average annualized habitat unit (AAHU) perspective. The TSP/NER plan involves construction of 56 structures and other water management features, as well as the opportunistic operation of the Houma Navigation Canal (HNC) Lock Complex, in an effort to address holistically the declining health of the Terrebonne marsh ecosystem, while meeting the planning objectives.

EPA supports the rationale provided for defining the NER plan and EPA further supports the selection of Alternative 2 as the TSP. EPA does so in light of the urgency of addressing dramatic wetland habitat loss and degradation in the study area, while recognizing that there are a number of technical and design uncertainties yet to be worked through. The tight schedule under which this DSEIS was prepared resulted in publication of the document before all planning evaluations have been completed. While EPA believes this work should be completed prior to final plan approval, EPA does not believe that these analyses will alter the alternatives ranking. Therefore, EPA recommends that final approval of the TSP/NER plan be conditioned upon

1014



8

completion of additional modeling and hydrology work needed prior to final project design and implementation of the plan. See the USFWS's May 2010 Draft Fish and Wildlife Coordination Act Report for details (Vol. III, Appendix B, pages 47-49).

EPA's support for the TSP is also predicated on the potential for adaptively responding to continually refined data, according to the management and monitoring plan (Vol. III, Appendix I). The incorporation of a monitoring plan and the commitment to adaptive management is a vital component for dealing with the uncertainties associated with the ecosystem modeling and for coordinating this project with other planned and future restoration and storm damage risk reduction projects in the area.

While this plan represents a valuable contribution to reducing the ecosystem degradation in the study area, a sustainable and resilient coastal ecosystem will quite likely require additional hydrologic manipulations. It is unlikely that this project alone will result in a sustainable ecosystem. The project features will not actively introduce additional sediment, nutrients, and freshwater from other sources. It will instead redistribute and more efficiently utilize existing freshwater within the system.

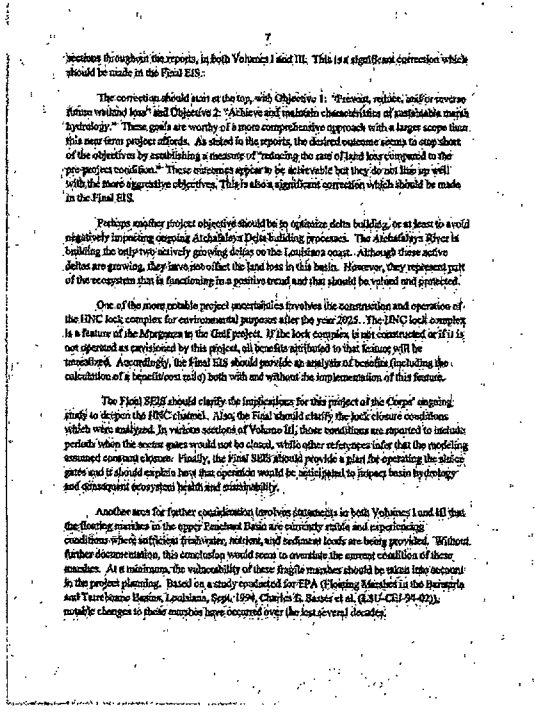
With that frame of reference, the project cost of $311,050,000 deserves careful consideration. Although the benefit area of the project is large and the ecosystem values to the nation are great, the cost is high and the benefits are incremental. These first cost benefits to the nation will only be realized if a future commitment is made to augment this project with additional hydrologic manipulations at a landscape scale.

This point cannot be overemphasized. As noted in the report, "[t]he project area is declining and imperiled. While the project cannot stop the natural processes of sea level rise, subsidence, and storm-caused erosion, the project can greatly slow down the disappearance of these landforms by decreasing the rate of decline of wetland habitat in the coastal system" (Vol. I, page 4-51).

Relative sea level rise (RSLR) evaluation curves were developed for three different sea level rise scenarios. The TSP/NER plan would provide benefits under the low and the intermediate RSLR scenarios. However, at the high RSLR rate, "marsh collapse is predicted to begin in 2017, when RSLR rate reaches 10 mm/yr. This rate represents a threshold believed to indicate rapid marsh collapse." None of the alternatives would prevent marsh collapse at the high RSLR rate. Once again, this is a large investment for benefits which will require additional treatment efforts to insure sustainability beyond the next seven years. This is too large an investment not to be part of a comprehensive plan of attack.

This project holds the promise of reducing additional wetland losses by some 9,655 acres. That is a far different scenario than "resulting in a net gain of 9,655 acres," as cited in various

101.5



7

sections throughout the reports, in both Volumes I and III. This is a significant correction which should be made in the Final EIS.:

The correction should start at the top, with Objective 1: "Prevent, reduce, and/or reverse future wetland loss" and Objective 2: "Achieve and maintain characteristics of sustainable marsh hydrology." These goals are worthy of a more comprehensive approach with a larger scope than this near-term project affords. As stated in the reports, the desired outcome seems to stop short of the objectives by establishing a measure of "reducing the rate of land loss compared to the pre-project condition." These outcomes appear to be achievable but they do not line up well with the more aggressive objectives. This is also a significant correction which should be made in the Final EIS.

Perhaps another project objective should be to optimize delta building, or at least to avoid negatively impacting ongoing Atchafalaya Delta building processes. The Atchafalaya River is building the only two actively growing deltas on the Louisiana coast. Although these active deltas are growing, they have not offset the land loss in the basin. However, they represent part of the ecosystem that is functioning in a positive trend and that should be valued and protected.

One of the more notable project uncertainties involves the construction and operation of the HNC lock complex for environmental purposes after the year 2025. The HNC lock complex is a feature of the Morganza to the Gulf project. If the lock complex is not constructed or if it is not operated as envisioned by this project, all benefits attributed to that feature will be invalidated. Accordingly, the Final EIS should provide an analysis of benefits including the calculation of a benefit/cost ratio) both with and without the implementation of this feature.

The Final SEIS should clarify the implications for this project of the Corps' ongoing study to deepen the HNC channel. Also, the Final should clarify the lock closure conditions which were analyzed. In various sections of Volume III, those conditions are reported to include periods when the sector gates would not be closed, while other references infer that the modeling assumed constant closure. Finally, the Final SEIS should provide a plan for operating the sector gates and it should explain how that operation would be optimized to impact basin hydrology and consequent ecosystem health and sustainability.

Another area for further consideration involves statements in both Volumes I and III that the floating marshes in the upper Barataria Basin are currently stable and experiencing conditions where sufficient freshwater, nutrient, and sediment loads are being provided. Without further documentation, this conclusion would seem to overstate the current condition of these marshes. At a minimum, the vulnerability of these fragile marshes should be taken into account in the project planning. Based on a study conducted for EPA (Floating Marshes in the Barataria and Terrebonne Basins, Louisiana, Sept. 1994, Charles E. Sasser et al. (LSU-CEI-94-02)), notable changes to these marshes have occurred over the last several decades.

1016

Six of the study sites in the Louisiana State University (LSU) project lie within the LCA ARTM/MOHNL Project study area. Based on habitat mapping and the results of other work by the same researchers, some floating marsh habitats have changed over the last several decades from one type of flotant to another type, or to open water. In the northern Terrebonne basin and upper Bayou Penchant basin, large areas of formerly *Panicum hemitomon* thick-mat flotant marsh converted to thin-mat *Eleocharis* flotant marshes or to open water. While much remains unknown as to what processes have operated on these areas to produce such dramatically different results, possible contributors include: altered hydrology due to canal construction and dredging; flux of organic material from the marsh due to hydrologic changes; nutria herbivory; nutrient dynamics due to altered hydrology; burning; and floods/storms.

With regard to compensatory mitigation, the report states that "[t]emporary negative impacts to the marsh associated with excavation of canals and management structures will be compensated for by creation of new marsh of better quality as a result of the reintroduction of freshwater, nutrients, and sediments into the Study Area" (Vol. I, page 4-68 and Vol. III, Section 3, page 49). The more likely case is that marsh degradation will be slowed by these measures. Additional marsh creation should be considered, however, if excess dredged material is available beyond that which is required for canal bank construction. In addition, all actions identified in the Clean Water Act Section 404(b) evaluation to minimize impact should be incorporated into the final plan.

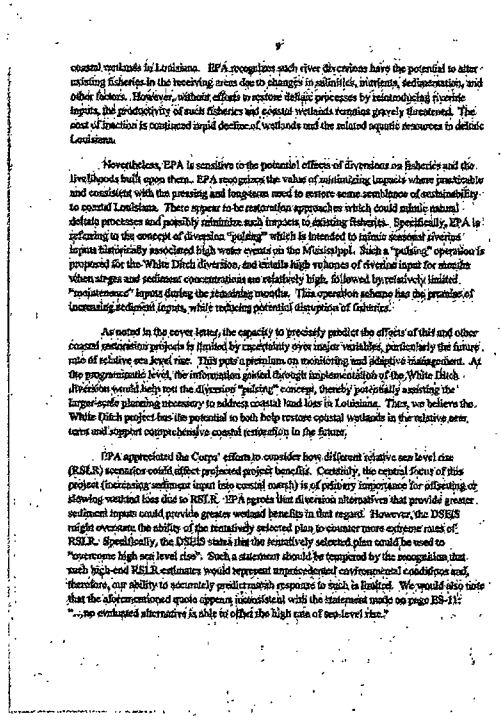
Finally, EPA suggests that, to the degree possible, the Final EIS include an updated assessment of the Deepwater Horizon oil spill impacts to the Terrebonne basin ecological resources subject to this project proposal. The baseline conditions should be modified as necessary and a projection of the potential for the TSP/NER plan, or any individual features of other alternatives, for remediating those impacts should be considered. The TSP/NEP plan should be modified if the incorporation of other features could reasonably be expected to provide incremental benefits to protect the marshes from further oil spill damage under non-storm and/or storm conditions.

As a partner with the Corps of Engineers and others in the restoration of coastal Louisiana, EPA offers these comments in an effort to promote the most effective long-term wetlands protection and restoration strategy for the study area. This near term project could provide a platform for a sustainable coastal ecosystem, when viewed in tandem with measures to provide additional inputs of sediments and flows.

3. Medium Diversion at White Ditch DSEIS, May 2010

As noted in our cover letter, EPA supports the proposed White Ditch diversion. It is consistent with our long-standing priority of re-establishing Mississippi River inputs to help undo to some extent the major disruption of deltaic processes that underlies the ongoing loss of

1017



coastal wetlands in Louisiana. EPA recognizes such river diversions have the potential to alter existing fisheries in the receiving areas due to changes in salinities, nutrients, sedimentation, and other factors. However, without efforts to restore deltaic processes by reintroducing riverine inputs, the productivity of such fisheries and coastal wetlands remains gravely threatened. The cost of inaction is continued rapid decline of wetlands and the related aquatic resources in deltaic Louisiana.

Nevertheless, EPA is sensitive to the potential effects of diversions on fisheries and the livelihoods built upon them. EPA recognizes the value of minimizing impacts where practicable and consistent with the pressing and long-term need to restore some semblance of sustainability to coastal Louisiana. There appear to be restoration approaches which could mimic natural deltaic processes and possibly minimize such impacts to existing fisheries. Specifically, EPA is referring to the concept of diversion "pulsing" which is intended to mimic seasonal riverine inputs historically associated high water events on the Mississippi. Such a "pulsing" operation is proposed for the White Ditch diversion, and entails high volumes of diverted input for months when stages and sediment concentrations are relatively high, followed by relatively limited "maintenance" inputs during the remaining months. This operation scheme has the promise of increasing sediment inputs, while reducing potential disruption of fisheries.

As noted in the cover letter, the capacity to precisely predict the effects of this and other coastal restoration projects is limited by uncertainty over major variables, particularly the future rate of relative sea level rise. This puts a premium on monitoring and adaptive management. At the programmatic level, the information gained through implementation of the White Ditch diversion would help test the diversion "pulsing" concept, thereby potentially assisting the larger-scale planning necessary to address coastal land loss in Louisiana. Thus, we believe the White Ditch project has the potential to both help restore coastal wetlands in the relative near term and support comprehensive coastal restoration in the future.

EPA appreciated the Corps' efforts to consider how different relative sea level rise (RSLR) scenarios could affect projected project benefits. Certainly, the central focus of this project (increasing sediment input into coastal marsh) is of primary importance for offsetting or slowing wetland loss due to RSLR. EPA agrees that diversion alternatives that provide greater sediment inputs could provide greater wetland benefits in that regard. However, the DSEIS might overstate the ability of the tentatively selected plan to counter more extreme rates of RSLR. Specifically, the DSEIS states that the tentatively selected plan could be used to "overcome high sea level rise". Such a statement should be tempered by the recognition that such high-end RSLR estimates would represent unprecedented environmental conditions and, therefore, our ability to accurately predict marsh response to such is limited. We would also note that the aforementioned quote appears inconsistent with the statement made on page ES-11: "...no evaluated alternative is able to offset the high rate of sea-level rise."

1018

More information and analysis should be provided on potential inputs of nutrients and agrochemicals as a result of the proposed diversion. For example, data is available on the fluctuating levels of atrazine concentrations in the Mississippi River. This information could be combined with the proposed diversion operational scheme and alternatives to estimate potential atrazine inputs into the estuary. Similar analysis should be done for nutrient loading. EPA suggests the Final SEIS include a graph showing atrazine concentrations in the Mississippi River over the period of a year. Such a graph should also include a line showing proposed diversion discharge rates over the same period of time. This would highlight the relationship between diversion discharge rates and atrazine concentrations in the river. On the subject of atrazine, EPA asks the Corps to correct the apparent wording error on page 5-24: "The long-term effects of prolonged, low-level, exposure to atrazine on both plants and animals, especially amphibians, *would be currently being investigated.*" (Emphasis added) If such long-term effects are indeed currently being studied, EPA asks whether the Corps plans to review the findings of such investigation and if necessary incorporate that information into the operational scheme for this proposed diversion.

With respect to nutrients, dissolved oxygen, and other water quality issues, EPA recommends the Corps consider adding water quality parameters to the monitoring plan and adaptive management scheme. The goal would be to have the ability to detect and respond to any unforeseen adverse water quality impacts that could result from operation of the proposed diversion. This would include measurements of dissolved oxygen levels in open water areas, as well as monitoring for atrazine, metals, and any other pollutants of concern.

The DSEIS should provide additional information on potential salinity and associated habitat changes expected to occur due to the proposed diversion and alternatives. The final SEIS should include maps showing existing marsh types and anticipated changes in marsh types associated with the proposed project and alternatives. It would also be informative to include maps showing existing base-case isohaline lines and the anticipated changes in such over time (i.e., during the high-flow period, the middle of any "rebound" period, and low flow months.

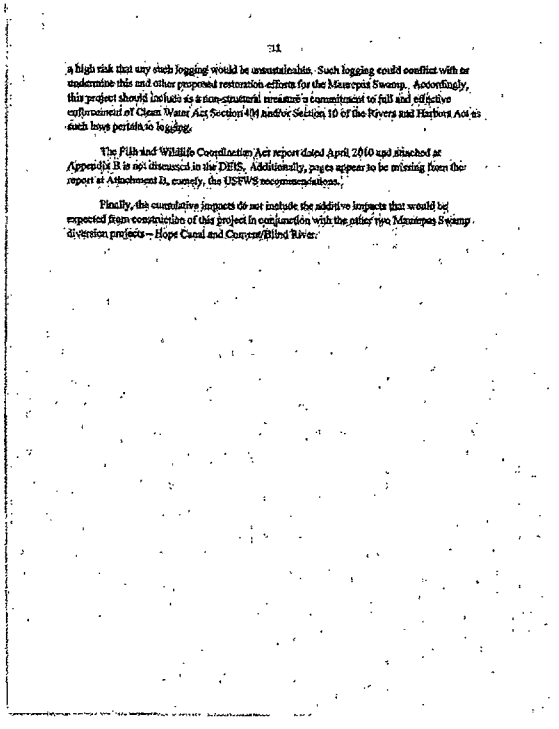
Finally, as noted in our cover letter, EPA supports recommendations made by the National Marine Fisheries Service with respect to any additional analysis (including modeling) needed to adequately assess and disclose potential effects on fisheries.

4. Amite River Diversion Canal Modification DSEIS, May 2010

Both the TSP and the NER plan appear to be good projects from a cost-benefit perspective. EPA supports either alternative TSP or NER plan.

There is likely continued interest on the part of some landowners to log cypress in the Maurepas Swamp. Given the degraded state of the swamp throughout much of this area, there is

1019



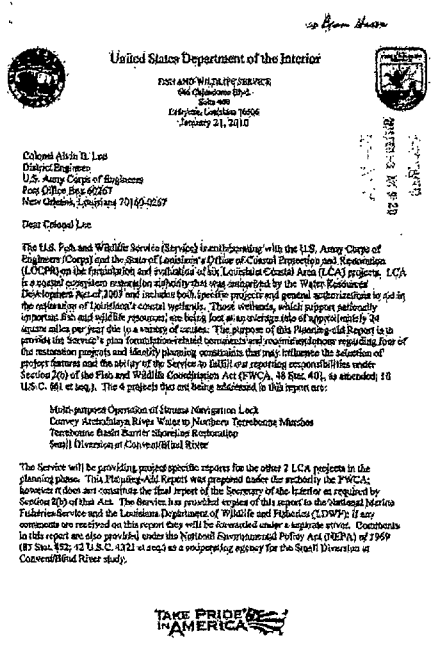
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a high risk that any such logging would be unsustainable. Such logging could conflict with or undermine this and other proposed restoration efforts for the Maurepas Swamp. Accordingly, this project should include as a non-structural measure a commitment to full and effective enforcement of Clean Water Act Section 404 and/or Section 10 of the Rivers and Harbors Act as such laws pertain to logging.

The Fish and Wildlife Coordination Act report dated April 2010 and attached at Appendix B is not discussed in the DEIS. Additionally, pages appear to be missing from the report at Attachment B, namely, the USFWS recommendations.

Finally, the cumulative impacts do not include the additive impacts that would be expected from construction of this project in conjunction with the other two Maurepas Swamp diversion projects – Hope Canal and Convent/Blind River.

1020



United States Department of the Interior

FISH AND WILDLIFE SERVICE
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January 21, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee

The U.S. Fish and Wildlife Service (Service) is cost-sharing with the U.S. Army Corps of Engineers (Corps) and the State of Louisiana's Office of Coastal Protection and Restoration (LOCPR) on the formulation and evaluation of six Louisiana Coastal Area (LCA) projects. LCA is a coastal ecosystem restoration authority that was comprised by the Water Resources Development Act of 2007 and includes both specific projects and general authorizations to aid in the restoration of Louisiana's coastal wetlands. Those wetlands, which support nationally important fish and wildlife resources, are being lost at an average rate of approximately 24 square miles per year due to a variety of causes. The purpose of this Planning-Aid Report is to provide the Service's plan formulation-related comments and recommendations regarding four of the restoration projects and identify planning constraints that may influence the selection of project features and the ability of the Service to fulfill our reporting responsibilities under Section 2(b) of the Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The 4 projects that are being addressed in this report are:

Multi-purpose Operation of Houma Navigation Lock
Convey Atchafalaya River Water to Northern Terrebonne Marshes
Terrebonne Basin Barrier Shoreline Restoration
Small Diversion at Convent/Blind River

The Service will be providing project specific reports for the other 2 LCA projects in the planning phase. This Planning-Aid Report was prepared under the authority the FWCA; however it does not constitute the final report of the Secretary of the Interior as required by Section 2(b) of the Act. The Service has provided copies of this report to the National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries (LDWF). If any comments are received on this report they will be forwarded under a separate cover. Comments in this report are also provided under the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.) as a cooperating agency for the Small Diversion at Convent/Blind River study.

TAKE PRIDE IN AMERICA

10211

The Service previously submitted draft FWCA Reports (i.e., September 26, 2003 [comprehensive plan], May 28, 2004 [draft near-term plan], and October 6, 2006 [final near-term plan]) during the development of the LCA near-term plan. Habitat values and fish and wildlife resources (but not habitat acreage) described in these previous reports remain relatively unchanged and are therefore incorporated herein by reference.

We recognize that the (initially) condensed study schedule (i.e., study completion within three years from authorization) was developed in response to the significant and ongoing rapid loss of coastal wetlands. Considering the scope and complexity of the suite of these LCA projects, that schedule, because of a one year delay in getting cost-sharing documents signed, should be acknowledged as a key planning constraint, and risks and uncertainties associated with enacting such an abbreviated study schedule (i.e., reduced to two years) should also be thoroughly considered in any plan log and NEPA documents. We also recognize that relatively new policies requirements (i.e., model certification and analysis of sea-level rise) implemented by the Corps have also contributed to some delays in essential data analysis. Additionally, the Service recognizes that some of our comments provided below regarding the analyses and findings of the LCA projects may be of an interim nature of planning efforts proceed. General comments that apply to the overall planning process are presented below and are followed by general project-type comments and then by project specific comments, recommendations, and data needs.

The expedited schedule of the impact (i.e., benefit) analysis has curtailed time available for hydrological modeling work, precluding the correction of known model limitations and errors and also required utilizing assumptions and data extrapolations in the impacts analysis that would have normally been more refined. Currently, coastal fisheries impact assessments may be conducted without the use of models that would have otherwise provided an overall indication of the cumulative effect of multiple restoration (planned and operating) and flood protection projects on fishery resources within a coastal basin. The Corps has verbally indicated that use of these type models will be incorporated in future planning efforts. Former Service comments regarding cumulative impacts (that should be thoroughly examined in NEPA documents) may be contingent upon completion of such modeling efforts. During a more typical project planning study, when sufficient time to conduct detailed impact analyses is available, the Service would usually rely upon more robust data and assumptions than is currently available.

The shortened time frame of the planning process has also reduced the amount of time used to fully develop and refine alternatives and alternative features. While many good alternatives for each LCA project were developed, the extensive process of alternative refinement and selection was reduced which could preclude the development of alternatives or alternative features which could increase restoration benefits. Therefore, while selection of a Tentatively Selected Plan (TSP) has occurred or is scheduled to soon occur, changes to the TSP may be warranted based on further planning efforts and review of existing assumptions and modeling (i.e., quality control).

All diversion projects should include monitoring that would not only measure the success of the project but also facilitate the recognition of existing and future maintenance needs as sedimentation occurs within the project area. Failure to include such monitoring may result in decreased benefits as areas experience sedimentation, vegetative response, and debris collection

1022

which could isolate areas from the influence of the diversion. Implementation of an adaptive management/maintenance program throughout the project area and over the life of the project, would also ensure such conditions would not prevail over the project life, significantly increasing the diversion's success. Varying the discharge of diversions during Mississippi River high water periods could increase shell and bedding availabilities, however, the historical study schedule has limited the examination of such adaptive management opportunities. The Service should be included in the development and implementation of both the monitoring and adaptive management/maintenance programs.

Convent Atchafalaya River Water to Northern Terrebonne Marshes and Multi-purpose Operation of Houma Navigation Lock)

Both of the subject LCA projects involve water management within a very large and hydrologically complex area and because these projects have substantial interaction they have been combined into one project. Given these factors, intensive hydrologic modeling is needed to evaluate the effects of the combined projects. Time needed to obtain adequate computer capabilities delayed the initiation of necessary hydrologic modeling. Therefore, to meet the project schedule, the array of project alternatives will be limited such that additional model runs to optimize channel sizes will not be done. If initial modeling suggests that there are other potentially viable project alternatives, there will not be sufficient time to assess those. More detailed comments regarding these studies are presented below:

1. Because of the shortened planning period and reduced amount of time allowed for hydrologic modeling runs, there was no time to complete the many Grand Bayou channel size and configuration alternatives. The LCA study intended to select the channel alternatives selected under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Central and East Terrebonne Freshwater Delivery Project, which examined a number of channel size and configuration alternatives. In that CWPPRA effort, a 7,500-square foot (sq ft) east branch channel alternative (i.e., single channel) was selected as the preferred alternative. However, because the hydrologic model used in the CWPPRA effort failed to adequately simulate flows in the Cutoff Canal, those model results are flawed and inadequate to support a decision on a preferred alternative. Although intending to use that CWPPRA preferred alternative, the model mesh was set up for the 7,500 sq ft bifurcated channel alternative (i.e., bifurcated channel).

2. The following structures were not included in the computer models, thus efforts to assess their impacts (especially when effects of the proposed Houma Navigation Channel Lock are slow/closed) may be flawed.

   The 2 structures through the Morganza to the Gulf levee through the southbank of Falgout Canal.

   The Penchant Plaza Superior Canal water control structure is not in the future without project (FWOP) model prediction.

1023

3. The WDZ channel flows in Alternative 2 are predicted to exceed that of the predicted upstream source channel. The WDZ channel is also assumed to be functioning under FWOP conditions.

4. These did not allow for the assessment of benefits for individual measures or groups of measures to improve the efficiency of measure combinations and the resulting alternatives. For example, in the Grand Bayou area, the proposed St. Louis Canal enlargement provides little additional freshwater input when combined with the proposed Grand Bayou enlargement. However, both features are combined in several alternatives, resulting in more costly alternatives.

5. Insufficient opportunity was provided to evaluate the effectiveness and benefits/value provided by individual marsh management features.

6. Because the diversion model allows only three year step changes, it is a less robust means of predicting future average yearly loss rate of standard spreadsheet methods which can incorporate numerous loss rate changes over time. Because there was not sufficient time to upgrade this modeling tool, the more robust spreadsheet-predicted FWOP acreages are compared with the diversion model generated futures with project (FWP) acreage. This may result in up to a 200-acre error by target year (TY) 100.

7. Because of the schedule, salinity outputs were not available to determine project and/or diversion influence areas from those model outputs. Instead, best professional judgement was used to determine the influence areas.

8. In some cases, salinity prediction models may not have been run long enough to fully illustrate project effects.

9. Polygons from wide/medium loss rates were determined included farmland.

10. Measured impacts did not remove spoil bank acreage – thus marsh impacts are overestimated.

11. Due to time constraints, diversion influence areas were assessed in the Wetland Value Assessment (WVA) as a single habitat type; separate WVAs on each habitat type are therefore needed.

12. For model project benefits, many assumptions have been made regarding the size and location of mitigation to the Civil Project features. These assumptions could later be found to be incorrect as that feasibility study work progresses.

Terrebonne Basin Barrier Shoreline Restoration

Project area assumes Barrier Island project boundaries encompass all emergent and subtidal habitat (i.e., 0.0 to -1.5 NAVD88) associated with the island, while deep water habitat

1024

moved the island is omitted. Subtidal habitat expands lakeward to the ~1.5 ft NAVD88 contour or a maximum distance of 1,000 feet from the island. In many instances, a barrier island project area changes throughout the evaluation period (i.e., 50 years) as the island erodes, migrates, and/or shrinks in size. As the island erodes, areas converting to deep coastal water (<-1.5 NAVD88) are removed from the project area and the boundary shrinks to the island outline. This information needs to be determined for all alternatives.

Barrier Island Wetland Value Assessment V1, V2, and V3 values - Recent changes to the Final Array of Alternatives resulted in the deletion of some and the addition of new alternatives to that array. The acreage of each of the habitat components (i.e., dune supratidal, and intertidal) should be provided as soon as possible for all new alternatives added to the revised Final Array (distributed to the Project Delivery Team on January 11, 2010).

Impacts to the threatened piping plover (Charadrius melodus) and/or its critical habitat via dredged material placement on the islands should be addressed in planning studies. Should the proposed project directly or indirectly affect the plovers or its critical habitat, formal consultation with this office will be necessary. If the effect would adversely affect piping plovers or would affect its critical habitat, formal consultation with the Service would be necessary. Formal consultation had specific timelines that the Service must adhere to and must be completed prior to completion of any NEPA document.

Small Diversion at Convent/Blind River

The TSP for Convent/Blind River Freshwater Diversion includes construction a gated culvert system and transfer canal along the Reddyville alignment to divert an average of 3,000 cubic feet per second of freshwater from the Mississippi River into the Maurepas swamps. In-swamp management measures (e.g. plugging spoil banks, installing additional culverts under U.S. Highway 61 and installing water control structures in existing canals) are proposed to facilitate and maximize freshwater throughput within the swamp. The USFWS has requested that a new alternative be formulated and evaluated in the final array of alternatives. That alternative would include all of the features of the TSP with the exception of water control structures within existing canals due to concern that water control structures will be difficult to operate and maintain.

To fully evaluate the benefits of the Convent/Blind River Freshwater Diversion TSP and compare alternatives, the following additional information and actions will be required:

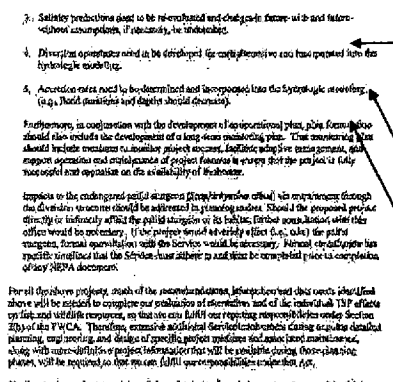
1. Additional results of hydrologic modeling efforts that identify/quantify influence areas at a more localized level indicating how water, sediment, and nutrients move through the system and within each hydrologic unit.

2. Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.

Concur. Additional modeling will be completed during PED which will better depict water, nutrient, and sediment flow through the system. The additional modeling results will also influence revisions to the feasibility-level monitoring and the adaptive management plan that are in place to refine habitat impact analysis and accretion rates.

Concur. Additional modeling will be done as part of PED to refine the water surface elevations along with limited swamp floor elevations in areas proximal to berm cuts and design features. During PED hydraulic analysis of the entire system will be performed.

1025



3. Salinity predictions need to be re-evaluated and changed to future-with and future-without assumptions, if necessary, be undertaken.

4. Diversion operations need to be developed for each alternative and then updated from the hydrologic modeling.

5. Accretion rates need to be determined and incorporated into the hydrologic modeling. (e.g., Hood Canal/pre and depth should decrease).

Furthermore, in conjunction with the development of the operational plan, plan formulation should also include the development of a long-term monitoring plan. That monitoring plan should include measures to monitor project success, facilitate adaptive management, and support operation and maintenance of project features to ensure that the project is fully successful and operates on the availability of freshwater.

Impacts to the endangered bald eagle (Haliaeetus leucocephalus) and its environment through the diversion operations should be addressed in planning studies. Should the proposed project directly or indirectly affect the bald eagle or its habitat, further consultation with the Service would be necessary. If the project would adversely affect (i.e., take) the bald eagle, formal consultation with the Service would be necessary. Formal consultation has explicit timelines that the Service must adhere to and must be completed prior to completion of any NEPA document.

For all the above projects, each of the recommendations listed does not specifically listed above will be needed to complete our evaluation of alternatives and of the individual TSP effects on fish and wildlife resources, so that we can fulfill our reporting responsibilities under Section 2(b) of the FWCA. Therefore, extensive additional fieldwork/research during detailed planning, engineering, and design of specific project features and associated maintenance, along with more definitive project information that will be available during those planning phases, will be required so that we can fulfill our responsibilities under that Act.

The Service has actively participated throughout plan formulation and evaluation of the LCA projects. Each of these LCA projects would, to varying degrees, restore coastal wetland habitat. Hence, implementing any of the proposed projects would be preferable to the continued loss and degradation of coastal wetlands and Louisiana's culturally significant fish and wildlife resources. We remain committed to working closely with all agencies involved in LCA planning efforts to further explore alternatives and alternative features and refine models and exploit opportunities in order to reduce the current degree of risk and uncertainty associated with their outputs and to assess optimum fish and wildlife resource benefits are achieved. The Service recognizes the formidable challenge that the Corps has been tasked with (i.e., balancing sufficient planning with meeting abbreviated Congressionally mandated deadlines), and we look

There have been several papers written on salinity changes in Lake Pontchartrain due to the diversions planned for Blind River and Hope Canal. (1. Georgiou, I.Y., McCorquodale, J. A., Schindler, J., Retana A.G., FitzGerald, D.M., Hughes, Z., Howes, N., 2009, Impact of Multiple Freshwater Diversions on the Salinity Distribution in the Pontchartrain Estuary under Tidal Forcing. 2. Georgiou, I.Y., 2010, High Frequency Response and Transport in the Pontchartrain Basin due to wind stress) What is important to learn from these studies is that the salinity levels in Lake Maurepas under normal conditions (i.e. no tropical events) are in the range considered a fresh water lake (less than 1 5pares per thousand). Within Lake Pontchartrain, the salinity levels are referred to as oligohaline (0.5-5.0 ppt). For the project area the salinity levels are not an issue at any times except tropical events and long term drought periods. The conditions of tropical events are so different that any modeling of salinity levels has no bearing on the project objectives. The key feature of the project is to be able to flush the salinity from the area, which based on the hydraulic detention times modeled in the report, can occur in less than 7 days which is sufficient to avoid salinity intrusion into the tree root zones thus causing some levels of mortality. A long drought period in 1999 caused the salinity levels of Lake Maurepas to approach 4 parts per thousand. This was for a short period and is at the threshold of survival for the bald cypress forest.

Based on the fact that the current system is a fresh water system the need for any salinity modeling within the project area is not warranted. It may be necessary to review the previous salinity models for Lake Pontchartrain and determine the effect of the diversion on that system. The modeling of the larger system with multiple freshwater inputs is beyond the scope and outside the area of the current project.

Diversion operations, specifically flowrates, were considered in the hydrologic modeling for each alternative

Agreed. Additional modeling will be completed during -PED which will better depict water, nutrient, and sediment flow through the system. The additional modeling results will also influence revisions to the feasibility-level monitoring and the adaptive management plan that are in place to refine habitat impact analysis and accretion rates

1026

forward to continuing the ongoing LCA planning efforts to restore Louisiana's nationally significant coastal wetlands and resources.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: EPA, Dallas, TX
CEMVN-PM-R
National Marine Fisheries Service, Baton Rouge, LA
LA Dept. of Wildlife and Fisheries, Baton Rouge, LA
LA Dept. of Natural Resources (CMD), Baton Rouge, LA
LOCPZ, Baton Rouge, LA
Natural Resource Conservation Service, Alexandria, LA

1027

United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506

April 30, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The Louisiana Coastal Area – Small Diversion at Convent/Blind River Integrated Feasibility Report and Environmental Impact Statement (EIS) is being prepared by the U.S. Army Corps of Engineers (Corps), New Orleans District, in partnership with the Louisiana Office of Coastal Protection and Restoration, under the authority of Title VII of the Water Resources Development Act (WRDA) (Public Law 110-114, 121 STAT. 1270) of 2007. Enclosed is our Draft Fish and Wildlife Coordination Act Report for the LCA – Small Diversion at Convent/Blind River project. This report does not constitute the 2(b) report of the Fish and Wildlife Service (Service). This draft report has not been reviewed by the Louisiana Department of Wildlife and Fisheries (LDWF) or the National Marine Fisheries Service (NMFS); however, their comments will be incorporated into the final report.

Should your staff have any questions regarding the enclosed draft report, please have them contact Angelo Trahan of this office at 337/291-3137.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

Enclosures

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1028

the LCA - Small Diversion at Convent/Blind River project were developed, the reiterative process of alternatives refinement and selection was reduced which could preclude the development of alternatives or alternative features which could increase restoration benefits. Therefore, while selection of a TSP has incurred changes to the TSP and/or the TSP features may be warranted based on further planning efforts and refinement of existing assumptions and modeling (i.e., quality control).

The intent of the habitat assessment is to provide a comparison of alternative benefit values and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influences areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit under the operational plan identified.
- Water levels and average flow elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.
- Due to time constraints, impacts associated with the channelization canal were summed up for habitat association as a single habitat type; acreage WVAs on each habitat type are therefore needed.

SERVICE POSITION AND RECOMMENDATIONS

The TSP will benefit the fish and wildlife resources that depend on the shallow flats by providing freshwater, nutrients, and sediment to the many acres that facilitate sediment deposition, increase organic production, increase biological productivity, and reduce conversion of existing habitat to open water. Approximately 21,369 acres would benefit from the proposed project resulting in 6,421 AAHUs of existing habitat at the end of the project life. The Service supports implementation of Alternative 2, a 1,500 cfs diversion at Kentucky, provided the following fish and wildlife recommendations are implemented concurrently with project implementation:

1. Because of the expedited schedule, we continue to find the Corps continues to coordinate with the agencies during the remaining Feasibility phase and the Preconstruction, Engineering, and Design (PED) phase to evaluate any new project features, development of the operational plan, and/or changes in the design fully incorporate adequate fish and wildlife conservation measures and that those features can be adequately evaluated with regards to impacts to fish and wildlife resources.

2. We recommend that hydrologic modeling efforts better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within

22

Acknowledged. It is the intent of the USACE and DCFR to continue coordination with the agencies to complete the feasibility phase and on into the PED phase to fully and adequately address impacts to fish and wildlife.

Concur. Additional modeling will be completed during – PED which will better depict water, nutrient, and sediment flow through the system. The additional modeling results will also influence revisions to the feasibility level monitoring and the adaptive management plan that are in place to refine the habitat impact analysis and accretion rates.

1029

each hydrologic unit under the proposed operational plan. These hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and conduct detailed impact analyses. Operation rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Brackish issues be fully addressed without including this in the analysis.

3. To accommodate changing soils and vegetation needs for the region, we recommend that the diversion structure, as well as the outfall management system, be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

4. We recommend that water levels and swamp floor elevations be determined on a refined scale and incorporated into the hydrologic modeling.

5. Salinity predictions should be included in the hydrologic modeling efforts and re-evaluated, and, if necessary, changes be undertaken.

6. Due to time constraints, impacts associated with the transmission canal were assessed in the habitat assessment as a single habitat type; separate WVAs on each habitat type are recommended.

7. If a proposed project feature is changed significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

8. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

9. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), ordnance, and/or commotion, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

10. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at:

13

Concur. The feasibility level monitoring and adaptive management plan includes both pre- and post-diversion monitoring of sediment accretion, elevation, forest composition, and forest productivity. As more specific design information becomes available in the PED phase, the monitoring and adaptive management plan will be revised to address changing environmental conditions and the Project delivery Team will propose more concrete and formalized communication mechanisms for the exchange of information to inform operational decisions related to the diversion structure and outfall management system.

Concur. Additional modeling will be done as part of PED to refine the water surface elevations along with limited swamp floor elevations in areas proximal to berm cuts and design features. During PED hydraulic analysis of the entire system will be performed.

There have been several papers written on salinity changes in Lake Pontchartrain due to the diversions planned for Blind River and Hope Canal. (1. Georgiou, I.Y., McCorquodale, J. A., Schindler, J., Rotava A.G., FitzGerald, D M., Hughes, Z , Howes, N., 2009, Impact of Multiple Freshwater Diversions on the Salinity Distribution in the Pontchartrain Estuary under Tidal Forcing. 2. Georgiou, I.Y., 2010, High Frequency Response and Transport in the Pontchartrain Basin due to wind stress) What is important to learn from these studies is that the salinity levels in Lake Maurepas under normal conditions (i.e. no tropical events) are in the range considered a fresh water lake (less than 1.5 parts per thousand). Within Lake Pontchartrain, the salinity levels are referred to as oligohaline (0.5 5.0 ppt). For the project area the salinity levels are not an issue at any times except tropical events and long term drought periods. The conditions of tropical events are so different that any modeling of salinity levels has no bearing on the project objectives. The key feature of the project is to be able to flush the salinity from the area, which based on the hydraulic detention times modeled in the report, can occur in less than 7 days which is sufficient to avoid salinity intrusion into the tree root zones thus causing some levels of mortality. A long drought period in 1999 caused the salinity levels of Lake Maurepas to approach 4 parts per thousand This was for a short period and is at the threshold of survival for the bald cypress forest.

Based on the fact that the current system is a fresh water system the need for any salinity modeling within the project area is not warranted. It may be necessary to review the previous salinity models for Lake Pontchartrain and determine the effect of the diversion on that system. The modeling of the larger system with multiple freshwater inputs is beyond the scope and outside the area of the current project.

Discussion. The alignment for the transmission canal is located almost wholly within agriculturally active lands and thus was treated as a single habitat type. The WVA was conducted in a manner consistent with the habitat type within the project study area the majority of which is cypress-tupelo. A sensitivity analysis will be performed to the extent possible for the WVA to demonstrate which variables are most sensitive, and therefore, crucial to the success of the project, to address the fact that the benefits presented depend on a number of highly uncertain factors, and to demonstrate whether the range of benefits estimated in the WVA will still be realized.

Concur. USACE will re-initiate coordination with USFWS if any delay greater than one year is realized or if any of the project features changes significantly; this will be done to ensure no adverse effects to any Federally listed threatened or endangered species or their critical habitats.

1030

which hydrologic unit under the proposed operational plan. These hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and assess detailed impacts analysis. Assessment tools need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits can not be fully addressed without including this in the analysis.

3. To help maximize changing goals and restoration levels for the region, we recommend that the diversion structure, as well as the habitat management system, be designed to incorporate operational flexibility to achieve that giving environmental conditions through an adaptive management program.

4. We recommend that water levels and season those elevations be determined with a refined acidic And interpreted into the hydrologic modeling.

5. Salinity conditions should be included in the hydrologic modeling efforts and re-evaluated, and, if necessary, changes in undertaken.

6. Fire to four, specimens, displays associated with the construction event were agreed in the habitat assessment to a single habitat type, separate W/Ac are much habitat type are recommended.

7. (If proposed project features do not result significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps initiate coordination with the USFWS to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species of their critical habitat.

8. Avoid adverse impacts to bald eagle nesting locations and wintering bald eagles through careful design of project features and timing of implementation. A qualified biologist should interpret the proposed work site for the presence of both occupied nesting bald eagles during the nesting season (i.e., February 14 through October 31 for nesting bald nesting activities, and October through mid-May for bald eagles).

9. To minimize disturbance to activities concerning nesting bald eagles, herons, egrets, night herons, ibis, and snowy spoonbills, ospreys, and/or cormorants, all activity occurring within 1,000 feet of a worksite would be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site construction personnel be informed of the need to identify active nesting birds and their nests, and should avoid affecting them during the nesting season.

10. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. This evaluation may be conducted on-line or

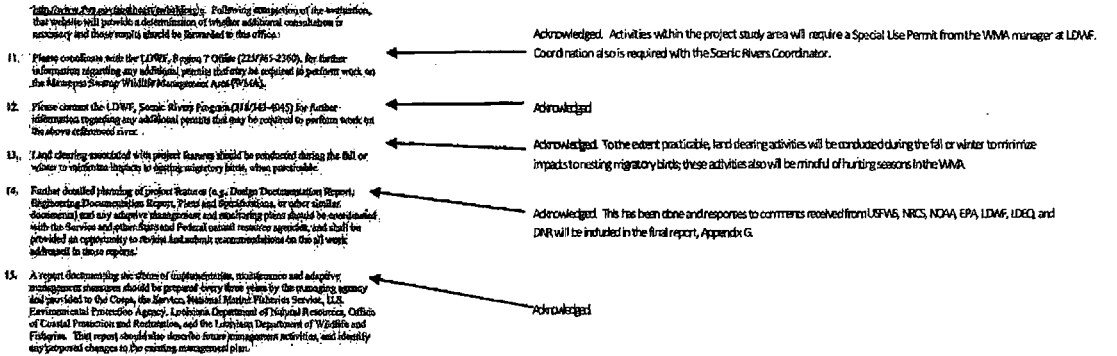
Agreed. USACE will re-initiate coordination with USFWS if any delay greater than one year is realized or if any of the project features changes significantly; this will be done to ensure no adverse affects to any Federally listed threatened or endangered species or their critical habitats.

Acknowledged

Acknowledged

Acknowledged

1031



[illegible] [illegible] [illegible]. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

11. Please coordinate with the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on the Maurepas Swamp Wildlife Management Area (WMA).

12. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

13. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

14. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar documents) and any adaptive management and monitoring plans should be coordinated with the Service and other State and Federal natural resource agencies, and shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

15. A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. That report should also describe future management activities, and identify any proposed changes to the existing management plan.

Acknowledged. Activities within the project study area will require a Special Use Permit from the WMA manager at LDWF. Coordination also is required with the Scenic Rivers Coordinator.

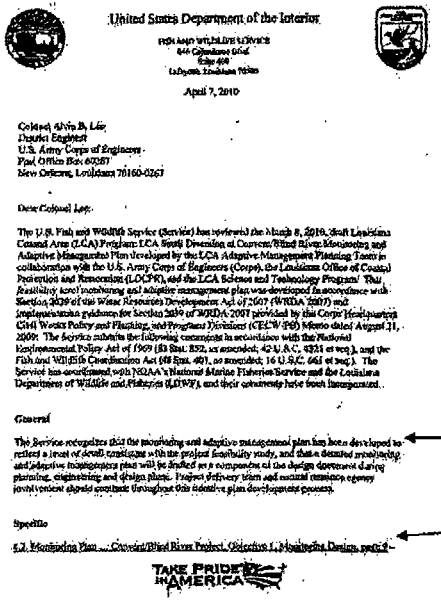
Acknowledged

Acknowledged. To the extent practicable, land clearing activities will be conducted during the fall or winter to minimize impacts to nesting migratory birds; these activities also will be mindful of hunting seasons in the WMA.

Acknowledged. This has been done and responses to comments received from USFWS, NRCS, NOAA, EPA, LDWF, LDEQ, and DNR will be included in the final report, Appendix G.

Acknowledged

1032



United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd
Suite 400
Lafayette, Louisiana 70506

April 7, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

The U.S. Fish and Wildlife Service (Service) has reviewed the March 8, 2010, draft Louisiana Coastal Area (LCA) Project LCA Small Diversion at Convent/Blind River Monitoring and Adaptive Management Plan developed by the LCA Adaptive Management Planning Team in collaboration with the U.S. Army Corps of Engineers (Corps), the Louisiana Office of Coastal Protection and Restoration (LOCPR), and the LCA Science and Technology Program. This feasibility level monitoring and adaptive management plan was developed in accordance with Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) and implementation guidance for Section 2039 of WRDA 2007 provided by the Corps Headquarters Civil Works Policy and Planning and Programs Directorate (CECW-PCP) Memo dated August 31, 2009. The Service submits the following comments in accordance with the National Environmental Policy Act of 1969 (83 Stat. 852, as amended; 42 U.S.C. 4321 et seq.), and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Service has coordinated with NOAA's National Marine Fisheries Service and the Louisiana Department of Wildlife and Fisheries (LDWF), and their comments have been incorporated.

General

The Service recognizes that the monitoring and adaptive management plan has been developed to reflect a level of detail consistent with the project feasibility study, and that a detailed monitoring and adaptive management plan will be drafted as a component of the design document during planning, engineering and design phase. Project delivery team and natural resource agency involvement should continue throughout this iterative plan development process.

It is the intent of the Adaptive Management Planning Team to continue coordination with the Project Delivery Team and their natural resource agency team members.

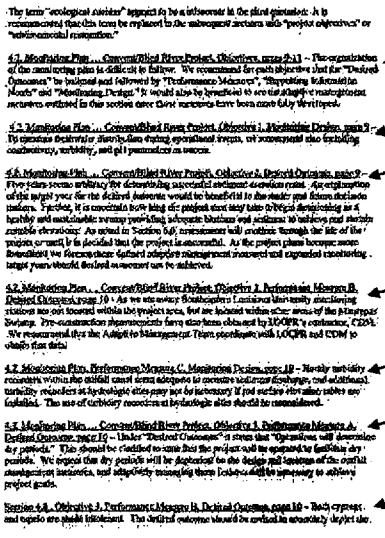
Specific

1. Monitoring Plan – Convent/Blind River Project, Objective 1, Monitoring Design, pg 1 –

We do not see the referenced quotation in that section. However, the term "ecological success" comes directly from USACE guidance on implementation of monitoring and adaptive management plans dated August 2009. Therefore, this term must be utilized.

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1033



The term "ecological monitor" appears to be a misnomer in the plant guidance. It is recommended that this term be replaced by the subsequent sections with "project objectives" or "environmental assessment."

4.1 Monitoring Plan ... Convent/Blind River Project, Objectives, page 9-11 – The organization of the monitoring plan is difficult to follow. We recommend for each objective that the "Desired Outcomes" be indicated and followed by "Performance Measures", "Reporting Schedule/Months" and "Monitoring Design." It would also be beneficial to see the adaptive management measures outlined in this section once these measures have been established.

4.2 Monitoring Plan ... Convent/Blind River Project, Objective 1, Monitoring Design, page 9 – The monitor determine diurnal flow during operational events, environment also including conductivity, turbidity, and pH parameters as needed.

4.6 Monitoring Plan ... Convent/Blind River Project, Objective 5, Desired Outcome, page 9 – Five years seems arbitrary for determining successful sediment accretion rates. An explanation of the target year for the desired elements would be beneficial to the reader and future decision makers. Further, it is uncertain how long the project may take to begin functioning as a healthy and sustainable swamp. We agree that during the more detailed development of the Monitoring and Adaptive Management plan in PED, more defined adaptive management measures and expanded monitoring target years may be included should desired outcomes not be achieved.

4.2 Monitoring Plan ... Convent/Blind River Project, Objective 1, Performance Measure B, Desired Outcome, page 10 – As we are aware, Stantec/Jacques Whitford initially established stations are not located within the project area, but are located within other areas of the Mississagi Swamp. Pre-construction measurements have since been obtained by LOCPR's contractor, CDM. We recommend that the Adaptive Management Team coordinate with LOCPR and CDM to obtain that data.

4.2 Monitoring Plan, Performance Measure C, Monitoring Design, page 10 – Hourly turbidity recorders within the outfall canal seem adequate to measure sediment discharge, and additional turbidity recorders at hydrologic sites may not be necessary if soil section does not allow tubes are installed. The use of turbidity recorders at hydrologic sites should be reconsidered.

4.5 Monitoring Plan ... Convent/Blind River Project, Objective 3, Performance Measure A, Desired Outcome, page 10 – Under "Desired Outcome" it states that "Operations will determine dry periods." This should be clarified to state that the project will be operated to facilitate dry periods. We expect that dry periods will be dependent on the design and location of the outfall channel/control structures, and adaptively managing them to the extent will be necessary to achieve project goals.

Section 4.4, Objective 3, Performance Measure B, Desired Outcome, page 10 – Both cypress and tupelo are shade intolerant. The desired outcome should be revised to accurately depict the

Your concern is noted. We may revisit the organizational structure and format during plan revision during PED.

We concur. The multi-parameter instrument used in the synoptic survey can include your recommended parameters.

We agree that five years is somewhat arbitrary for determining successful sediment accretion rates; however a time frame had to be established. We are open to a better suggestion. We agree that it is uncertain how long the project area may take to begin functioning as a healthy and sustainable swamp. We agree that during the more detailed development of the Monitoring and Adaptive Management plan in PED, more defined adaptive management measures and expanded monitoring target years may be included should desired outcomes not be achieved.

Although SLU stations may not be within this project area, tree growth rates will be informative for establishing baseline conditions. Adaptive Management Team will coordinate to obtain CDM data.

The turbidity recorders are included at hydrologic sites because flocculant soils may prohibit accurate measurements of elevation and accretion using SET's and feldspar markers.

We have changed language as suggested. We agree that outfall management features may need to be adaptively managed as stated in section 7.2 Potential Adaptive Management Measures.

The desired outcome was slightly changed to state "Performance of this measure is most dependent ..." It is understood that shade could potentially influence the outcome of this measure which is one reason why densitometer and hemispherical photography measurements, which estimate the amount of crown cover, is also being measured.

1034

limits of this performance measure. Performance of this measure is dependent on achieving historic hydrologic patterns (extended dry periods in the swamp and would be more probable in areas that allow sufficient light (i.e., deforested swamp habitats that are converting to marsh/open water).

Section 4.2., Objective 1, Performance Measure B, Monitoring Design, Page 10 – Changes in forest classes is not reflected in the Performance Measure. Documenting the increase or decrease in the number of cypress and tupelo should be adequate. If these species decline project success would not be obtained. If it is a goal to document cover class changes, that should be included as a performance measure.

Language has been revised to clarify. It is not the goal to document changes in cover class, but only to determine numbers of baldcypress and tupelo sapling and seedlings.

Section 4.2., Objective 4, Page 15 – Hydrologic and water quality parameters are a significant portion of the monitoring procedures and should provide performance measures for improving aquatic habitat within the project area. We recommend revising Objective 4 to include performance measures, descriptors, and design relative to improving aquatic habitat based on water quality parameters (i.e., increased dissolved oxygen concentration).

The monitoring plan was developed to directly measures factors if possible. Monitoring for objectives one, two, and three is the minimal information necessary to determine project success and/or adaptive management needs. The team will coordinate with LDWF to incorporate their biological sampling to indirectly measures habitat which will further strengthen the data used to determine project success.

Additionally during PED the Adaptive management and monitoring plan will be revised based on the final project designs. At this time the water quality elements will be revisited and revised as necessary in coordination with agencies to ensure that the appropriate level of monitoring and adaptive management actions are in place to identify any water quality issues and remedy them if they should occur.

Furthermore, improved fish and wildlife habitat could be also measured indirectly through fish surveys or wildlife surveys, and the Conceptual Ecological Model (page 15) indicates that fish sampling will be performed. The LDWF have historical data on Bayou Pierre and is still presently surveying it to use a point in their biological sampling program. We recommend coordinating with the LDWF to incorporate and expand their baseline data to develop performance measures and desired outcomes for this objective; please contact Robert Bourgeois and Heather Finley with LDWF at (225) 765-0765, and (225) 765-2956, respectively.

Comment noted and language revised accordingly.

Section 4.2., Objective 4, Risk Endpoint, page 16 – It is unclear as to the implication of the monitoring decision point titled "Risk Endpoint," and it is only listed as an item under Objective 4. It may be beneficial to the reader to define this and other adaptive management terms in the plan.

All vegetation sampling is conducted annually.

Section 4.2.1, Monitoring Procedures, Vegetation, page 11 – This section states that diameter-at-breast height (DBH) of all tagged trees will be measured at regular fixed intervals. These intervals should be identified whether it is annually, biannually, or by some another protocol.

Both monitoring locations and reference sites have yet to be established, but will be established during the plan revision in PED. When discussing establishment of these sites, adaptive management team will coordinate with LDCRR and CPRA.

Section 4.2.1, Monitoring Procedures, Vegetation, page 11, and Sediment Accretion and Elevation, page 12 – Reference locations should be designated within the monitoring and adaptive management plan and should be coordinated with LDCRR and CPRA who may have already implemented reference locations.

We concur on including conductivity and pH at interior and river hydrologic stations. Pre-project monitoring is critical and this project will conduct pre-construction monitoring for two years during PED. Satellite photography was considered during plan development but was dropped due to the inability to track distribution of freshwater and sediments due to tree cover.

Section 4.2.1, Monitoring Procedures, Hydrology, page 14 – We recommend including conductivity and salinity (ppt) to the hydrologic parameters of the interior swamp. We also recommend expanding the sampling area and parameters of the open water habitats (i.e., Blind River and Mississippi River Outfall boundary) to include the project area drainage channels which support local aquatic habitat. Collecting baseline conditions are important to understand changes as a result relative to an action; therefore, including pre-project sampling should be

1035

included.

In regards to tracking the distribution of freshwater and sediments, we recommend considering using satellite photography as an adaptive management tool. Partner Allegheny with the Corps' Engineer Research and Development Center and Pete Gilbert with the Corps' New Orleans District have used satellite signatures and gauge data to identify flow paths (and flooding regimes) at different river discharges into the Atchafalaya and Barataria basins, respectively. We suggest including this method to supplement the analysis and help identify areas not receiving flow (frequency/duration) and use this information to guide outfall management.

Section 4.2.1: Monitoring Procedure; Water Quality, page 12 – Higher salinity values within the project area are a result of tropical storm events and possibly severe drought conditions. Hourly measurements seem unnecessary.

The multi-parameter instrument used to measure salinity also measures water level, which requires hourly measurements to calculate depth, duration and frequency of flooding. Additionally, less frequent discrete measurements would require many more field team deployments which would not provide any significant cost savings compared to the additional cost of the instrumentation and data processing.

We like this suggestion and agree that this information is necessary and that the plan should define these time frames. However, it is impossible to estimate these dates at this early stage in the project. We will address this during the plan revision in PED.

Section 5.0, Assessment, page 14 – We recommend development of a table that identifies each performance measure, anticipated completion dates for each phase of the planned assessment action, and expected dates for report dissemination to the Adaptive Management Team and the Program Management Team. We understand that assessment completion and report delivery dates will be tentative and subject to change; however, assurance should be provided that reasonable time frames will be established, and necessary modifications will be identified and brought to the attention of the program managers in a timely manner. In the absence of a schedule for action, data analysis and reporting and identification of needed modifications could be unacceptably delayed or not completed.

Concur. The final report reflects this change.

Annex 1, Conceptual Ecological Model, Section 2.2, Project Background, page 2 – The last sentence should be revised to state, "These factors combined with increasing occurrences of episodic high salinities ...will result in a highly degraded swamp system which is at risk of conversion to open water."

Concur. The final report reflects this change

Annex 1, Conceptual Ecological Model, Section 2.2, Project Background, page 6 – The project description should be revised to state that the proposed diversion project could introduce up to 3,000 cubic feet per second.

Annex 1, Conceptual Ecological Model, Section 3.1.2, Altered Hydrology, page 10 – While cypress and tupelo trees are able to grow in flooded conditions, prolonged flooding could result in decreased growth rates and eventually tree mortality. Increasing dry periods from existing conditions could be very beneficial to the existing forest stand. We recommend revising this section accordingly.

Concur. The final report reflects this change.

Annex 1, Conceptual Ecological Model, Section 3.2.2, Fish and Wildlife, pages 14-15 – The bald eagle was removed from the Federal list of threatened and endangered species on August 8, 2007. Further, the endangered West Indian manatee (*Trichechus inunguis*) and pallid sturgeon (*Scaphirhynchus albus*) are likely to occur in the project area. This section should be revised accordingly.

Concur. The final report reflects this change.

1036

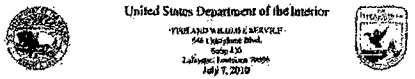
We appreciate the opportunity to review and comment on the draft monitoring and adaptive management plan, and look forward to continued coordination with the LCA Adaptive Management Framework Team. Should you have any questions regarding our comments, please contact Angela Trahan (337/291-3137) at this office.

Sincerely,

Pamela E. Boggs
Supervisor
Louisiana Field Office

cc: EPA, Dallas, TX
NMFS, Baton Rouge, LA
Corps, New Orleans, LA (Attention: Dr. William Klein, CEMVN-PM-RS)
LDWF, Region 7 Office, Baton Rouge, LA
LDWF, Baton Rouge, LA (Attn: Kyle Balkum)
LDWF, Baton Rouge, LA (Attn: Hester Fixley)
LCPB, Baton Rouge, LA

1037



United States Department of the Interior

FISH AND WILDLIFE SERVICE
646 Cajundome Blvd.
Suite 400
Lafayette, Louisiana 70506
July 7, 2010

Colonel Alvin B. Lee
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Lee:

Please reference the letter and attached Biological Assessment (BA) dated May 21, 2010, sent by Mr. Richard Boe, Acting, Chief of your Environmental Branch, requesting our concurrence with your determination of effects of the proposed Small Diversion at Convent/Blind River to the endangered pallid sturgeon (*Scaphirhynchus albus*). You have determined that the project is likely to adversely affect this species. The Fish and Wildlife Service (Service) comments are provided in accordance with Section 7 of the Endangered Species Act (87 stat. 884, as amended; 16 U.S.C. 1531 et seq.).

The proposed project involves the construction of a small sized (up to 3,000 cubic feet per second (cfs)) freshwater diversion located at approximately River Mile (RM) 160 near Romeville, Louisiana for the purpose of helping freshwater flow into a portion of the Maurepas Basin. The proposed operating plan has not been fully developed. Informal consultation between the U.S. Army Corps of Engineers (Corps) and the Service has been ongoing since 2005; however, no coordination has been conducted for the proposed project.

According to your BA, pallid sturgeon are known to be extremely abundant in the vicinity of the proposed diversion. Furthermore, recent sampling has confirmed at least one pallid sturgeon has been entrained in the Davis Pond freshwater Diversion (RM 119). The Corps concluded that the Small Diversion at Convent/Blind River is likely (i.e., has the potential) to adversely affect the pallid sturgeon. Considering the above information and the information on the swimming ability of sturgeon presented in the BA, the Service concurs with the Corps' conclusion.

In order to ensure compliance with the Endangered Species Act, and to ensure the Service has sufficient information required to initiate formal consultation the following information will be required:

1) The distance and velocity of flow fields excepting from the structure into the river should be determined, if feasible. This determination should be done at the proposed discharges (and various structure openings to achieve those discharges) to determine

a. The velocity through the culvert at design flow is approximately 10 feet per second. (Triple 10 foot by 10 foot culverts with a cross section area of 300 feet and a diversion flow of 3000 cubic feet per second.)

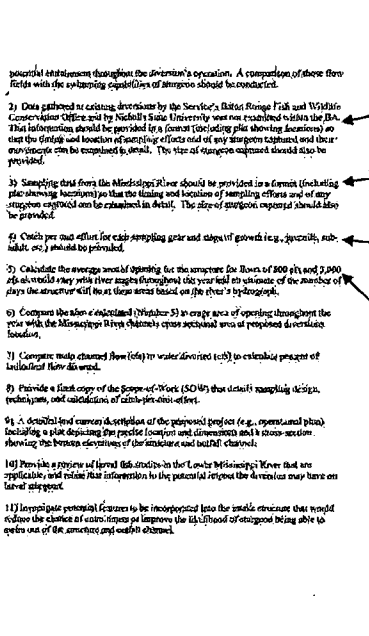
b. There is in the current conceptual design a trash rack that will be considerably larger in total area than the culverts and will be sloped at a distance approximately 10 feet from the face of the culverts.

c. The conceptual design shows the inlet channel from the Mississippi River a distance of approximately 300 feet, to be concrete lined. This lining is not to protect from inlet velocities caused by the diversion, but from the velocities of the Mississippi River which can range from 4 to 6 feet per second.

d. From the reports available the Pallid Sturgeon adults can swim at about 8 feet per second for short periods. The young sturgeons are limited to about 1 to 2 feet per second. They can actually swim upstream in higher velocity currents due to their ability to use the channel bottom and sides for propulsion. (2.)

e. At a distance of 30 feet from culvert face the velocity from the diversion is approximately 2.5 feet per second which is less than the 5 feet per second normal velocity in the Mississippi River. The actual configuration of the diversion entrance will be more downstream than shown on the current feasibility drawings for the purpose of keeping floating debris from entering the diversion channel. This may also assist in keeping the Pallid Sturgeon from entering the diversion.

1038



potential entrainment throughout the diversion's operation. A comparison of these flow fields with the sampling capabilities of sturgeon should be conducted.

2) Data gathered at existing diversions by the Service's Ohio River Fish and Wildlife Conservation Office and by Nicholls State University must be examined within the BA. That information should be provided in a format (including plan showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (including plan showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, sub-adult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs. It would vary with river stages throughout this year-field to estimate of the number of days the structure will be at these areas based on the river's hydrograph.

6) Compare the also e calculated (Number 5) as cross area of opening throughout the year with the Mississippi River channel's cross sectional area at proposed diversions locations.

7) Compare mean channel flow (cfs) to water diverted (cfs) to calculate percent of bulk/total flow diverted.

8) Provide a hard copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculations of catch-per-unit-effort.

9) A detailed and current description of the proposed project (e.g., operational plan) including a plat depicting the precise location and dimensions and a cross-section showing the bottom elevations of the structure and bottom channel.

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable, and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Incorporate potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and exhibit distress.

Response to be provided by Glen Constance.

Response to be provided by ERDC.

Response to be provided by ERDC.

a. The culvert is currently set at elevation 0 MSL and the top is at elevation 10 MSL so at the operating point of 11 MSL in the River the diversion will deliver 3000 cubic feet per second. The diversion gates are automatically adjusted to maintain the 3000 cubic feet per second with changing levels of the Mississippi River and changing downstream tidal conditions from Lake Maurepas.

b. The following table shows the calculated flow and culvert cross section area for the River stages below 11 feet MSL:

1039

potential entrainment throughout the diversion's operation. A computation of these flow limits with the swimming capabilities of sturgeon should be conducted.

2) Data gathered at existing diversions by the Service's Bacon Escape Fish and Wildlife Conservation Office and by Nicholls State University was not examined within the EA. That information should be provided in a format (including plot showing locations) so that the timing and location of sampling efforts and of any sturgeon captured and their movements can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (including plot showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, sub-adult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs as would vary with river stages throughout the year and an estimate of the number of days the structure will be at these rates based on the river's hydrograph.

6) Compare the above calculated (5) either 5) average area of opening throughout the year with the Mississippi River channels cross sectional area at proposed diversions location.

7) Compare main channel flow (cfs) to water diverted (cfs) to calculate percent of latitudinal flow diverted;

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculation of catch per-unit-effort.

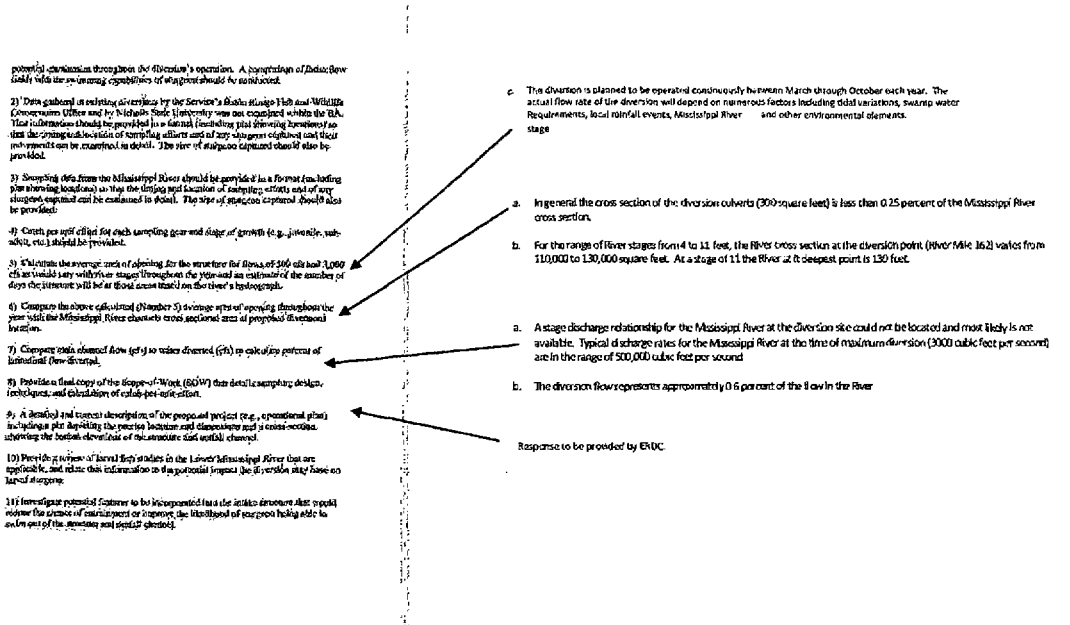
9) Actualized and existing description of the proposed project (e.g., operational plan) including a plot depicting the overlay for inlet and diversions and a cross-section showing the bottom elevations of the structure and outfall channel.

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable, and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Investigate potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and outfall channel.

Blind River Diversion Culverts Flow - Stage Relationship				
Stage In Mississippi River (feet)	Culvert Cross Section (sq. feet)	Discharge Flow Rate (cubic feet / sec.)	Velocity at Face of Culverts (Feet / Sec.)	Annual Average Percent Exceedence (%)
>11	For River stages greater than 11 the gates will be automatically controlled to limit flows to 3000 cubic feet per second			
11	300	3000	10	47
10	300	2900	9.7	48
9	270	2600	9.5	51
8	240	2300	9.6	56
7	210	1800	8.6	61
6	180	1300	7.2	68
5	150	1000	6.7	74
4	120	800	6.7	80
<4	For River stages less than 4, flows are negligible and depend on Lake Maurepas tidal variations.			

1040



potential variations throughout the diversion's operation. A comparison of fish flow fields with the swimming capabilities of target species should be conducted.

2) Data gathered at existing diversions by the Service's Alpena Fishery Resources Office and by Michigan State University was not examined within the EA. That information should be provided in a format (including plan drawing locations) so that the geographic location of sampling efforts and of any sturgeon captured and their movements can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format including plan drawing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, subadult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 1,000 cfs as would vary with river stages throughout the year and an estimate of the number of days the structure will be at those areas based on the river's hydrograph.

6) Compare the above calculated (Number 5) average area of opening throughout the year with the Mississippi River channel's cross sectional area at proposed diversion location.

7) Compare total channel flow (cfs) to water diverted (cfs) to calculate percent of withdrawal (low-diversion).

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculation of catch-per-unit-effort.

9) A detailed and correct description of the proposed project (e.g., operational plan) including a plan depicting the precise location and dimensions and a cross-section showing the bottom elevation of the structure and outfall channel.

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable, and relate this information to the potential impact the diversion may have on larval sturgeon.

11) Investigate potential features to be incorporated into the intake structure that could reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the screening and outfall channel.

c. The diversion is planned to be operated continuously between March through October each year. The actual flow rate of the diversion will depend on numerous factors including tidal variations, swamp water Requirements, local rainfall events, Mississippi River stage and other environmental elements.

a. In general the cross section of the diversion culverts (300 square feet) is less than 0.25 percent of the Mississippi River cross section.

b. For the range of River stages from 4 to 11 feet, the River cross section at the diversion point (River Mile 162) varies from 110,000 to 130,000 square feet. At a stage of 11 the River at it deepest point is 130 feet.

a. A stage discharge relationship for the Mississippi River at the diversion site could not be located and most likely is not available. Typical discharge rates for the Mississippi River at the time of maximum diversion (3000 cubic feet per second) are in the range of 500,000 cubic feet per second

b. The diversion flow represents approximately 0.6 percent of the flow in the River

Response to be provided by ENDC

1041

...operational measures throughout the diversion's operations. A comparison of these flow fields with the swimming capabilities of sturgeon should be conducted.

2) Data collected at existing diversions by the Service's Region 4 Fish and Wildlife Conservation Office and by Nicholls State University who are contracted within the BA. This information should be provided in a format (like bullet) plot showing locations) so that the timing and location of sampling efforts and pallid sturgeon captured and their movements can be examined in depth. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (like bullet) plot showing locations) so that the timing and location of sampling efforts and pallid sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, subadult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs in vessel very small gaps throughout the year and an estimate of the number of days the structure will be at these areas listed on the flyer's paragraph.

6) Compare the above calculated (Number 5) average area of opening throughout the year with the Mississippi River channel's cross sectional area at proposed diversion's position.

7) Compare main channel flow (cfs) to areas directed (cfs) to calculate percent of diminished flow diverted.

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, techniques, and calculation of catch-per-unit-effort.

9) A detailed and current description of the proposed project (e.g., operational plans) including a plan depicting the precise location and dimensions and a cross-section showing the bottom elevation of the structure and outfall channel.;

10) Provide a review of larval fish studies in the Lower Mississippi River that are applicable and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Describe any potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and outfall channel.

a. The diversion is a gated structure with gates automatically controlled to divert a set volume of flow from 500 to 3000 cubic feet per second.

b. The current design includes a trapezoidal channel that will connect the culverts at the levee to the Mississippi. The culverts and the inlet channel elevations will be at approximately 0 Mean Sea Level (MSDBS).

c. At the end of the entrance channel there is proposed to be a trash rack approximately 20 feet in height (El 0 to El. 20) sloped at approximately 60 degrees to horizontal. The primary purpose of the rack is to keep debris from entering the St. James drainage system and the Blind River.

d. The culverts are proposed to be three 10 foot by 10 foot cast in place concrete culverts with integral cut off wall to protect the integrity of the existing levee. Slide gates will be used to control the flow and to shut tightly to stop all diversion flow.

e. After the flow passes through the culverts at velocities of 10 feet per second they enter a stilling basin that is part of the transmission canal extending approximately 3 miles to the St. James drainage system. The transmission canal is a trapezoidal earthen channel with elevated guide levees. Typical channel velocities are 1.5 to 2.0 feet per second.

f. St. James drainage canals are used for distribution to the swamp through calibrated berm gaps through the spoil banks from the drainage channel dredging.

g. To control short circuiting of diversion waters to the Blind River the drainage canals will be modified with control structures. The exact design of the control structures may change during the design and value engineering process, but are currently in the project as downward opening crest gates at the locations.

h. There will be four sets of culverts installed under Highway 61 to promote hydraulic connectivity through the swamp.

1042

potential entrainment throughout the diversion's operation. A comparison of these flow fields, with the swimming capabilities of sturgeon, should be conducted.

2) Data gathered at existing diversions by the Service's Baton Rouge Fish and Wildlife Conservation Office and by Nicholls State University was not examined within the EA. That information should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured and their movements can be examined in detail. The size of sturgeon captured should also be provided.

3) Sampling data from the Mississippi River should be provided in a format (including plat showing locations) so that the timing and location of sampling efforts and of any sturgeon captured can be examined in detail. The size of sturgeon captured should also be provided.

4) Catch per unit effort for each sampling gear and stage of growth (e.g., juvenile, sub-adult, etc.) should be provided.

5) Calculate the average area of opening for the structure for flows of 500 cfs and 3,000 cfs as would vary with river stages throughout the year and an estimate of the number of days the structure will be at those areas based on the river's hydrograph.

6) Compare the above calculated (Number 5) average area of opening throughout the year with the Mississippi River channels cross sectional area at proposed diversion location.

7) Compare main channel flow (cfs) to water diverted (cfs) to calculate percent of hydraulic flow diverted.

8) Provide a final copy of the Scope-of-Work (SOW) that details sampling design, methodology, and calculation of catch-per-unit-effort.

9) A detailed and current description of the proposed project (e.g., operational plan) including a plat depicting the precise location and dimensions and a cross-section showing the bottom elevations of the structure and outfall channel.

10) Provide a review of larval fish studies on the Lower Mississippi River that are applicable, and relate that information to the potential impact the diversion may have on larval sturgeon.

11) Investigate potential features to be incorporated into the intake structure that would reduce the chance of entrainment or improve the likelihood of sturgeon being able to swim out of the structure and outfall channel.

Response to be provided by ERDC.

a. As mentioned earlier the angle that the diversion meets the River can be turned towards the downstream direction by about 15 to 20 degrees so that floating debris will not enter the diversion channel.

b. A short wall could be included in the inlet channel so that the sturgeons that primarily swim near the bottom would not enter the diversion channel and would stay in the main body of the River.

1043

(12) The relative abundance of pallid sturgeon compared to the shovelnose sturgeon and other fish species in the Lower Mississippi River. The relative abundance should be presented by sampling gear type and by stage of growth (e.g., juvenile, sub-adult, etc.).

The formal consultation process for the project will not begin until we receive the above information, or a statement explaining why that information cannot be made available. We will confirm our receipt of this information in our notification letter to you which will also outline the dates within which formal consultation on the proposed action should be complete and our biological opinion delivered.

Response to be provided by LHOC.

Section 7 of the ESA allows the Service up to 90 calendar days to conclude formal consultation with your agency and an additional 45 calendar days to prepare our biological opinion. As a reminder, the ESA requires that after initiation of formal consultation the Federal action agency may not make any irreversible or irretrievable commitment of resources that limits future options. This practice insures agency actions do not preclude the formulation or implementation of reasonable and prudent alternatives that avoid jeopardizing the continued existence of endangered and threatened species or destroying or modifying their critical habitats.

If you have any questions or concerns about this consultation or the consultation process in general, please feel free to contact David Walther of this office at 337/291-3122.

Sincerely,

James F. Boggs
Supervisor
Louisiana Field Office

cc: FWS, Ecological Services, Jackson, MS
FWS, Fish and Wildlife Resource Office, Baton Rouge, LA
SHPO, Vicksburg, MS
LDWF, Natural Heritage Program, Baton Rouge, LA
OPCR, Baton Rouge, LA

1044

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
1001 Indian School Road NW, Suite 348
Albuquerque, New Mexico 87104

ER 10/878
File 9043.1

June 29, 2010

Joan Exnicios
Chief, Environmental Planning & Compliance Branch
New Orleans District
U.S. Army Corps of Engineers
PO Box 60267
New Orleans, Louisiana 70160-0267

Subject: Draft Environmental Impact Statement for Small Diversion at Convent/Blind River, Freshwater Diversion Project, Integrated Feasibility Study, Louisiana Coastal Area (LCA), St. James Parish, LA

Dear Ms. Exnicios:

The U.S. Department of the Interior has reviewed the information provided and offers the following comments in accordance with provisions of the National Environmental Policy Act (NEPA) of 1969 (83 Stat. 852; 42 U.S.C. 4321 et seq.), the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

The tentatively selected plan will benefit the fish and wildlife resources that depend on the Maurepas Swamp by providing freshwater, nutrients, and sediments to the study area thus facilitating sediment deposition, increased organic production, increased biological productivity, and reduced conversion of swamp habitat to open water. Approximately 21,349 acres would benefit from the proposed project resulting in 6,421 Average Annual Habitat Units of swamp habitat at the end of the project life.

General Comments

The DEIS provides a good description of fish and wildlife resources within the study area, the purpose and need for the proposed action, program objectives, critical needs and opportunities, and potential risks and uncertainties. Given the substantial adverse future impacts to coastal wetlands and their associated fish and wildlife resources that are expected to occur under future-without-project conditions, the U.S. Fish and Wildlife Service strongly supports authorization of the proposed freshwater diversion project, as it would improve environmental conditions by increasing swamp productivity and reducing the trend of deterioration in the Maurepas Swamp.

1045

Please reference the Corps' Biological Assessment (BA) provided in Appendix A. The Corps has evaluated proposed project's effects on the Federally-listed as threatened Gulf sturgeon (*Acipenser oxyrinchus desoto*), endangered pallid sturgeon (*Scaphirhynchus albus*), and endangered West Indian manatee (*Trichechus manatus*).

The pallid sturgeon is found in both the Mississippi and Atchafalaya Rivers (with known concentrations in the vicinity of the Old River Control Structure Complex); it is possibly found in the Red River as well. The pallid sturgeon is adapted to large, free-flowing, turbid rivers with a diverse assemblage of physical characteristics that are in a constant state of change. Detailed habitat requirements of this fish are not known, but it is believed to spawn in Louisiana. Habitat loss through river channelization and dam construction has adversely affected this species throughout its range. Entrainment issues associated with dredging operations in the Mississippi and Atchafalaya Rivers and through diversion structures off the Mississippi River are two potential effects that should be addressed in future planning studies and/or in analyzing current project effects.

Sampling conducted by the Corps' Engineer Research and Development Center (ERDC) in 2005 and 2006 for the Lake Maurepas Diversion Project, a Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) project, resulted in the capture of 10 adult pallid sturgeon in the Mississippi River near the Gramercy Bridge. That location provides habitat similar to the littoral habitat of the proposed Blind River/Convent Diversion sites. The Corps has determined that due to the documented populations of pallid sturgeon near the diversion site, the proposed project activities have the potential to adversely affect the pallid sturgeon. Furthermore, additional surveying is ongoing near the proposed Convent/Blind River project area as well as other proposed diversion locations to ascertain more accurate population data. Because of the proposed project is likely to affect pallid sturgeon and monitoring is ongoing, further ESA consultation is necessary, and coordination with the FWS should continue.

West Indian manatees occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals. Please be aware, however, manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana.

According to the BA, the FWS's standard manatee protection measures will be implemented to avoid impacts to the manatee, therefore the FWS concurs that the proposed project is not likely to adversely affect the West Indian manatee.

The Gulf sturgeon is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in these rivers and streams until November and in estuarine or marine waters during the remainder of the year. Sturgeon less than 2 years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations

General comment statements within this letter with regard to protection of the pallid sturgeon and continued coordination with USFWS are acknowledged.

1046

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such as those caused by water control structures that limit and prevent spawning, poor water quality, and over fishing have negatively affected fish species.

Sampling conducted by the Corps' ERDC from November 2005 through June 2006 for the CWPPRA, Lake Maurepas Diversion Project resulted in no Gulf sturgeon being detected via telemetry nor captured in Lake Maurepas. Additionally, Gulf sturgeon likely inhabit Lake Maurepas only during annual migration between the marine habitats and their spawning habitats along the tributary rivers of the north shore of Lake Pontchartrain. The Corps has determined that changes to study area salinity and water temperatures associated with the proposed diversion of freshwater from the Mississippi river are unlikely to adversely affect the Gulf sturgeon as they are only likely to enter the study area during migration. The FWS concurs with the Corp's determination that the proposed project is not likely to adversely affect the Gulf sturgeon. However, should additional hydrologic modeling determine that proposed project would influence Lake Maurepas salinities and water temperatures, additional consultation will be necessary.

The FWS's Lafayette Field Office supports implementation of the proposed project and provided the following fish and wildlife recommendations in their April 2010 Draft FWCA Report:

1. Because of the expedited schedule, we recommend that the Corps continue to coordinate with the agencies during the remaining Feasibility phase and the Preconstruction, Engineering, and Design (PED) phase to ensure any new project features, development of the operational plan, and/or changes in the design fully incorporate adequate fish and wildlife conservation measures and that these features can be adequately evaluated with regards to impacts to fish and wildlife resources.

2. We recommend that hydrologic modeling efforts better identify/quantify influence areas and how water (freshwater and nutrients) moves through the system and within each hydrologic unit under the proposed operational plan. These hydrologic modeling results should be provided to the habitat evaluation team with adequate time to evaluate the results and conduct detailed impacts analysis. Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

3. To accommodate changing goals and restoration needs for the region, we recommend that the diversion structure, as well as the outfall management system, be designed to incorporate operational flexibility to address changing environmental conditions through an adaptive management program.

4. We recommend that water levels and swamp floor elevations be determined on a refined scale and incorporated into the hydrologic modeling.

5. Salinity predictions should be included in the hydrologic modeling effort and re-evaluated, and, if necessary, changes be undertaken.

6. Due to time constraints, impacts associated with the transmission canal were assessed in the habitat assessment as a single habitat type; separate HVAs on each

Acknowledged. It is the intent of the USACE and DCPR to continue coordination with the agencies to complete the feasibility phase and go into the PED phase to fully and adequately address impacts to fish and wildlife.

Concur. Additional modeling will be done as part of PED to refine the water surface elevations along with limited swamp floor elevations in areas proximal to berm cuts and design features. During PED hydraulic analysis of the entire system will be performed.

Concur. The feasibility level monitoring and adaptive management plan includes both pre- and post-diversion monitoring of sediment accretion, elevation, forest composition, and forest productivity. As more specific design information becomes available in the PED phase, this monitoring and adaptive management plan will be revised to address changing environmental conditions and the Project delivery Team will propose more concrete and formalized communication mechanisms for the exchange of information to inform operational decisions related to the diversion structure and outfall management system.

Concur. Additional modeling will be done as part of PED to refine the water surface elevations along with limited swamp floor elevations in areas proximal to berm cuts and design features. During PED hydraulic analysis of the entire system will be performed.

1047

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6. Due to time constraints, impacts associated with the transmission canal were assessed in the habitat assessment as a single habitat type; separate WVAs on each

There have been several papers written on salinity changes in Lake Pontchartrain due to the diversions planned for Blind River and Hope Canal. (1. Georgiou, I.Y., McCorquodale, J. A., Schindler, J., Retana A.G., FitzGerald, D.M., Hughes, Z., Howes, N., 2009, Impact of Multiple Freshwater Diversions on the Salinity Distribution in the Pontchartrain Estuary under Tidal Forcing. 2. Georgiou, I.Y., 2010, High Frequency Response and Transport in the Pontchartrain Basin due to wind stress) What is important to learn from these studies is that the salinity levels in Lake Maurepas under normal conditions (i.e. no tropical events) are in the range considered a fresh water lake (less than 1.5 parts per thousand). Within Lake Pontchartrain, the salinity levels are referred to as oligohaline (0.5-5.0 ppt). For the project area the salinity levels are not an issue at any times except tropical events and long term drought periods. The conditions of tropical events are so different that any modeling of salinity levels has no bearing on the project objectives. The key feature of the project is to be able to flush the salinity from the area, which based on the hydraulic detention times modeled in the report, can occur in less than 7 days which is sufficient to avoid salinity intrusion into the tree root zones thus causing some levels of mortality. A long drought period in 1999 caused the salinity levels of Lake Maurepas to approach 4 parts per thousand. This was for a short period and is at the threshold of survival for the bald cypress forest.

Based on the fact that the current system is a fresh water system the need for any salinity modeling within the project area is not warranted. It may be necessary to review the previous salinity models for Lake Pontchartrain and determine the effect of the diversion on that system. The modeling of the larger system with multiple freshwater inputs is beyond the scope and outside the area of the current project

Discussion. The alignment for the transmission canal is located almost wholly within agriculturally active lands and thus was treated as a single habitat type. The WVA was conducted in a manner consistent with the habitat type within the project study area the majority of which is cypress-tupelo. A sensitivity analysis will be performed to the extent possible for the WVA to demonstrate which variables are most sensitive, and therefore, crucial to the success of the project, to address the fact that the benefits presented depend on a number of highly uncertain factors, and to demonstrate whether the range of benefits estimated in the WVA will still be realized.

1048

habitat type are recommended.

7. If a proposed project feature is changed significantly or is not implemented within one year of the Endangered Species Act consultation letter, we recommend that the Corps reinitiate coordination with our office to ensure that the proposed project would not adversely affect any Federally listed threatened or endangered species or their critical habitat.

Concur. USACE will re-initiate coordination with USFWS if any delay greater than one year is realized or if any of the project features change significantly; this will be done to ensure no adverse affects to any Federally listed threatened or endangered species or their critical habitats.

8. Avoid adverse impacts to bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. A qualified biologist should inspect the proposed work site for the presence of undocumented wading bird nesting colonies and bald eagles during the nesting season (i.e., February 16 through October 31 for wading bird nesting colonies, and October through mid-May for bald eagles).

Acknowledged

9. To minimize disturbance to colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), activities, worker movements, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period (i.e., September 1 through February 15, exact dates may vary within this window depending on species present). In addition, we recommend that on-site contract personnel be informed of the need to identify colonial nesting birds and their nests, and should avoid affecting them during the breeding season.

Acknowledged.

10. Because bald eagles are known to nest within the proposed study area, we recommend that an evaluation be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/eagle/. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary and those results should be forwarded to this office.

Acknowledged.

11. Please coordinate with the LDWF, Region 7 Office (225/765-2360), for further information regarding any additional permits that may be required to perform work on the Maurepas Swamp Wildlife Management Area (WMA).

Acknowledged. Activities within the project study area will require a Special Use Permit from the WMA manager at LDWF Coordination also is required with the Scenic Rivers Coordinator

Acknowledged.

12. Please contact the LDWF, Scenic Rivers Program (318/343-4045) for further information regarding any additional permits that may be required to perform work on the above referenced river.

Acknowledged.

13. Land clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

Acknowledged. To the extent practicable, land clearing activities will be conducted during the fall or winter to minimize impacts to nesting migratory birds; these activities also will be mindful of hunting seasons in the WMA.

14. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, or other similar document(s)) and any adaptive management and monitoring plans should be coordinated with the FWS and other State and Federal natural resource agencies, which shall be provided an opportunity to review and submit recommendations on all the work addressed in those reports.

Acknowledged. This has been done and responses to comments received from USFWS, NRCS, NOAA, EPA, LDWF, LDEQ, and DNR will be included in the final report, Appendix C.

1049

5

15 A report documenting the status of implementation, maintenance and adaptive management measures should be prepared every three years by the managing agency and provided to the Corps, the FWS, National Marine Fisheries Service, U.S. Environmental Protection Agency, Louisiana Department of Natural Resources, Office of Coastal Protection and Restoration, and the Louisiana Department of Wildlife and Fisheries. This report should also describe future management activities, and identify any proposed changes to the existing management plan.

Acknowledged.

Additionally, the FWS recommends that project designs for cross culverts proposed under U.S. Highway 61 and the Kansas City Southern Railroad and other bridge openings incorporate features to ensure fish and wildlife passage. This should be incorporated into the design of the project culverts and bridges that would also facilitate other restoration initiatives of the project (e.g., improving hydrology, and the movement of sediment and nutrients). Please refer to the following websites for additional information:

- Wildlife and Roads: A resource for mitigating the effects of roads on wildlife using wildlife crossings such as overpasses, underpasses, and crosswalks.

  http://www.wildlifeandroads.org/decisiongmde/

- Evaluation of the Use and Effectiveness of Wildlife Crossings, Final Report Prepared by U S. Geological Survey for the National Cooperative Highway Research Program Transportation Research Board of The National Academies.

  http://www.trb.org/NotesDocs/25-27_FR.pdf

The culverts to be installed under Highway 61 are low profile culverts that will be mostly submerged. Aquatic life will be able to cross through the culverts as well as small animals that can swim through the culverts when water levels are low. There may be times when the culverts become totally submerged.

Due to the elevation of the road it is not possible to allow for culverts of sufficient height to allow for passage of deer and other large animals. The roadway is an impediment to flow movement through the swamp and the culverts will allow the flow to equalize on both sides of the road.

Specific Comments

3.7.7 Monitoring Plan and Adaptive Management, page 3-101, line 27 – The Monitoring and Adaptive Management Plan is included in Appendix F; this section should be revised accordingly. Additionally, monitoring objectives and performance measures discussed in the main report do not coincide with those detailed in the draft Monitoring and Adaptive Management Plan. The FWS recognizes that the development of the monitoring and adaptive management plan is an iterative process that reflects a level of detail consistent with the project feasibility study. Accordingly, a more detailed monitoring and adaptive management plan will be drafted as a component of the design document during planning, engineering and design phase. The FWS recommends that project delivery team and natural resource agency involvement continue throughout this iterative plan development process. Furthermore, please reference the FWS's comments dated April 7, 2010, regarding the March 8, 2010 draft Monitoring and Adaptive Management Plan.

Goals and objectives in the Monitoring and Adaptive Management Plan are not significantly different than stated elsewhere in the report (section 2.4). The Adaptive Management Framework Team added more detail to the objectives to better relate them to monitoring components.

Coordination between the Project Delivery Team and USFWS and other agencies will be continued throughout PED, including updates to the monitoring and adaptive management plan.

Appendix A, Biological Assessment – As previously stated, the FWS concurs with the Corps not likely to adversely affect determination for impacts to the Gulf sturgeon and the West Indian manatee. However, because of the proposed project is likely to affect pallid sturgeon, further ESA consultation and coordination with the FWS should continue.

Acknowledged.

1050

We appreciate the opportunity to provide comments on the subject document. If your staff has additional questions regarding our comments, please contact FWS's Lafayette Field Office Angela Trahan at (337) 291-3137.

Sincerely,

Stephen R. Spencer
Regional Environmental Officer

cc: U.S. Environmental Protection Agency, Dallas, TX
Attn: Barbara Keeler
NOAA's National Marine Fisheries Service, Baton Rouge, LA
Attn: Mr. Richard Hartman
Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA
Attn: Mr. Kyle Balkum
Louisiana Department of Wildlife and Fisheries, Natural Heritage Program, Baton Rouge, LA
Louisiana Office of Coastal Protection and Restoration, Baton Rouge, LA

1051

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Volume IV

APPENDIX H:

Value Engineering Report

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Value Engineering Summary

During the week of May 18 to May 22, 2009 the Value Engineering (VE) team met to consider three projects: Small Diversion at Convent Blind River, Amite River Diversion Canal Modification, and Medium Diversion at White Ditch. The results of the VE study were published in a report prepared by Value Management Strategies, Inc. dated June 2009.

For the Small Diversion at Convent Blind River the VE team identified three (3) items as key strategies to consider and three (3) less important items to also be considered. The key items and the follow up for how the item was covered in the final feasibility study development are included for each as follows.

CB-1 Provide method for transferring water under the railroad and US 61 to the north restoration area.

The project Tentatively Selected Plan (TSP) includes 4 culvert crossings under highway 61 which follows the recommendation of the VE study. During project development it was discovered that several existing openings are provided under the railroad so those culverts for connectivity are not required. The culverts provide the connectivity to the more northerly hydrologic units.

CB-2 Use the Blind River to distribute fresh water to the project area.

The Blind River does divide the project area and receives all of the water diverted through the swamp. As the project was further developed, the concept of using additional berm gaps to distribute flow made the use of the Blind River for distribution a lower priority. In addition, further research on the Blind River designation as a scenic river in the State of Louisiana, greatly restricted any features that could be placed in the River. The advanced hydraulic calculations showed good distribution through the use of control structures and berm gaps, so using the River for distribution was no longer required.

CB-3 Consider reversible pumping of proposed river siphons to facilitate low river stage diversion flow

The project Tentatively Selected Plan (TSP) does not use siphons. When the final hydraulics and cost estimates were completed the least costly diversion method was gated culverts. These culverts are located so that there will be flow diverted for most of the year with the exception of extreme low river stages.

The additional three items are as follows with how each item was treated in the final feasibility study:

CB-4 Construct "environmentally friendly" conveyance channels

The transmission canal is designed with shallow 5:1 side slopes and the right of way was widened from 400 feet to 500 feet to allow a more environmentally friendly foot print which could be part of a recreation feature.

CB- 5 Define the hydrologic connectivity of project areas

The later modeling in the study determined the amount of flow from the diversion, through the berm gaps and into the hydrologic units in the study area. These flows were also used in the WVA to determine the environmental benefits derived from the diverted flows.

CB-6 Obtain Total Maximum Daily Flow (TMDL) waiver for diversion into Blind River

The diversion will force flow through the swamp area utilizing the berm gaps and the control structures. The swamp will have sufficient vegetation that the nutrients will be utilized and the flow into the Blind River should be relatively clean from both nutrients and sediment. It is anticipated the Blind River will environmentally benefit from the greater flows from the diversion.

The overall project has an extensive monitoring plan and includes costs for adaptive management to assure that the overall water quality in the Blind River is not degraded. The State agencies will work together to monitor the diversion operation to assist with the overall environmental improvement of the Blind River.

In addition to the six (6) Blind River specific recommendations there were ten (10) General and Plan Formulation recommendations. The following is a list of those recommendations and how they were addressed specifically in the Blind River report.

G-1 Develop plan strategies that account for rise in sea level

This project prepared a complete analysis of sea level rise scenarios and the results are made part of the report.

G-2 Provide clarification and address the WRDA 2007 regarding specified authorized funding limits and the extent of planning development of LCA projects

The Blind River project reviewed the WRDA language and the proposed Tentatively Selected Plan (TSP) is within the WRDA funding limits.

G-3 Define plan alternatives that can be optimized within project authorization

The Blind River project is within the authorization and was optimized at a flow of 3000 cubic feet per second diversion rate.

G-4 Amend project authorizations to include additional federal funding for "first phase" adaptive management measures.

The Blind River cost estimate includes the costs for monitoring and adaptive management for the first 10 years of the project.

G-5 Establish permanent trust fund for project maintainability

The project is proposed to be maintained by the State of Louisiana. The State will have adequate funds for long term maintenance and operation.

G-6 Identify impacts of multiple diversion structures on the Mississippi River and fresh water and sediment requirement of project areas

The State of Louisiana and the Corps of Engineers are conducting parallel studies on the Mississippi River and the Lake Maurepas areas to determine the long term effects of the combination of diversions and other coastal restoration efforts.

G-7 Incorporate comprehensive monitoring of project benefits before, during and after completion of diversion measures

The Blind River project has established baseline monitoring sites and continuous monitoring equipment that will be used continuously during the life of the project.

G- 8 Identify and address potential real and perceived drainage impact of proposed diversion flows.

The canals for the Blind River project have all been modeled and there is no adverse drainage or flooding as a result of the project. Additional modeling work will be completed during the engineering phase of the project.

G-9 Redefine project constraints versus project issues

The Blind River constraints and objectives have been modified to satisfy review comments.

G-10 Revisit weighted matrix of ranking initial alternative and plan elements

The matrix was revised and the final array of alternatives used the IWR-PLAN program for the final economic screening of the alternatives to select the Tentatively Selected Plan (TSP).

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Louisiana Coastal Area Program (LCA) Program: Small Diversion at Convent/Blind River Project Feasibility-Level Monitoring and Adaptive Management Plan

July 20, 2010



OFFICE OF
Coastal Protection
and Restoration



US Army Corps
of Engineers
New Orleans District

TABLE OF CONTENTS

1.0 Introduction 1
1.1 Authorization for Adaptive Management in the LCA Program 1
1.2 Procedure for Drafting Adaptive Management Plans for LCA Projects 1
1.3 LCA Communication Structure for Implementation of Adaptive Management 3
2.0 Project Adaptive Management Planning 4
2.1 Project Goals and Objectives 5
2.2 Management and Restoration Actions 5
2.3 Conceptual Ecological Model for Monitoring and Adaptive Management 5
2.4 Sources of Uncertainty 6
3.0 Rationale for Adaptive Management 6
3.1 Adaptive Management Program for the Small Diversion at Convent/Blind River Project 7
4.0 Monitoring 8
4.1 Rationale for Monitoring 8
4.2. Monitoring Plan for the Small Diversion at Convent/Blind River Project 9
4.2.1 Monitoring Procedures 11
4.2.2 Use of Monitoring Results and Analyses 13
5.0 Database Management 13
5.1 Description and Location 14
5.2 Data Storage and Retrieval 14
5.3 Analysis, Summarization, and Reporting 14
6.0 Assessment 14
6.1 Assessment Process 15
6.2 Variances and Success 15
6.3 Frequency of Assessments 15
6.4 Documentation and Reporting 16
7.0 Decision-Making 16
7.1 Decision Criteria 16
7.2 Potential Adaptive Management Measures 17
7.3 Project Close-Out 17
8.0 Costs for Implementation of Monitoring and Adaptive Management Programs 18
8.1 Costs for Implementation of Monitoring Program 18
8.2 Costs for Implementation of Adaptive Management Program 20
9.0 Literature Cited 21

List of Figures

Figure 1. Set-up Phase of the LCA Adaptive Management Framework.

Figure 2. Implementation Phase of the LCA Adaptive Management Framework.

Figure 3. LCA Communication Structure for Implementation of Adaptive Management.

List of Tables

Table 1. Preliminary Cost Estimates for Implementation of the Monitoring Program for the LCA Small Diversion at Convent/Blind River Project
Table 2. Preliminary Cost Estimates for Set-up of Adaptive Management Program for the LCA Small Diversion at Convent/Blind River Project

Table 3. Preliminary Cost Estimates for Implementation of Adaptive Management Program for the LCA Small Diversion at Convent/Blind River Project

List of Attachments

Annex 1. LCA Small Diversion at Convent/Blind River Project Conceptual Ecological Model

1.0 INTRODUCTION

This document outlines the feasibility-level monitoring and adaptive management plan for the Louisiana Coastal Area (LCA) Program: Small Diversion at Convent/Blind River project. The LCA Adaptive Management Framework Team developed this monitoring and adaptive management plan with assistance from the Project Delivery Team (PDT). This plan identifies and describes the monitoring and adaptive management activities proposed for the project and estimates their cost and duration. This plan will be further developed in the preconstruction, engineering, and design (PED) phase as specific design details are made available.

1.1 Authorization for Adaptive Management in the LCA Program

The LCA Ecosystem Restoration Study Chief's Report (2005) states (for the 15 near-term features aimed at addressing the critical restoration needs):

> *"...the feasibility level of detail decision documents will identify specific sites, scales, and adaptive management measures, and will optimize features and outputs necessary to achieve the restoration objectives...to ensure that LCA ecosystem restoration objectives are realized, monitoring and adaptive management must be a critical element of LCA projects."*

Section 7003(a) of Water Resources Development Act of 2007 (WRDA 2007) stipulates:

> *"The Secretary may carry out a program for ecosystem restoration, Louisiana Coastal Area, Louisiana, substantially in accordance with the report of the Chief of Engineers, dated January 31, 2005."*

Additionally, Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires that an adaptive management plan be developed for all ecosystem restoration projects.

At the programmatic level, knowledge gained from monitoring one project can be applied to other projects. Opportunities for this type of adaptive management are common for the projects within the LCA Ecosystem Restoration Study (USACE 2004), which also builds upon lessons learned in other related efforts such as the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA). Oversight by the LCA Science and Technology (S&T) Program and the LCA Adaptive Management Planning Team provides the basic structure to ensure that knowledge gained is effectively shared across programs and projects.

1.2 Procedure for Drafting Adaptive Management Plans for LCA Projects

The U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District (USACE MVN), Louisiana Office of Coastal Protection and Restoration (OCPR), and the LCA S&T Program collaborated to establish a general framework for adaptive management to be applied to all LCA projects. The framework for adaptive management is consistent with the previously mentioned implementation guidance, as well as with the guidance provided by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's (NOAA) "Availability of a Final Addendum to the Handbook for Habitat Conservation Planning and Incidental Take Permitting Process" in Federal Register vol. 65, No. 106 35242. The LCA

adaptive management framework includes both a set-up phase (Figure 1) and an implementation phase (Figure 2).

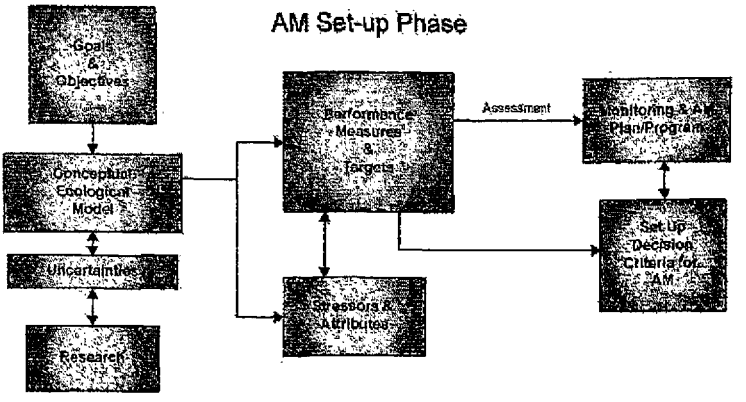


Figure 1. Set-up Phase of the LCA Adaptive Management Framework.

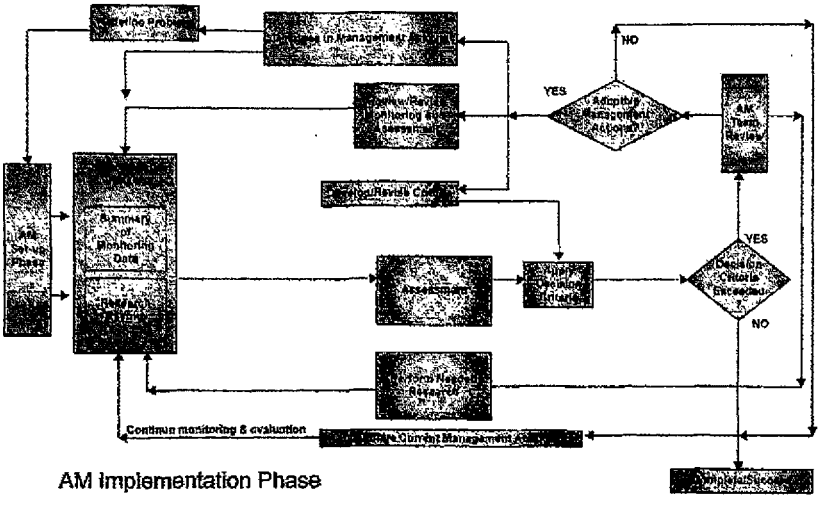


Figure 2. Implementation Phase of the LCA Adaptive Management Framework.

1.3 LCA Communication Structure for Implementation of Adaptive Management

To execute an adaptive management strategy for the LCA Ecosystem Restoration Plan, a communication structure has been identified (Figure 3). The structure establishes clear lines of communication between LCA Program Management, an Adaptive Management Planning Team, the S&T Program, PDTs, and stakeholders. Successful implementation will require the right resources being coupled at the right time to support the framework components.

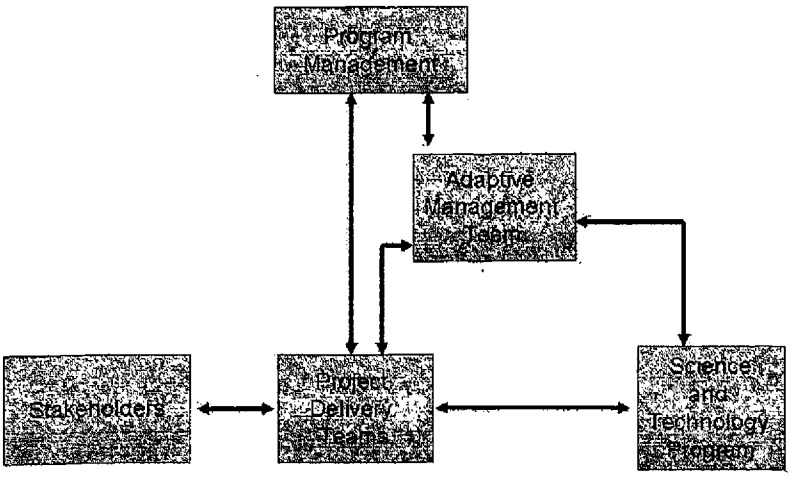


Figure 3. LCA Communication Structure for Implementation of Adaptive Management.

As part of the LCA Program communication structure for implementation of adaptive management (Figure 3), an LCA Adaptive Management Planning Team will be established. This team will be led jointly by a Senior Planner from the USACE and a counterpart from the OCPR. Other team members include USACE and State support staff and representatives from USFWS, NOAA, Natural Resources Conservation Service (NRCS), and Louisiana Department of Wildlife and Fisheries (LDWF). These members will be selected on the basis of their knowledge of ecosystem restoration, coastal Louisiana ecosystems and adaptive management. Other resources and expertise will be brought in as needed. This team will be responsible for recommending project and program adaptive management actions to the LCA Management Team.

The LCA Science and Technology (S&T) Office was established by the USACE and the State of Louisiana (the non-Federal sponsor) to effectively address coastal ecosystem restoration needs and to provide a strategy, organizational structure, and process to facilitate integration of science and technology into the adaptive management process. Under the Adaptive Management Framework, there are five primary elements in the LCA S&T Program, and each element differs in emphasis and requirements. These elements include: (1) science information needs, (2) data

acquisition and monitoring, (3) modeling, (4) research, and (5) data management and reporting (assessment).

Under the LCA S&T Program, an Assessment Team will be established. This team will be led by the S&T Director and a representative of the U.S. Geological Survey (USGS) who will also serve as direct liaisons between the S&T Assessment Team and the LCA Adaptive Management Planning Team. Other members will be identified from Federal and State agencies. Responsibilities of this team include analysis and reporting of data to the LCA Adaptive Management Planning Team and the LCA Program Management Team.

2.0 PROJECT ADAPTIVE MANAGEMENT PLANNING

Specific LCA PDTs assisted the LCA Adaptive Management Framework Team in developing the monitoring and adaptive management plan for each specific project. The members of the Adaptive Management Framework Team for this project were Tomma Barnes, USACE-MVN; Steve Bartell, E2 Consulting Engineers; Laura Brandt, USFWS; Craig Fischenich, USACE/Engineer Research and Development Center; Barbara Kleiss, USACE Mississippi Valley Division; Carol Parsons Richards, OCPR; Greg Steyer, USGS National Wetlands Research Center; and John Troutman, OCPR.

The resulting adaptive management plan for the Small Diversion at Convent/Blind River project describes and justifies whether adaptive management is needed in relation to the tentatively selected plan (TSP) identified in the Feasibility Study. The plan also identifies how adaptive management would be conducted for the project and who would be responsible for this project-specific adaptive management program. The developed plan outlines how the results of the project-specific monitoring program would be used to adaptively manage the project, including specification of conditions that would demonstrate project success and terminate the adaptive management program.

The Adaptive Management Plan for this project reflects a level of detail consistent with the project Feasibility Study. The primary intent was to develop monitoring and adaptive management actions appropriate for the project's restoration goals and objectives. The specified management actions permit estimation of the adaptive management program costs and duration for the project.

The following adaptive management plan section (1) identifies the restoration goals and objectives identified for the Small Diversion at Convent/Blind River project, (2) outlines management actions that can be undertaken to achieve the project goals and objectives, (3) presents a conceptual ecological model that relates management actions to desired project outcomes, and (4) lists sources of uncertainty that would recommend the use of adaptive management for this project. Subsequent sections describe monitoring, assessment, decision-making, and data management in support of adaptive management.

The level of detail in this plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Uncertainties remain concerning the exact project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were similarly estimated using currently available information. Uncertainties will be addressed in the preconstruction, engineering, and design (PED) phase, and a detailed monitoring and adaptive

management plan, including a detailed cost breakdown, will be drafted as a component of the design document.

2.1 Project Goals and Objectives

During initial stages of project development, the PDT, with stakeholder input, developed restoration goals and objectives to be achieved by the Small Diversion at Convent/Blind River project. These goal and objectives were subsequently refined through interactions with the LCA Adaptive Management Framework Team. The overarching goal of this project is to stop the continuing degradation in the southeastern portion of the Maurepas Swamp and restore coastal wetlands in the project area. This project has been planned to help achieve and sustain a larger-scale coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thereby contribute to the well-being of the Nation. The specific restoration objectives of the Small Diversion at Convent/Blind River project are to:

- Promote water distribution in the southeastern portion of the Maurepas Swamp to move stagnant water out of the system.
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.
- Increase the durations of dry periods in the swamp to improve baldcypress and tupelo productivity and to increase seed germination and survival of these key species.
- Improve fish and wildlife habitat in the swamp and in Blind River.

2.2 Management and Restoration Actions

The PDT performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Many alternatives were considered, evaluated, and screened in producing a final array of alternatives. The PDT subsequently identified a tentatively selected plan (TSP).

The TSP is Alternative Two (2), which is a 3,000 cubic feet per second (cfs) diversion located at Romeville, Louisiana. The proposed diversion structure includes the following features: inlet screens, three 11' by 10' culverts, a crossing at Highway 44, and a dissipation structure. The transmission canal is an earthen trapezoid with a water depth of approximately 10 feet, with raised berms along its banks. The canal will cross one railroad and one road. At each crossing, there will be a maximum of four features, each with three 4'x6' culverts, for a combined maximum total of 24 culverts. The drainage channel control structures consist of six concrete structures with downward opening weir gates. There are thirty (30) berm gaps, each approximately 500 feet wide.

2.3 Conceptual Ecological Model for Monitoring and Adaptive Management

As part of the planning process, members of the Small Diversion at Convent/Blind River project PDT developed a conceptual ecological model for the swamp ecosystem in the project area to represent current understanding of ecosystem structure and function in the project area, identify performance measures, and help select parameters for monitoring (Annex 1). The model illustrates the effects of important natural and anthropogenic activities that result in different ecological stressors on the system. The effects of concern can be measured for selected

performance measures defined as specific physical, chemical, and biological attributes of the system.

2.4 Sources of Uncertainty

A fundamental tenet underlying adaptive management is decision-making under uncertainty. There are many uncertainties associated with restoration of the swamp ecosystems included in the Small Diversion at Convent/Blind River project. These uncertainties can be conveniently categorized as follows:

Swamp water, sediment, and nutrient requirements

- Magnitude and duration of inundation
- Magnitude and duration of dry conditions
- Annual sediment requirements
- Nutrients required for desired productivity

Current local runoff water quantities and quality

- Distribution of flow by time and quantity
- Water quality based on permitted discharges
- Flow path through channels and swamp

Mississippi River water quantities and quality

- Available river stage to produce desired flows
- Concentrations of sediment and nutrients for diversion

Swamp responses from application of water, sediment, and nutrients

- Growth curves based on hydroperiod and nutrient application
- Litter production based on nutrient and water levels
- Tree propagation in relation to regulated hydroperiod.

Subsidence, salinity, and water level trends

- Subsidence rates (+/-) throughout the project life
- Water level trends (+/-) throughout the project life
- Variable and extreme salinities that negatively impact vegetation

Potential climate change issues, such as sea level rise, in addition to regional subsidence rates are significant scientific uncertainties for all LCA projects. These issues were incorporated in the plan formulation process (Appendix L Engineering, Chapter 2 Coastal Processes) and will be monitored by gathering data on water levels, salinities, and land elevation (see section 4.2.1). These data will inform adaptive management actions.

3.0 RATIONALE FOR ADAPTIVE MANAGEMENT

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties. All projects face uncertainties with the principal sources of uncertainty including (1) incomplete description and understanding of relevant ecosystem structure and function, (2) imprecise relationships between project management actions and corresponding outcomes, (3) engineering challenges in implementing project alternatives, and (4) ambiguous management and decision-making processes.

Given these uncertainties, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to desired project outcomes. In the case of the Small Diversion at Convent/Blind River project, the adaptive management program will use the results of continued project monitoring to manage the project in order to achieve the previously stated project goals and objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

Several questions were considered to determine if adaptive management should be applied to the Small Diversion at Convent/Blind River project:

1) Are the ecosystems to be restored sufficiently understood in terms of hydrology and ecology, and can project outcomes be accurately predicted given recognized natural and anthropogenic stressors?

2) Can the most effective project design and operation to achieve project goals and objectives be readily identified?

3) Are the measures of this restoration project's performance well understood and agreed upon by all parties?

4) Can project management actions be adjusted in relation to monitoring results?

A 'NO' answer to questions 1-3 and a 'YES' answer to question 4 identifies the project as a candidate that could benefit from adaptive management. The Framework Team and the PDT decided that the project meets these qualifications, and therefore is a candidate for adaptive management.

For the Small Diversion at Convent/Blind River project, there are a number of uncertainties associated with ecosystem needs and how the ecosystem will respond to the restoration project. In addition, there are associated uncertainties about the best design and operation for the project. Using an adaptive management approach during project planning provided a mechanism for building flexibility into project design and for providing new knowledge to better define anticipated ecological responses. This also enabled better selection of appropriate design and operating scenarios to meet the project objectives. Additionally, an adaptive management approach will help define project success and identify outcomes that should realistically be expected for the project.

3.1 Adaptive Management Program for the Small Diversion at Convent/Blind River Project

An Adaptive Management Program for the Small Diversion at Convent/Blind River project is needed to ensure proper implementation of adaptive management. The Program will also facilitate coordination of projects within the LCA Program and coordination among PDTs, the LCA S&T, and LCA Program Management. The LCA Adaptive Management Planning Team will lead all LCA project and program adaptive management recommendations and actions. This team is responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. If this team determines that adaptive management actions are needed, the team will coordinate a path forward with project planners and project managers. Other PDT members may be solicited as needed; for instance, if the

adaptive management measure is operational, operations and hydraulics representatives will be asked to participate.

The LCA Adaptive Management Planning Team is also responsible for project documentation, reporting, and external communication. Table 2 lists the cost estimates for these adaptive management activities.

4.0 MONITORING

Independent of adaptive management, an effective monitoring program will be required to determine if the project outcomes are consistent with original project goals and objectives. The power of a monitoring program developed to support adaptive management lies in the establishment of feedback between continued project monitoring and corresponding project management. A carefully designed monitoring program is central to the project's adaptive management program.

4.1 Rationale for Monitoring

Monitoring must be closely integrated with all other LCA adaptive management components because it is the key to the evaluation and learning components of adaptive management. Project and system level objectives must be identified to determine appropriate indicators to monitor. In order to be effective, monitoring designs must be able to discern ecosystem responses caused by project implementation (i.e., management actions) from natural variability. In coastal Louisiana, there are many existing restoration and protection projects already constructed, and many more are planned under different authorizations and programs. In combination, these projects will ultimately influence much of coastal Louisiana. Monitoring must therefore be conducted at project and system-wide scales to evaluate long-term, large-scale status and trends and short-term performance.

Achieving monitoring objectives will require monitoring that focuses on different spatial and temporal scales. Spatially, a project might achieve local objectives, but have little or no measurable effect at larger scales. Temporally, monitoring designs need to consider the amount of time it could take for slowly changing ecological variables to respond to management actions. Additionally, monitoring should be designed to measure the persistence of near-term effects. Larger-scale effects will generally take longer to develop and longer to detect than more localized effects.

Monitoring for large-scale effects can be more difficult than for local effects because the ecological linkages become more complicated as factors outside project boundaries influence processes and biota that affect desired project outcomes. The benefits of improved habitat in one location may be counteracted by degradation at another location, thus showing no overall benefit at large scales. In addition, monitoring at large scales can involve changes in underlying conditions over time or space and be very labor intensive. When possible, specific monitoring and large-scale information needs should be interrelated. In some cases, large-scale monitoring may be just an extension of local monitoring in space and time, but it may also involve designs and procedures that are separate from site-specific monitoring and extend beyond the purview of the project teams.

When possible, specific monitoring and large scale information needs should be integrated with monitoring efforts that are underway in coastal Louisiana. The CWPPRA program has been monitoring restoration and protection projects in coastal Louisiana since 1990 (Steyer and

Stewart 1992, Steyer et al. 1995). The monitoring program incorporates a system-level wetland assessment component called the Coastwide Reference Monitoring System (CRMS-Wetlands, Steyer et al. 2003). CRMS-Wetlands provides system-wide performance measures that are evaluated to help determine the cumulative effects of restoration and protection projects in coastal Louisiana. LCA monitoring plans should benefit from existing monitoring networks to the extent practicable and participate in the implementation of CRMS-Wetlands. Such participation can maintain the data consistencies necessary to conduct project and programmatic adaptive management.

4.2 Monitoring Plan for the Small Diversion at Convent/Blind River Project

According to the CECW-PB Memo dated 31 August 2009, "Monitoring includes the systemic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits." The following discussion outlines key components of a monitoring plan that will support the LCA Small Diversion at Convent/Blind River project Adaptive Management Program.

The plan identifies performance measures along with desired outcomes (i.e. targets) in relation to specific project goals and objectives. A performance measure includes specific feature(s) to be monitored to determine project performance. In addition, if applicable, a risk endpoint was identified. Risk endpoints measure undesirable outcomes of a management or restoration action. A monitoring design was established to determine if the desired outcome or risk endpoint is met.

Upon completion of the Small Diversion at Convent/Blind River project, monitoring for ecological success will be initiated and will continue until ecological success is achieved, as defined by the project-specific objectives. This monitoring plan includes the minimum monitoring actions to evaluate success. Although the law allows for a ten-year cost-shared monitoring plan, ten years of monitoring may not be required. Once ecological success has been achieved, which may occur in less than ten years post-construction, no further monitoring will be performed. If success cannot be determined within that ten-year period of monitoring, any additional monitoring will be a non-Federal responsibility. This plan estimated monitoring costs for a period of ten years because that is the maximum allowed federal contribution to monitoring. As soon as ecological success is achieved, monitoring will cease.

Additional monitoring is identified as supporting information needs that will help to further understand and corroborate project effects.

Objective 1: Promote water distribution in the southeast portion of the Maurepas Swamp to move stagnant water out of the system.

Performance Measure 1: Freshwater distribution during operational events

Desired Outcome: Increase hydrologic connectivity and area of extent of freshwater movement into the project area above pre-project conditions.

Monitoring Design: Synoptic hydrologic surveys, using salinity, temperature, dissolved oxygen, conductivity, turbidity, pH, and velocity as tracers, will be conducted during selected low flow and high flow operational events to track distribution of freshwater.

Objective 2: Facilitate swamp building, at a rate greater than swamp loss to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.

Performance Measure 2a: Sediment accretion and elevation

Desired Outcome: Accretion rate equals or exceeds subsidence rate after five years.

Monitoring Design: Sediment erosion tables (SETs) will serve as an elevation benchmark and marker horizons or sediment traps will be used to assess accretion.

Supporting Information Need: Total suspended sediment (TSS) will be collected to help understand how sediment contributions through the diversion may enhance swamp productivity and land building.

Performance Measure 2b: Swamp production and extent

Desired Outcome: A statistically significant increase in basal area increment of baldcypress and tupelo in the swamp from existing conditions, that is, existing conditions defined from pre-construction measurements from CRMS-Wetlands stations and Southeastern Louisiana University historic monitoring.

Monitoring Design: Diameter at breast height (dbh) and overstory tree cover will be measured to estimate production.

Performance Measure 2c: Annual sediment discharge

Desired Outcome: Deliver 86,480 M-tons of sediment through the Convent/Blind River diversion each year.

Monitoring Design: Hourly turbidity recorders will be deployed in the outfall channel and at hydrologic sites and correlated to TSS to investigate this measure.

Objective 3: Establish hydroperiod fluctuation in the swamp to improve baldcypress and tupelo productivity and their seed germination and survival by increasing the length of dry periods in the swamp.

Performance Measure 3a: Depth, duration, and frequency of flooding in the swamp

Desired Outcome: A statistically significant decrease from pre-project condition average flood durations (existing conditions defined from pre-construction measurements from CRMS stations). The project will be operated to facilitate dry periods. These dry periods should be targeted every year if possible.

Desired Outcome: Maintain dry periods (moist soils) in the swamp for a minimum 7-35 days during summer and early fall for seed germination and maintain water levels below seedling height to promote seedling survival.

Monitoring Design: Hourly hydrologic recorders will be deployed to investigate this measure.

Performance Measure 3b: Number of baldcypress and tupelo seedlings and saplings

Desired Outcome: A 25% increase in the number of baldcypress and tupelo saplings per acre from pre-project conditions five years after project implementation and 50% increase after 10 years. Performance of this measure is most dependent on achieving extended dry periods in the swamp.

Monitoring Design: Understory vegetation will be measured to determine numbers of baldcypress seedlings and saplings in order to assess regeneration. Herbaceous vegetation will also be measured to determine changes in cover classes.

Objective 4. Improve fish and wildlife habitat in the swamp and in Blind River.

Performance Measure: No applicable performance measure

Desired Outcome: Swamp production, hydroperiod, and water quality measures will be used to assess this objective.

Monitoring Design: Fish and wildlife habitat is linked to the performance measures associated with objectives 1-3, focused on improving habitat. Therefore, no specific monitoring is proposed for this objective.

Risk Endpoint: Water quality impairment in Blind River and Lake Maurepas

Desired Outcome: Do not create or contribute to nitrate loading in Blind River that will result in a Louisiana 303 (d) listing. If listed, a total maximum daily load (TMDL) assessment will be considered in coordination with Louisiana Department of Environmental Quality (DEQ).

Monitoring Design: Nutrient sampling will be designed in coordination with DEQ, if needed.

4.2.1 Monitoring Procedures

The following monitoring procedures will provide the information necessary to evaluate the previously identified project-specific objectives for the Small Diversion at Convent/Blind River project:

Vegetation: Swamp production and regeneration will be assessed at 5 locations within the project area and 3 reference locations annually. Retention and/or increase of overstory tree cover (objective 2) from pre-project levels will be determined using a spherical densiometer and hemispherical photography techniques as described in the CRMS-Wetlands standard operating procedures manual (Folse et al. 2008). Densiometer readings and hemispherical photographs will be taken within sampling plots at fixed time intervals. In order to track the growth of trees within the project and reference areas, especially baldcypress and tupelo, all trees (≥5 cm dbh) within each sampling plot will be identified to species level, tagged with a numbered aluminum tree tag, and the diameter measured at 4.5 ft above the ground (Folse et al. 2008 and references therein). The dbh of all tagged trees will be measured annually at which time both "new" trees (i.e., grew to ≥ 5 cm dbh from previous sampling time) and dead trees will also be identified. The dbh data will be used to calculate basal area increment (BAI) which will provide estimates of primary productivity (Megonigal et al. 1997). BAI is the difference in basal area (calculated from dbh) of individual trees between sampling times. The understory (i.e., < 5 cm dbh and 50 cm – 137 cm tall) and herbaceous (i.e., < 5 cm dbh and < 50 cm tall) will be sampled according to Folse et al. (2008) to determine if baldcypress and tupelo are regenerating.

Hydrology: Continuous stage, velocity, turbidity, pH, conductivity, salinity, and dissolved oxygen measurements will be conducted at 1 Mississippi River outfall location and 5 locations on Blind River where TSS and other water quality parameters are collected. To determine whether the hydrology in the project area is being restored and maintained to that of a natural swamp, water level, salinity, temperature, turbidity pH, conductivity, and dissolved oxygen within the swamp will be measured hourly with datasondes at 5 locations within the project area and at 3 reference locations. Each water level gauge will be surveyed relative to the top of the

rod-surface elevation table (RSET) (NAVD88) and will be serviced approximately 9 times per year. Duration and frequency of flooding will be calculated using water levels and the average elevation of the wetland surface. During selected operational events, synoptic hydrologic surveys will be conducted to track distribution of freshwater. Returning the hydroperiod of the project area to that of a typical swamp is essential to decreasing the mortality rate of baldcypress and tupelo trees and increasing biomass and regeneration of these species.

Sediment Input: Sediments introduced into the project area from the Mississippi River are expected to contribute to soil building and thus a net surface elevation increase or stabilization. Water discharge through the diversion structure will be monitored hourly with an acoustic Doppler current meter (ADCM). Hourly turbidity measurements will be measured with a logging optical backscatter nephlometric turbidity sensor, which will be field serviced and calibrated each month. During each field servicing event, a depth-integrated water sample will be taken from the outfall channel, and the sample will be analyzed for total suspended solids (TSS) by filtering 100-250 mL of each sample through pre-rinsed, pre-ashed, pre-weighed 47mm GF/F microfiber filters. Filters will be dried for 24 hours at 105° C, then combusted for 1 hour at 550° C and weighed following Standard Methods (1992). Thus, the inorganic fraction of TSS will be used as the metric for suspended solids in diverted river water. Linear regression will be used to estimate the relationship between turbidity and TSS, and hourly turbidity data will then be used to obtain hourly TSS values. Instantaneous sediment flux through the diversion structure $flux_{sed}$ will be calculated as

$$flux_{sed} = q_{div} \times tss$$

where q_{div} and tss are the volume discharge and suspended sediment concentrations in the outfall channel, respectively. Total sediment delivery Q over the time interval $0 - T$ will be determined as

$$Q = \int_0^T flux_{sed}\, dt$$

where t is time.

Distribution of diverted sediments through the project area will be assessed by collection of hourly turbidity time series at each hydrologic monitoring site (above) by affixing an optical backscatter nephlometric turbidity sensor to each water quality sonde. Water samples will be collected during monthly servicing of the sensors, and these samples will be analyzed for TSS and used to calibrate the turbidity sensors to TSS.

Sediment Accretion and Elevation: Sediment accretion and elevation will be assessed at 5 locations within the project area and 3 reference locations one to two times per year during dry periods. Sediment elevation within the project area will be measured over time by using the RSET technique which is described in Folse et al. (2008) and references therein. The RSET allows for precise, repeated measurements of the soil elevation. Marker horizons consisting of feldspar clay or crawfish pans will be used to determine vertical accretion/loss within the project area (Folse et al. 2008). If no persistent dry periods occur or sediments are too flocculant for accurate measurements from RSET or feldspar clay/crawfish pans, the top of the RSET rod will be surveyed every 3 years to estimate subsidence rate. Maintenance of elevation should help regulate flooding stress, contributing to decreased tree mortality rates and increased biomass production and regeneration.

Water Quality: Measuring and monitoring various water quality parameters, including salinity, conductivity, pH, nutrients, and TSS will dictate whether inputs from the Mississippi River are impacting water quality in the project area. Monitoring these parameters will document the quality of the diverted water and address risk endpoint concerns. To determine if these inputs are flushing saline waters from the project area, the concentration of salt in swamp water will be measured hourly at hydrology locations and discretely by using a porewater sipper device when sondes are serviced (Folse et al. 2008). Nutrients (Total Nitrogen [TN], Ammonia, Nitrate+Nitrite, Total Phosphorous [TP]) will be measured every two months at the one Mississippi River outfall location and five TSS locations on Blind River and at 8 hydrologic monitoring sites according to methods described in Day et al. (2001) to determine if input from the Mississippi River is contributing to increased nutrient loads. Duration of this sampling schedule will be dependent upon final project design and operations. Water samples will be collected in 500 mL acid-washed polyethylene bottles, stored on ice and taken to laboratory for processing. Within 24 hrs, 60 mL from each water sample will be filtered through pre-rinsed 25 mm 0.45 µm Millipore filters. Samples and filters will be frozen until analyzed within one month of collection. Nitrate and nitrite will be determined separately using automated cadmium reduction method, ammonium by automated phenate method and phosphate by automated ascorbic acid reduction method (Standard Methods 1992).

4.2.2 Use of Monitoring Results and Analyses

Project monitoring is the responsibility of the OCPR and the USACE. However, because of the need to integrate monitoring for programmatic adaptive management, extensive agency coordination is required. A monitoring workgroup, led by the LCA S&T Program and the USGS, will be responsible for ensuring that project-specific monitoring plans are technically competent and appropriately integrated within a system-wide assessment and monitoring plan (SWAMP).

The results of the monitoring program will be communicated to an Assessment Team that will use the information to assess system responses to management, evaluate overall project performance, and construct project report cards. Recommended modifications (i.e., adaptation) of the Small Diversion at Convent/Blind River project will be provided as appropriate.

5.0 DATABASE MANAGEMENT

Database management is an important component of the monitoring plan and the overall adaptive management program. Data collected as part of the monitoring and adaptive management plans for the LCA projects will be archived as prescribed in the "LCA Data Management Strategic Plan" developed for the LCA S&T Office, and further developed by the LCA S&T Data Management Working Group.

Data standards, quality assurance, and quality control procedures and metadata standards will be prescribed by the LCA S&T Data Management Working Group. Data collected for LCA with similar data types and collection frequencies as those data collected under the CRMS program will be managed by the Louisiana Strategic Online Natural Resources Information System (SONRIS). Pre-existing standard operating procedures built for SONRIS cover issues such as data upload process and format, quality assurance/quality control, and public data release. Storage of all other LCA collected data (spatial or non-spatial) will be handled by the LCA project-specific data libraries on LCA.GOV.

Where applicable, Open Geospatial Consortium standards will be used to facilitate data sharing among interested parties. Data analysis and reporting responsibilities will be shared between project assessment and adaptive management efforts in order to provide Small Diversion at Convent/Blind River project reports for the LCA Program Management Team.

5.1 Description and Location

The data management plan should identify the computing hardware and any specialized or custom software used in data management for an adaptive management program. Opportunities exist to develop either a centralized or distributed data management system. The data managers, with input from the Adaptive Management Planning Team, should determine which approach best suits the needs of the overall adaptive management program.

Individuals with responsibility for data management activities (data managers) in support of an adaptive management program should be identified. The data managers should collaborate with the Adaptive Management Planning Team in developing a data management plan to support the adaptive management program. The data management plan should be incorporated into the overall program adaptive management plan, either in the main body of the adaptive management plan or as an appendix.

5.2 Data Storage and Retrieval

Data standards, quality assurance and quality control procedures and metadata standards will be prescribed by the Data Management Working Group, and will be complementary with the CRMS-Wetlands program and SONRIS database. Data will be served using a map services tool, similar to that currently employed by the CRMS-Wetlands project.

5.3 Analysis, Summarization, and Reporting

Data analysis and reporting responsibilities will be shared between project and programmatic adaptive management efforts in order to provide reports for the Small Diversion at Convent/Blind River project Assessment Team, project managers, and decision-makers.

6.0 ASSESSMENT

The assessment phase of the framework describes the process by which the results of the monitoring efforts will be compared to the desired project performance measures and/or acceptable risk endpoints (i.e., decision criteria) that reflect the goals and objectives of the management or restoration action. The assessment process addresses the frequency and timing for comparison of monitoring results to the selected measures and endpoints. The nature and format (e.g., qualitative, quantitative) of these comparisons are defined as part of this phase. The resulting methods for assessment should be documented as part of the overall adaptive management plan.

The results of the Small Diversion at Convent/Blind River project monitoring program will be regularly assessed in relation to the desired project outcomes as described by the previously specified project performance measures. This assessment process continually measures the progress of the project in relation to the stated project goals and objectives and is critical to the project adaptive management program. The assessments will continue through the life of the project or until it is decided that the project has successfully achieved its goals and objectives.

6.1 Assessment Process

The Assessment Team assigned to the Small Diversion at Convent/Blind River project will identify a combination of qualitative (i.e., professional judgment) and quantitative methods for comparing the values of the performance measures produced by monitoring with the selected values of these measures that define criteria for evaluating project effectiveness.

The appropriate statistical comparisons (e.g., hypothesis testing, ANOVA, multivariate methods, etc.) will be used to summarize monitoring data as they are obtained and compare these data summaries with the project decision criteria. These continued assessments will be documented as part of the project reporting and data management system.

6.2 Variances and Success

The project Assessment Team will collaborate with project managers and decision-makers to define magnitudes of difference (e.g., statistical differences, significance levels) between the values of monitored performance measures and the desired values (i.e., decision criteria) that will constitute variances. Meaningful comparisons between monitoring results and desired performance will require characterization of historical and current spatial-temporal variability that define baseline conditions. Variances (or their absence) will be used to recommend adaptive management actions, including (1) continuation of the project without modification, (2) modification of the project within original design specifications, (3) development of new alternatives, or (4) termination of operation of the Convent/Blind River diversion structure.

Conceptual models have been developed for each project describing the linkages between stressors and performance measures. The assessments will help determine if the observed responses are linked to the project. Each project has been formulated to address as many system stressors as feasible. If the stressors targeted by the project have changed and the performance measure has not, the linkages in the conceptual model should be examined to determine what other factors may be influencing the performance measure response.

The assessments will also determine if the responses are undesirable (e.g., are moving away from restoration goals) and if the responses have met the success criteria for the project. If performance measures are not responding as desired because the stressor has not changed enough in the desired direction, then recommendations should be made concerning modifications to the project. If the stressor has changed as expected/desired and the performance measure has not, additional research may be necessary to understand why.

From a system-wide perspective, scientific and technical information would be generated from the implementation of a system-wide monitoring effort. Information generated from this effort should be linked to evaluation LCA performance and system response. From a project-level perspective, monitoring plans should be designed to inform adaptive management decision-making by providing monitoring data that are relevant to addressing uncertainty.

Similarly, for multiple performance measures and corresponding monitoring results, the Assessment Team will determine the number and magnitude of variances within a single assessment that will be required to recommend modifications to the project.

6.3 Frequency of Assessments

Ideally, the frequency of assessments for the Small Diversion at Convent/Blind River project would be determined by the relevant ecological scales of each performance measure. The

project's technical support staff will identify for each performance measure the appropriate timescale for assessment. The project should have a combination of short-, medium-, and long-term performance measures. Assessments should be performed at a five year interval at a minimum; however, depending on the timescale of expected responses of the specific measure and frequency of data collection, it may be determined during PED that more frequent reporting may be necessary.

6.4 Documentation and Reporting

The Assessment Team will document each of the performed assessments and communicate the results of its deliberations to the managers and decision-makers designated for the Small Diversion at Convent/Blind River project. The Assessment Team will work with the project monitoring team and monitoring workgroup to produce periodic reports that will measure progress towards project goals and objectives as characterized by the selected performance measures. The results of the assessments will be communicated regularly to the project managers and decision-makers.

7.0 DECISION-MAKING

Adaptive management is distinguished from more traditional monitoring, in part, through implementation of an organized, coherent, and documented decision process. For the Small Diversion at Convent/Blind River project Adaptive Management Program, the decision process includes (1) anticipation of the kinds of management decisions that are possible within the original project design, (2) specification of values of performance measures that will be used as decision criteria, (3) establishment of a consensus approach to decision-making, and (4) a mechanism to document, report, and archive decisions made during the timeframe of the Adaptive Management Program.

7.1 Decision Criteria

Decision criteria, also referred to as adaptive management triggers, are used to determine if and when adaptive management opportunities should be implemented. These criteria are usually ranges of expected and/or desirable outcomes. They can be qualitative or quantitative based on the nature of the performance measure and the level of information necessary to make a decision. Desired outcomes can be based on reference sites, predicted values, or comparison to historic conditions. Several potential decision criteria are identified below, based on the project objectives and performance measures.

Swamp water, sediment, and nutrient requirements:

- Desired inundation patterns are not met and there is less than a 10% increase in duration of dry periods in the swamp
- Insufficient nutrient uptake in the swamp contributes to excess TMDLs for TN and TP in Blind River
- Insufficient sediment input leads to no net increase; therefore, the subsidence rate cannot be reversed

To meaningfully manage these parameters, hydraulic models would need to be revisited and recalibrated based on field data and observations prior to change in management of a diversion and/or in swamp structures.

Current local runoff water quantities and quality

- Local drainage upgrades and surrounding area development contribute lesser/greater flow than was anticipated
- Water quality impacts from local drainage

To change water budget and water quality, coordination with the local public works/drainage operators would be required.

Swamp responses from application of water, sediment, and nutrients

- Less than 25% increase in baldcypress/tupelo sapling numbers
- Habitat switching from swamp to marsh or open water habitat
- Fish kills

To manage these outcomes, hydraulic models may need to be revisited and recalibrated based on field data and observations prior to change in management of a diversion and/or in swamp structures. Additional modeling or experimental efforts might be required to understand and manage observed biotic responses.

7.2 Potential Adaptive Management Measures

The project report card, drafted by the Assessment Team, will be used to evaluate project status and adaptive management needs. The Assessment Team may submit recommendations for adaptive management actions to the Adaptive Management Planning Team. The Adaptive Management Planning Team will investigate and further refine adaptive management recommendations and present them to the Program Management Team. Some potential adaptive management actions for this project may include modifying the operation of the diversion structure or modifying operation of outfall management features and to allow operational flexibility, such as pulsing, based on monitoring results. The monitoring and assessment teams should continue to evaluate operations to maximize benefits and minimize dredging requirements.

7.3 Project Close-Out

Close-out of the project would occur when it is determined that the project has been successful or when the maximum ten-year monitoring period has been reached. Success would be considered to have been achieved when the following objectives have been met, or when it is clear that they will be met based upon the trends for the site conditions and processes. Project success would be based on the following:

- Promote water distribution in the southeast portion of Maurepas Swamp to move stagnant water out of the system
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.
- Establish hydroperiod fluctuation in the swamp to improve baldcypress and tupelo productivity and their seed germination and survival, by increasing the length of dry periods in the swamp.
- Improve fish and wildlife habitat in the swamp and in Blind River.

There may be issues related to the sustainability of the project that would require some monitoring and management beyond achieving these objectives. Due to the variable nature of the Louisiana coastal zone, the monitoring baseline may change during the period of analysis. Consequently, it may be appropriate to consider extending project-specific monitoring and adaptive management beyond ten years

8.0 COSTS FOR IMPLEMENTATION OF MONITORING AND ADAPTIVE MANAGEMENT PROGRAMS

The costs associated with implementing the LCA monitoring and adaptive management plans were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. Because uncertainties remain as to the exact project features, monitoring elements, and adaptive management opportunities, the costs estimated in Tables 1, 2, and 3 (below) will be refined in the PED phase during the development of the detailed monitoring and adaptive management plans.

8.1 Costs for Implementation of Monitoring Program

Costs to be incurred during the PED and construction phases include drafting of the detailed monitoring plan, monitoring site establishment and pre-construction and construction data acquisition to establish baseline conditions. Cost calculations for post-construction monitoring are displayed as a ten-year (maximum) total. If ecological success is determined earlier (prior to ten years post-construction), the monitoring program will cease and costs will decrease accordingly.

It is intended that monitoring conducted under the LCA program will utilize centralized data management, data analysis, and reporting functions. All data collection activities will follow consistent and standardized processes regardless of the organization responsible for monitoring. Cost estimates include monitoring equipment, monitoring station establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements in Table 1 below. These estimates account for a 2.6% annual inflation rate, adopted from the CWPPRA Program. The current total estimate for implementing the monitoring and assessment program for this project is $4,841,500. Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs.

Table 1. Preliminary Cost Estimates for Implementation of the Monitoring Program for the LCA Small Diversion at Convent/Blind River Project.

Category	Activities	2 yr PED Setup & Data Acquisition	3 yr Construction	40 yr Post-Construction	Total
Monitoring: planning and management	Monitoring workgroup, drafting detailed monitoring plan, working with PDTs on performance measures	$135,900	$53,200	$210,100	$399,200
Monitoring: data collection	Landrights, site construction, and surveying	$129,300			$129,300
	Vegetation	$64,900	$103,700	$409,600	$578,200
	Hydrology	$229,200	$366,600	$1,447,300	$2,043,100
	Sediment input	$37,400	$59,900	$236,300	$333,600
	Sediment accretion and elevation	$25,900	$41,500	$163,800	$231,200
	Water quality	$64,000	$102,400	$404,400	$570,800
Database management	Database development, management, and maintenance; webpage development for communication of data to stakeholders	$62,400	$99,800	$393,900	$556,100
TOTAL		**$749,000**	**$827,100**	**$3,265,400**	**$4,841,500**

8.2 Costs for Implementation of Adaptive Management Program

Costs for the project's adaptive management program were based on estimated level of effort. The current total estimate for implementing the adaptive management program is $1,780,000. Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs.

Table 2. Preliminary Cost Estimates for Set-up of Adaptive Management Program for the LCA Small Diversion at Convent/Blind River Project.

Category	Annual Cost	5-yr Total
Detailed AM Plan and Program set-up (during PED and Construction phases)	$100,000	$500,000
TOTAL	**$100,000**	**$500,000**

Table 3. Preliminary Cost Estimates for Implementation of Adaptive Management Program for the LCA Small Diversion at Convent/Blind River Project.

Category	Annual Cost	10-yr Total
Management of AM Program (post-construction)	$50,000	$500,000
Assessment	$47,000	$470,000
Decision-making	$31,000	$310,000
TOTAL	**$128,000**	**$1,280,000**

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DRAFT

ANNEX 1. LCA Small Diversion at Convent/Blind River Project Conceptual Ecological Model

1.0 INTRODUCTION

1.1 Conceptual Ecological Model Definition

Although the term "conceptual ecological model" (CEM) may be applied to numerous disciplines, CEMs are generally simple, qualitative models, represented by a diagram, that describe general functional relationships among the essential components of an ecosystem. CEMs typically document and summarize current understanding of, and assumptions about, ecosystem function. When applied specifically to ecosystem restoration projects, CEMs also describe how restoration actions propose to alter ecosystem processes or components to improve system health (Fischenich 2008). To describe ecosystem function, a CEM usually diagrams relationships between major anthropogenic and natural drivers, biological indicators, and target ecosystem conditions.

1.2 Purpose and Functions of Conceptual Ecological Models

CEMs can be particularly helpful in providing assistance with four important tasks: ecosystem description, communication, ecosystem restoration plan formulation, and monitoring and adaptive management.

1.2.1 Ecosystem Simplification

Because natural systems are inherently complex, resource managers must utilize tools that simplify ecosystem relationships and functions within the target ecosystem. An understanding of the target ecosystem is paramount to planning and constructing achievable ecosystem restoration projects. During CEM development, known and unknown connections and causalities in the systems are identified and delineated (Fischenich 2008).

CEMs can promote ecosystem description and simplification through the following processes:

- Organization of existing scientific information;
- Clear depiction of system components and interactions;
- Promotion of understanding of the ecosystem;
- Diagnosis of underlying ecosystem problems;
- Isolation of cause and effect relationships; and
- Identification of elements most likely to demonstrate ecosystem responses.

1.2.2 Communication

CEMs are an effective tool for the communication of complex ecosystem processes to a large diverse audience (Fischenich 2008). It is vitally important that project teams understand ecosystem function in order to realistically predict accomplishments to be achieved by restoration projects. CEMs can facilitate effective communication between project team members about ecosystem function, processes, and problems, and can assist in reaching consensus within the project team on project goals and objectives.

Because CEMs summarize relationships among the important attributes of complex ecosystems, they can serve as the basis for sound scientific debate. Stakeholder groups, agency functions (e.g., planning and operations), and technical disciplines typically relate to systems resource use and management independently, but CEMs can be used to link these perspectives.

The process of model development is at least as valuable as the model itself and affords an opportunity to draw fresh insight as well as address unique concerns or characteristics for a given project. Workshops to construct CEMs facilitate brainstorming sessions that explore alternative ways to compress a complex system into a small set of variables and functions. This interactive process of system model construction facilitates communication between project team members and almost always identifies inadequately understood or controversial model components.

CEMs can promote communication by facilitating the following:

- Integrating input from multiple sources and informing groups of the ideas, interactions, and involvement of other groups (Fischenich 2008);
- Assembling project/study managers with the project team and stakeholders to discuss ecosystem condition, problems, and potential solutions;
- Synthesizing current understanding of ecosystem function;
- Developing consensus on a working set of hypotheses that explain habitat changes;
- Developing consensus on indicators that can reflect project-specific ecological conditions; and
- Establishing a shared vocabulary among project participants.

1.2.3 Plan Formulation

Formulating a plan for an effective ecosystem restoration project requires an understanding of the following elements:

- The underlying cause(s) of habitat degradation;
- The manner in which causal mechanisms influence ecosystem components and dynamics; and
- The manner in which intervening with a restoration project may reduce the effects of degradation.

These three elements should form the basis of any CEM applied to project formulation (Fischenich 2008).

CEMs can provide valuable assistance to the plan formulation process through the following:

- Supporting decision-making by assembling existing applicable science;
- Assisting with formulation of project goals and objectives, indicators, management strategies, and results;
- Providing a common framework among team members from which to develop alternatives;
- Supplementing numerical models to assess project benefits and impacts; and
- Identifying biological attributes or indicators that should be monitored to best interpret ecosystem conditions, changes, and trends.

1.2.4 Science, Monitoring, and Adaptive Management

Through the recognition of important physical, chemical, or biological processes in an ecosystem, CEMs identify aspects of the ecosystem that should be measured. Hypotheses about uncertain relationships or interactions between components may be tested and the model may be revised through research and/or an adaptive management process. Indicators for this process may occur at any level of organization, including the landscape, community, population, or genetic levels; and may be compositional (i.e., referring to the variety of elements in a system), structural (i.e., referring to the organization or pattern of the system), or functional (i.e., referring to ecological processes) in nature.

CEMs can be helpful in restoration science, monitoring, and adaptive management through the following:

- Making qualitative predictions of ecosystem response;
- Identifying possible system thresholds that can warn when ecological responses may diverge from the desired effect;
- Outlining further restoration and/or research and development needs;
- Identifying appropriate monitoring indicators and metrics;
- Providing a basis for implementing adaptive management strategies;
- Interpreting and tracking changes in project targets;
- Summarizing the most important ecosystem descriptors, spatial and temporal scales, and current and potential threats to the system;
- Facilitating open discussion and debate about the nature of the system and important management issues;
- Determining indicators for monitoring;
- Helping interpret monitoring results and explore alternative courses of management;
- Establishing an institutional record of the ideas that inspired the management and monitoring plan;
- Forecasting and evaluating effects on system integrity, stress, risks, and other changes;
- Identifying knowledge gaps and the prioritization of research;
- Interpreting and monitoring changes in target indicators; and
- Assisting in qualitative predictions and providing a key foundation for the development of benefits metrics, monitoring plans, and performance measures.

1.2.5 Limitations of Conceptual Ecological Models

CEMs cannot identify the most significant natural resources within the target ecosystem or prioritize project objectives. They do not directly contribute to the negotiations and trade-offs common to ecosystem restoration projects. CEMs are not *The truth*, but are simplified depictions of reality. They are not *Final*, but rather provide a flexible framework that evolves as understanding of the ecosystem increases. CEMs are not *Comprehensive* because they focus only upon those components of an ecosystem deemed relevant while ignoring other important (but not immediately germane) elements. CEMs do not, in and of themselves, quantify restoration

outcomes, but identify indicators that can be monitored to determine responses within the target ecosystem to restoration outputs.

Good conceptual models effectively communicate which aspects of the ecosystem are essential to the problem, and distinguish those outside the control of the implementing agency. The best conceptual models focus on key ecosystem attributes, are relevant, reliable, and practical for the problem considered, and communicate the message to a wide audience.

1.3 Types of Conceptual Ecological Models

CEMs can be classified according to both their composition and their presentation format. They can take the form of any combination of narratives, tables, matrices of factors, or box-and-arrow diagrams. The most common types of CEMs are narrative, tabular, matrix, and various forms of schematic representations. A comprehensive discussion of these types of CEMs is provided in Fischenich (2008). Despite the variety in types of CEMs, "no single form will be useful in all circumstances" (Fischenich 2008). Therefore, it is of vital importance to establish the specific plan formulation needs to be addressed by the CEM, and develop the CEM accordingly because "[c]onceptual models . . . are most useful when they are adapted to solve specific problems" (Fischenich 2008).

1.3.1 Application of Conceptual Ecological Models to LCA Projects

CEMs have been widely used in other regions of North America when planning large-scale restoration projects (Barnes and Mazzotti 2005). The LCA team has decided to utilize the Ogden model (Ogden and Davis 1999). The LCA team recognizes that CEM development, like plan formulation, is likely to be an iterative process, and that CEMs developed for LCA projects during early plan formulation may be dramatically changed before project construction.

1.3.2 Model Components

The schematic organization of the CEM is depicted in Figure 1 and includes the following components:

- *Drivers*- This component includes major external driving forces that have large-scale influences on natural systems. Drivers may be natural (e.g., eustatic sea level rise) or anthropogenic (e.g., hydrologic alteration) in nature.
- *Ecological Stressors*- This component includes physical or chemical changes that occur within natural systems, which are produced or affected by drivers and are directly responsible for significant changes in biological components, patterns, and relationships in natural systems.
- *Ecological Effects*- This component includes biological, physical, or chemical responses within the natural system that are produced or affected by stressors. CEMs propose linkages between one or more ecological stressors and ecological effects and attributes to explain changes that have occurred in ecosystems.
- *Attributes*- This component (also known as indicators or end points) is a frugal subset of all potential elements or components of natural systems representative of overall

ecological conditions. Attributes may include populations, species, communities, or chemical processes. Performance measures and restoration objectives are established for each attribute. Post-project status and trends among attributes are measured by a system-wide monitoring and assessment program as a means of determining success of a program in reducing or eliminating adverse effects of stressors.

- *Performance measures-* This component includes specific features of each attribute to be monitored to determine the degree to which attribute is responding to projects designed to correct adverse effects of stressors (i.e., to determine success of the project).

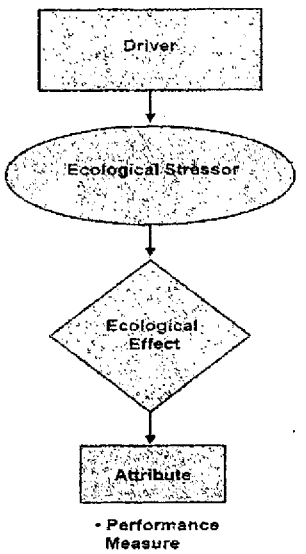


Figure 1. Conceptual Ecological Model Schematic Diagram.

This CEM does not attempt to explain all possible relationships or include all possible factors influencing the performance measure targets within natural systems in the study area. Rather, the model attempts to simplify ecosystem function by containing only information deemed most relevant to ecosystem monitoring goals.

2.0 CONCEPTUAL ECOLOGICAL MODEL DEVELOPMENT

2.1 Methodology

A CEM was developed for the Small Diversion at Convent/Blind River project by members of the project team and the interagency Project Delivery Team. The creation of this CEM was an interactive and iterative process. Prior to model development, the project team reviewed existing information on the project study area. The project team identified drivers, ecological stressors, ecological effects, attributes and performance measures for the project and a preliminary CEM was developed in two formats. The CEM in each of these formats was provided to the

interagency Project Delivery Team and the then members from both teams met to clarify and improve the CEM, which is presented in this report. Additional information about the components of the CEM for this project is presented below.

2.2 Project Background

The Small Diversion at Convent/Blind River project was identified in the Louisiana Coastal Area (LCA), Louisiana - Ecosystem Restoration Study (2004 LCA Plan [USACE 2004]). The 2004 LCA Plan was recommended to the Congress by a Chief of Engineers report dated January 31, 2005. The 2004 LCA Plan recommended a coordinated, feasible solution to the identified critical water resource problems and opportunities in Coastal Louisiana.

The project was included in that plan along with other critical near-term restoration features throughout coastal Louisiana. This project, as well as ten additional projects, was recommended for further studies in anticipation that such features would be subsequently recommended for future Congressional authorization. The 2004 LCA Plan was developed by the State of Louisiana and the United States Army Corps of Engineers in order to implement some of the restoration strategies outlined in the 1998 Coast 2050 report.

The project was proposed to reverse the current decline of a portion of the Maurepas Swamp area and to prevent the transition of the swamp into marsh and open water. This project will work together with the Small Diversion at Hope Canal diversion and the LCA Amite River Diversion Canal Modification projects to bring Mississippi River water, sediment, and nutrients to the current swamp area. Reversing this decline will help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy, and culture. In light of Louisiana's extreme vulnerability to intense storms, this project may also provide some measure of flood damage protection.

The Maurepas Swamp is an area of considerable ecological, socio-economic, and cultural importance. Since the construction of the Mississippi River flood control levees, large portions of the Maurepas Swamp have largely been cut off from fresh water, sediments, and nutrients historically provided by the Mississippi River. Due to this disruption in natural processes, soil building in the swamp has been insufficient to keep up with subsidence and sea level rise. Consequently, much of the swamp is persistently flooded, the existing trees may be somewhat stressed, and there is little to no natural regeneration of baldcypress and tupelo trees, which are the dominant species in this swamp ecosystem. These factors, combined with increasing occurrences of high salinities, if not addressed, will result in a highly degraded swamp system which is at risk of conversion to open water.

This diversion project would reintroduce up to 3,000 cubic feet per second (cfs) of Mississippi River water into the southwest portion of the Maurepas Swamp, thereby increasing the flow of fresh water, nutrients, and fine-grained sediment into an area in the swamp that is somewhat stressed and in need of restoration. The diversion project is fully consistent with both the strategies used to develop the LCA restoration plan and the critical needs criteria for identifying near-term restoration opportunities.

2.2.1 Project Goals and Objectives

The purpose of the Small Diversion at Convent/Blind River project is to restore and protect the health and productivity of the swamps southwest of Lake Maurepas through reintroduction of Mississippi River water. The specific objectives of the project concept are to:

- Promote water distribution in the southeastern portion of the Maurepas Swamp to move stagnant water out of the system.
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp.
- Increase the durations of dry periods in the swamp to improve baldcypress and tupelo productivity and to increase seed germination and survival of these key species.

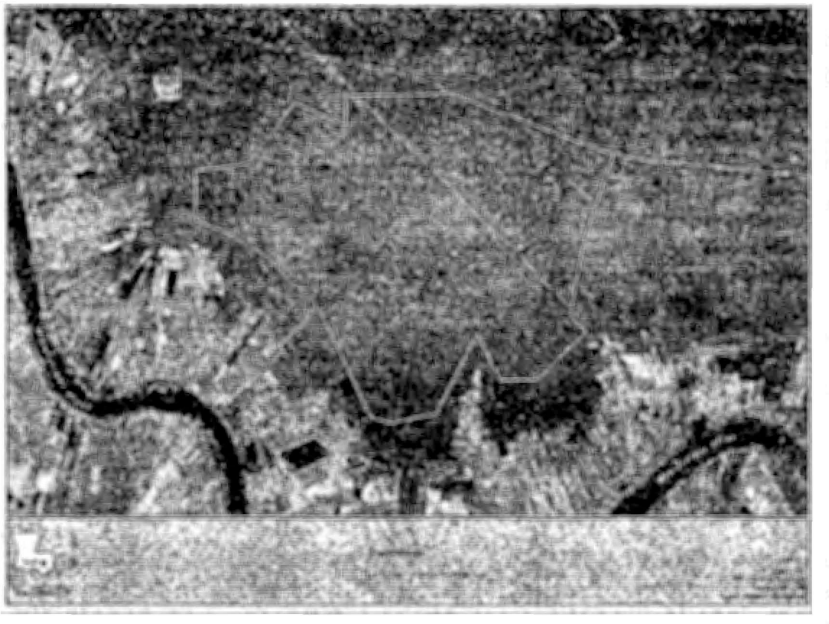
Improve fish and wildlife habitat in the swamp and in Blind River. This diversion project is located immediately west of the Hope Canal Diversion project and the influence areas are adjacent to each other. Both projects are planned to restore large areas of the Maurepas Swamp. As the diversion concepts and the swamp service areas are similar, many of the findings from the Hope Canal project will be applicable to this diversion project.

2.2.2 Project Description

The Maurepas Swamp is located in LCA Subprovince 1, west of Lake Pontchartrain and north of the I-10 corridor. The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises a total of approximately 232,928 acres, most of which is swamp, with some isolated areas of bottomland hardwood forest and fresh marsh. The diversion project involves evaluating a small hydraulic diversion (less than 5,000 cfs) from the Mississippi River into the Maurepas Swamp. Alternative locations for the proposed control structure in the vicinity of Romeville, located at Mississippi River Mile 161.5 above Head of Passes (AHP) were investigated. Reasonable alternatives were evaluated, and Alternative 2, diversion location at Romeville was selected.

The Blind River headwaters are located in St. James Parish approximately 23 miles north of Mississippi River at Mile 158.5 AHP. The Blind River flows north then east through Ascension and St. John the Baptist parishes before it empties into Lake Maurepas. The objective of this project is to introduce fresh water, sediment, and nutrients into the southwest portion of the Maurepas Swamp to help prevent the transition of the swamp into marsh and open water

Figure 2. Small Diversion at Convent/Blind River Project Study Area



3.0 CONCEPTUAL ECOLOGICAL MODEL DISCUSSION

The CEM developed for the Small Diversion at Convent/Blind River project is presented in Figure 3. Model components are identified and discussed in the following subsections.

3.1 Drivers

3.1.1 Natural Factors

Subsidence and Sea Level Rise

Increased subsidence is a physical response to lack of riverine input and the resulting loss of nutrients and sediments and decreased productivity in vegetation communities. The soil characteristics within the western Maurepas Swamp are indicative of a lack of riverine influence as evidenced by high soil organic matter content and low bulk density values (DeLaune et al. 1979, Hatton 1981, Messina and Conner 1998). Soil building within the Maurepas Swamp occurs almost exclusively as a result of organic productivity. Subsidence in this area is classified as intermediate, at about 1.1-2.0 feet per century (USACE 2004). With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that the swamps are now persistently flooded. Thomson (2000) also indicated that there has been a rise in mean sea level of 1.6 mm per annum from 1957 to 2000 near the study area.

Shaffer et al. (2003) conducted a subsidence investigation in the Maurepas Swamp immediately east of the project study area in support of CWPPRA project PO-29 *Mississippi River Reintroduction into Maurepas Swamp*. Subsidence rates for the PO-29 project area were measured by the installation of two surface elevation tables at 13 representative study sites. The tables could be set in four compass directions and utilized the mean value of nine pin readings of soil elevation. Readings were collected from October-November 2001 and compared against readings collected in October-November 2002 to provide an accurate estimate of the net subsidence rates within the Maurepas Swamp. The results of this subsidence investigation indicate an average net elevation decrease of slightly less than one centimeter for the study area during the interval between sampling, although actual rates varied considerably by habitat type.

The combination of increased flood duration due to subsidence and sea level rise and increased salinity are likely to convert freshwater swamps to marsh and open water. The altered hydrology prevents the regeneration of swamps (Penfound 1952, Shaffer et al. 2003).

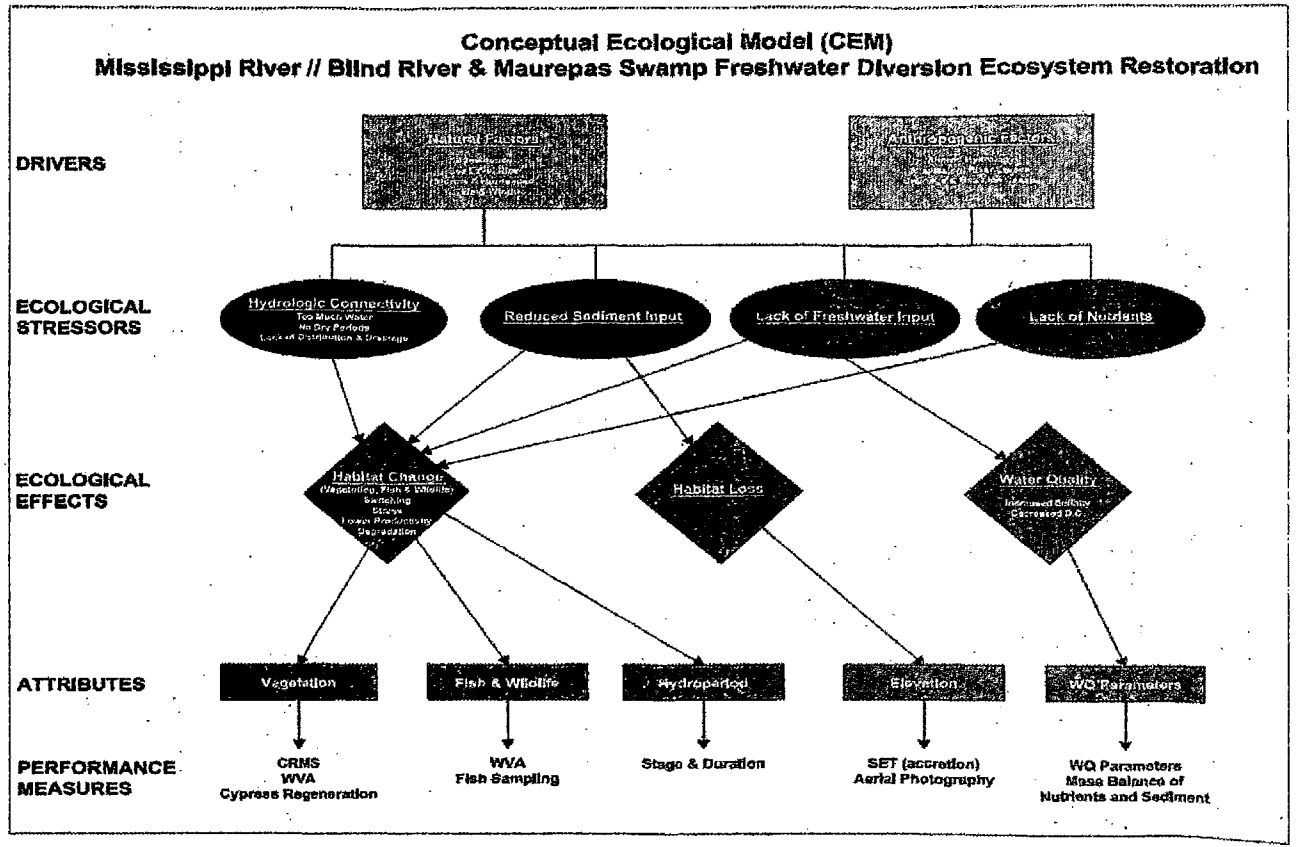


Figure 3. Conceptual Ecological Model, LCA Small Diversion at Convent/Blind River Project .

Storms and Hurricanes

Coastal storms, particularly tropical cyclone events, also exert a stochastic but severe influence on the study area. Storm surge frequency encourages continued degradation of the coastal forest habitat in and surrounding the study area, further reducing the ability of these habitats to attenuate storm surge. Consequently, an increase in storm surge and risk of flooding is imminent. Data obtained from the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center indicate that the storm centers of at least 14 tropical cyclones with a Saffir-Simpson Hurricane Scale of Category 2 or higher have passed within 50 miles of the study area during the interval 1851-2007, and at least 52 such tropical cyclones have passed within 100 miles of the study area during the same interval. The most recent tropical cyclones to affect the study area were hurricanes Katrina and Rita, which occurred in August 2005 and September 2005, respectively, and hurricanes Gustav and Ike, which occurred in September 2008.

Tides and Wind

The Blind River/Maurepas Swamp system is tidally affected although it is a freshwater system. The tides and wind affect the flow of water in the Blind River, and therefore the swamp, and are important natural driving factors. These factors were considered in addressing the hydrology and flow patterns in the system and in determining the appropriate measures for ecosystem restoration.

3.1.2 Anthropogenic Factors

Mississippi River Levees

With construction of the Mississippi River flood control levees, the Maurepas Swamp has been virtually cut off from any freshwater, sediment, and nutrient input from the Mississippi River floods. Thus, the only soil building has come from organic production within the wetlands, and vegetative productivity may be substantially depressed compared to pre-levee conditions. Subsidence in this area is classified as intermediate, at about 1.1 to 2.0 feet/century. With minimal soil building, moderately high subsidence rates, modified drainage in and around the swamp, there has been a net lowering of ground surface elevation, and the swamps are persistently inundated.

Altered Hydrology

Although the Blind River and Maurepas Swamp have been cut off from the Mississippi River, significant drainage flows to the river and the swamp from the northeast during large storms and hurricanes (that frequently occur in the study area, as indicated above). The flows are so large that the river and swamp drain slowly or not at all, resulting in high water levels, impoundment, and damping of the natural hydroperiod. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Existing baldcypress and tupelo trees are able to grow in flooded conditions. However, neither baldcypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede. The potential for re-establishment seems to also be hindered by the relatively low numbers of viable seeds observed in swamp seed banks and by herbivory.

Drainage Canals and Pipe Line Canals

Major drainage canals have been constructed in the project study area. These major drainage canals are associated with and essentially extend flows in Blind River throughout the project site. Canal construction has altered physical defining characteristics, including water storage, sheet flow, and nutrient and sediment input levels within swamp habitat in the study area. The canals are routinely dredged by St. James Parish and dredged material generated in the construction and maintenance of the canals is placed in spoil banks on both sides of the canal. These spoil banks form topographic high points within the study area that affect the distribution of water into the swamp.

Several gas transmission and hazardous liquid pipelines exist in the study area (refer to Table 4-33 in the main report). Dredged material banks that are higher than the natural land surface, and along with the many smaller canals dredged during exploration and pipeline installation, they alter the natural hydrology much the same way as drainage canals discussed previously. The banks constructed from dredged material create partially impounded areas that reduce water exchange resulting in water-logged areas and plant death.

3.2 Ecological Stressors

3.2.1 Hydrologic Connectivity

Hydrologic connectivity addresses the importance of the connection between the Blind River and Maurepas Swamp. The normal flow in the river and flow from large storm events and hurricanes are the ecological stressors that most affect the biological components and patterns that exist in the river and the swamp. These flows affect the drainage patterns in the system since high flows lead to impoundment and alteration of the hydroperiod. During the prolonged period of inundation, drainage is limited, resulting in too much water in the swamp for too long a period (high depth and duration). The overall effect is that there appear to be no dry periods in the swamp, which reduces or eliminates baldcypress and tupelo regeneration. Natural biological life cycle patterns can also be disturbed without dry periods. Impoundment within the study area has also resulted in decreased water quality.

3.2.2 Lack of Freshwater , Sediment, and Nutrient Input

Historically, hydrologic conditions within the study area were dominated by overbank flow from the Mississippi River, and by tidal influence from Lake Maurepas. Periodic flooding of the Mississippi River and/or the Blind River resulted in the inundation of baldcypress-tupelo habitat within the study area. Flooding occurred within the study area and vicinity on a cyclical basis, with peak water elevations in the late spring or fall. As floodwaters receded, surface waters in the study area were conveyed to the Blind River, and then to Lake Maurepas.

The implementation of flood control projects from the late 19th century to mid-20th century, including construction of flood protection levees on the Mississippi River and construction of major drainage canals, disrupted the natural hydrologic regime within the study area. Mississippi River channelization and levee construction greatly reduced overbank flooding in the study area, causing a loss of freshwater (as well as nutrients and sediments) in the ecosystem, decreased water quality, and increased subsidence. Input of freshwater, nutrients, and sediment are important to the biological make-up, productivity, and maintenance of the swamp relative to subsidence and sea level rise. The lack of periodic freshwater input has led to modifications in the swamp's ecology.

Loss of nutrients and sediments is a physical response to the lack of riverine input. Effler et al. (2006) examined the importance of nutrient influxes that accompany freshwater diversions or other hydrologic connectivity projects to swamp productivity. Nutrient augmentation of baldcypress and tupelo trees in the Maurepas Swamp (similar to nitrate loading rates expected from a small freshwater diversion) increased radial growth of both species (especially baldcypress) in degraded forest stands. Nutrient augmentation also increased nitrogen in foliage for both tree species. These findings support hypotheses that swamps in southeastern Louisiana are nutrient-limited, and existing trees can utilize, benefit from, and act as nutrient sinks for nutrient-laden river water accompanying diversions or other freshwater reintroductions.

Further evidence of nutrient starvation was identified in Shaffer et al. (2001). This study determined that nutrient augmentation significantly enhanced (by approximately 33 percent) biomass production of herbaceous vegetation at monitoring stations within the western Maurepas Swamp during 2000. Furthermore, several studies conducted over the last two decades have demonstrated that nutrient augmentation to baldcypress seedlings doubles growth rates in the western Maurepas Swamp (Boshart 1997, Forder 1995, Greene 1994, Myers et al. 1995), further indicating that the baldcypress-tupelo swamp in the study area and vicinity is nutrient-limited.

Shaffer et al. (2008) presented data at the Society of Wetland Scientists meeting on tree growth in the Maurepas Swamp. For the period 2000-2007, diameter growth was measured for over 1,800 trees. Diameter growth in the measured trees was significantly less than established growth levels for trees in healthy freshwater swamp systems. The study determined that in interior swamp locations such as the study area, the primary factor inhibiting diameter growth was nutrient-poor stagnant standing water and the lack of nutrient-rich freshwater throughput caused by the loss of hydrologic connectivity with riverine systems.

3.3 Ecological Effects

3.3.1 Habitat Change and Habitat Loss

Increased habitat conversion is a physical and biological response to both impoundment and the resulting lack of regeneration, increased seedling mortality as well as lack of riverine input and the resulting loss of nutrients and sediments resulting in decreased plant productivity. Hoeppner et al. (2007) concluded that the majority of the Maurepas Swamp is stressed and seems to be on a trajectory of slow degradation leading to a gradual conversion to marsh and open water. Stagnant flooding and nutrient deprivation appear to be the largest stressors in the swamp interior.

Natural regeneration throughout the Maurepas Swamp is very low and even absent at most sites (Hamilton and Shaffer 2001). Land conversion observations on the Manchac land-bridge and Jones Island demonstrate what is expected in the Maurepas Swamp in the coming decades, if no restoration action is taken. In 1956, most of the area of the Manchac land-bridge was dominated by second-growth swamp. By 1978, much of this swamp had converted to marsh and shrub-scrub, and by 1990 the marsh had begun to break up and convert to open water (Barras et al. 1994).

Under the continued influence of these conditions, tree mortality will continue to increase and tree density will continue to decline. Monitoring studies conducted for the CWPPRA PPL 12 proposal indicated that conversion of baldcypress-tupelo swamp to fresh marsh is already occurring in the Maurepas Swamp. The results of these monitoring studies indicate that many areas of interior swamp in the study area and vicinity that exhibit significantly stressed or dying

overstory vegetation also contain bulltongue (*Sagittaria lancifolia*) or arrow arum (*Peltandra virginica*) as understory vegetation.

Factors contributing to this conversion include the much greater tolerance of baldcypress and water tupelo with respect to herbaceous understory vegetation for long-term deep inundation, and the increasingly unconsolidated nature of swamp substrate caused by the reduction of below-ground productivity. Consequently, it is expected that the swamp habitat adjacent to the Blind River Canal would convert to open water or marsh habitat without implementation of the proposed project.

Souther and Shaffer (2000) reported that in the early 20th century, baldcypress swamps were harvested *en masse* in coastal Louisiana, and that in many harvested areas, natural regeneration did not occur; instead, these areas converted to marsh or open water. The study concluded that prolonged flooding or complete submergence within the swamps may have suppressed germination or growth rates of young seedlings and even caused mortality. Neither baldcypress nor tupelo seeds can germinate when flooded (Hamilton and Shaffer 2001). Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede. However, the seedlings require seasonal drying periods, and the substrate compaction associated with these drying periods, for their root systems to become properly established in the swamp substrate. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur, leading to failure of seedlings to establish themselves and replace older trees that have been lost to other processes (CWPPRA Task Force 2002).

Decreased productivity in vegetative communities in the study area is a biological response to the lack of riverine input. Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing levels of productivity in the western Maurepas Swamp are as low as 50 percent or even 25 percent of average values (Hamilton and Shaffer 2001).

As part of the CWPPRAPPL 11 effort to launch a project diverting Mississippi River water into the Maurepas Swamp, Shaffer et al. (2001) examined woody and herbaceous vegetation at 20 study sites in the Maurepas Swamp. The study examined cover values, annual production, herbaceous (understory) primary production, tree health and primary productivity, annual tree diameter growth, and litterfall production at these sites to develop a comprehensive picture of vegetation productivity in the region. The study concluded that salinity is currently an important stressor in the Maurepas Swamp, but that degradation of tupelo trees within the swamp has been occurring for decades and is almost certainly primarily due to altered hydrology and lack of throughput. The study determined that the low soil bulk densities and high soil organic matter content throughout much of this swamp are indicative of a lack of riverine influence.

The results of the Shaffer et al. (2001) and other studies indicate that the western Maurepas Swamp is highly degraded and would benefit from a substantial infusion of nutrients and freshwater from a river diversion or other freshwater reintroduction. Results of studies in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 300 to 500 percent (Rybczyk et al. 2002, Hamilton and Shaffer 2001).

3.3.2 Decreased Water Quality

Decreased water quality is a chemical response to the impoundment produced in the study area and the introduction of saline storm surge waters associated with tropical cyclone events. The Maurepas Swamp is characterized by nutrient-poor surface waters. Day et al. (2001) conducted a water quality analysis in support of CWPPRA Project PO-29 *Mississippi River Reintroduction into the Maurepas Swamps*. The observed concentrations of nitrate, ammonium, and nitrogen at surface water sampling stations within the western Maurepas Swamp were all reduced with respect to observed concentrations in the Mississippi River. The results of sampling of water quality parameters demonstrate that, for some nutrient forms, the Maurepas Basin has relatively low nutrient concentrations compared to the Mississippi River and other systems studied. The results of this study indicate that the baldcypress-tupelo swamp within the study area and vicinity is severely nutrient-limited.

Additionally, storm surges originating from Lake Maurepas associated with tropical cyclone events may exert a stochastic but severe stress upon the swamp habitat through salinity spikes in surface waters within the swamp. Recent tropical cyclone events, occurring at a rate of one to two per years, have produced measurable spikes in salinity within the western Maurepas Swamp (USACE 2004).

3.4 Attributes and Performance Measures

3.4.1 Vegetation Productivity

Swamp vegetation productivity has been identified as a key indicator of project success. Comparison of pre-project and post-project vegetation monitoring data would serve to determine if biomass production in plant communities within the study area increases in response to project features. A post-project increase in biomass production would also indicate the introduction of nutrients and sediment into the swamps as a result of the project. Three assessment performance measures have been identified for this attribute, including percent cover, diameter at breast height (dbh), and litterfall.

- *Percent cover* is the estimated percentage of the ground surface covered by vegetation. Canopy percent cover is the estimated percentage of the ground surface covered by tree canopies when the crowns are projected vertically. A high percent cover is indicative of significant productivity within the respective vegetation communities, and a high canopy percent cover is indicative of significant productivity within woody species.
- *Diameter at breast height (dbh)* is the measurement of tree diameter at a height of 4.5 feet above the forest floor on the uphill side of the tree. Ongoing monitoring studies of baldcypress and tupelo trees within the western Maurepas Swamp by Dr. Gary Shaffer indicate that average annual dbh increase for trees within the eastern study area is approximately one millimeter per year, a growth level that is significantly lower than expected levels of 1-2 centimeters per year for healthy baldcypress or tupelo trees (Shaffer, personal communication 2009).
- *Litterfall* is the measurement of the movement of leaves, twigs, and other forms of organic matter from the biosphere to the litter layer found in soil via interception in collection traps. Large volumes of litterfall are indicative of significant biomass production within the constituent forest community.

A post-project relative increase in productivity within the study area, as evidenced by these three measures, would be an indication of significant project success, while a post-project stabilization

of these measures would be an indication of moderate project success. Conversely, a post-project decline in these measures within the study area would indicate that the project did not succeed in increasing swamp vegetation productivity.

3.4.2 Fish and Wildlife Habitat

The Maurepas Swamp is an important habitat for a variety of fish and wildlife species, including crawfish, alligators, snapping turtles, blue crab, and channel catfish. The Maurepas Swamp also provides valuable habitat to a number of avian species, including neo-tropical migratory songbirds and waterfowl. Two threatened species (the bald eagle and Gulf sturgeon) are found in this area. Bald eagles typically nest in baldcypress trees near low salinity to intermediate marshes or open water. The Gulf sturgeon is a threatened species found in Lake Maurepas. Although extremely rare, the West Indian manatee has been sighted in the area a few times over the last 25 years. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of baldcypress/tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance. Wildlife habitat will be evaluated with the Wetland Value Assessment (WVA) procedure..

3.4.3 Hydroperiod

For any single year the hydroperiod of the swamp is bimodal. The water level generally rises in the spring, then falls to its lowest level during summer, rises to its highest level in the fall, and again falls to low levels in the winter. High water levels in the fall are attributed to tropical storms and hurricanes. Increases in flood duration are exacerbated by sea level rise and subsidence. Flood duration is one of the main drivers that control species diversity and productivity in the swamp.

Hydroperiod measurement is a key monitoring component for determining the hydrology and status of the project area. Flow in the Blind River will be measured and evaluated and piezometers will be established in Maurepas Swamp in each project area hydrologic unit.

3.4.4 Elevation

Ground surface elevation has been identified as a key indicator of project success with respect to reducing or reversing subsidence within the study area. Comparison of pre-project elevation levels with post-project elevation levels would serve to determine if sediment input and soil accretion is occurring within the study area in response to project features. A post-project increase in elevation would implicitly indicate the introduction of nutrients and sediment into the swamps as a result of the project, and would also indicate an increase in vegetation productivity and the resulting litterfall that is a principal factor in soil accretion within the Maurepas Swamp. Two assessment performance measures have been identified for this attribute, including surface elevation table (SET) measurements and feldspar marker horizon measurements.

- *Surface Elevation Table (SET) measurements* provide a constant reference plane in space from which the distance to the sediment surface can be measured by means of pins lowered to the sediment surface. Repeated measurements of elevation can be made with high precision because the orientation of the table in space remains fixed for each sampling. Elevation change measured by the SET is influenced by both surface and subsurface processes occurring within the soil profile.

- *Feldspar marker horizon measurements* involve the placement of a cohesive layer of feldspar clay on the ground surface. Soil borings are periodically extracted at the marker horizon location to measure the amount of soil deposition and/or accretion that has occurred above the horizon since placement. Significant quantities of soil atop marker horizons are indicative of soil building within the area, which in turn indicates an increase in relative elevation.

Post-project increases in elevation as evidenced by SET measurements or documented soil accretion atop a marker horizon within the study area would be an indication of significant project success, while a post-project stabilization of elevation as evidenced by these measures would be an indication of moderate project success. Conversely, a post-project decline in elevation within the study area would indicate that the project did not succeed in offsetting subsidence and, by extension, habitat conversion, and future land loss.

3.4.5 Water Quality

Surface water quality in interior locations in the study area has been identified as a key indicator of project success with respect to establishing hydrologic connectivity between the Blind River and associated major canals, and the adjacent swamp habitat. Comparison of pre-project and post-project water quality would serve to determine if freshwater throughput is introducing nutrients and flushing out saline waters within the study area in response to project features. A post-project improvement in water quality would implicitly indicate the introduction of freshwater and the associated nutrients and sediment into the swamps as a result of the project. Four assessment performance measures have been identified for this attribute, including total suspended solids (TSS), dissolved oxygen (DO), nutrients, and salinity.

- *Total suspended solids* (TSS) is a measurement of the total volume of sediment and other solids suspended in a given volume of water.
- *Dissolved oxygen* (DO) is a relative measure of the amount of oxygen that is dissolved in a given volume of water. Surface waters within the swamps in the study area are expected to exhibit lower DO concentrations than those of nearby waterbodies, because water movement (which exposes surface water to a greater volume of air through lateral movement and results in greater dissolution of oxygen) is virtually nonexistent in the swamps.
- *Nutrients* are chemical compounds or minerals contained in surface waters that are extracted by organisms for nourishment. Common nutrients in surface waters include nitrates, phosphates, and ammonia. Surface waters within the swamps adjacent to the Blind River and associated major canals have been demonstrated to be nutrient-poor with respect to other waterbodies in the area because the hydrology prevents the accumulation of nutrients from surface runoff.
- *Salinity* is a measure of the concentration of dissolved salt in a given volume of water. Surface waters within the study area often exhibit elevated salinity levels with respect to other area waterbodies because saline storm surges introduced into the swamps during tropical cyclone events become trapped in the impounded swamps and are not allowed to drain out of the study area.

Post-project improvements in water quality within the study area as evidenced by analyses of these measures would be an indication of significant project success, while a post-project

stabilization or decline in water quality within the study area would indicate that the project d not succeed in reestablishing riverine input to the study area and the resulting reintroduction nutrients and sediments associated with freshwater throughput.

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Volume IV

APPENDIX J:

Real Estate Plan

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Appendix J

REAL ESTATE PLAN

Small Diversion at Convent/Blind River

May 6, 2010

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Table of Contents

1. PROJECT PURPOSE:.....4
2. PROJECT SPONSOR:.....4
3. PROJECT LOCATION AND STUDY AREA:.....4
4. GENERAL PROJECT DESCRIPTION:.....7
5. LER.....10
6. ESTATES.....10
7. SPONSOR LAND ACQUISITION EXPERIENCE:.....12
8. UTILITY RELOCATIONS:.....12
9. PUBLIC LAW 91- 646 & ACQUISITION SCHEDULE:.....15
10. ACQUISITION COSTS:.....15
11. LANDOWNER ATTITUDE:.....16
12. ENVIRONMENTAL ISSUES:.....16
13. STATE / FEDERAL LANDS AND PROJECTS IN THE PLAN AREA:.....16
14. TIMBER / MINERAL / ROW CROP ACTIVITY:.....16
15. INDUCED FLOODING:.....18
16. ZONING ORDINANCES:.....19
17. RELOCATIONS ASSISTANCE BENEFITS:.....19
18. NAVIGATION SERVITUDE:.....19
19. ACQUISITION PRIOR TO PPA:.....19
20. NON-FEDERAL SPONSOR OWNED LER:.....19

List of Figures

FIGURE 1.1 LCA ECOSYSTEM RESTORATION STUDY, 2004 5
FIGURE 1.2 UPPER PONTCHARTRAIN SUB-BASIN 6
FIGURE 1.3 STUDY AREA MAP 6
FIGURE 1.4 PROJECT AREA MAP 8
FIGURE 1.5 ALTERNATIVE 2 - TSP 9

List of Exhibits

EXHIBIT I: ASSESSMENT OF NON FEDERAL SPONSOR
EXHIBIT II: CHART OF ACCOUNTS
EXHIBIT III: QUALITY CONTROL PLAN CHECKLIST

1. Project Purpose:

This Real Estate Plan (REP) presents a preliminary plan for the acquisitions of lands, eas ements, relocations and rights-o f-way necessary for construction and implementation of the projec t. This doc ument is for planning purposes only and is subject to change.

The Small Diversion at Convent/Blind Rive r restoration project was proposed to reverse the current decline of the southeast portion of the Maurepas Swamp and t o prevent the transition of the Swamp into marsh and open water. Reversing this dec line will help to develop a more su stainable wetland ecosy stem, which can serve to protect the local environment, economy and culture.

The Div ersion at Convent / Blind River restoration project suggests a small hydraulic diversion (3,000 cfs) from the Mi ssissippi River at Romeville into Maurepas Swamp. T he project will be for the restor ation of the southeaste rn Maurepas Swamp. The objective of this project is to introduce freshwater, sedi ment, and nutrients into the southeast portion of the Maurepas Swamp to im prove biolo gical productivity that will facilitate organic de position in th e Swamp, and preve nt further Swamp de terioration. The freshwater diversion will:

- Promote water distribution in the swamp
- Facilitate swamp building
- Establish hydroperiod fluctuation in the swamp
- Improve fish and wildlife in the swamp and in Blind River

2. Project Sponsor:

The non-F ederal sponsor is the Coastal Protection and Restoration Author ity of Louisiana (CPRA). However, the Office of Coastal Protection and Restoration (OCPR) is the implementing arm of CPRA, which has been given authority to acquire and hold these lands. As the non-Federal Spons or, CP RA through OCPR must provide all real estate interests required for this proposed project construction, i.e., all lands , easements, right of way relocations, and any other interests, incl uding suitable borrow and dredged or excavated material dispos al areas (LERRDs). OCPR has indicated it would provide all lands, water bodies, and/or water bottoms that are owned, claimed, or controlled by the State of Louisiana. If it becomes necessary, OCPR hav ing no "quick take" authority of its own, will partner with another public age ncy, s uch as the Pontchartrain Levee District (PLD), to acqu ire the la nds needed fo r this project. The NFS feels confident in being ab le to meet the "public need" requirements of the quick take statutes of the State of Louisiana.

3. Project Location and Study Area:

The study area for this project is incl uded as portions of t he Mississippi River Deltaic Plain within coastal s outheast Louisiana in the Lake Pontc hartrain Basin. The

Lake Pontchartrain Basin and its four sub-basins are shown in Figure 1.1. The study area for this project is within the Upper Lake Pontchartrain Sub-basin, Subprovince 1 on Figure 1.2. The Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River. Louisiana parishes in the study area include St. James and Ascension. The benefit area consists of the Maurepas Swamp and Blind River southwest of I-10.

The Project Area is located in St. James Parish in the vicinity of Romeville. It is bound on the north by Interstate Highway I-10 and the south by the St. James Canal and on the west by the St James Canal and the Old Tram Road extending south from Interstate Hwy I-10 to US Highway 61. The majority of the Project Area is comprised of land area reported to be approximately 35+/- square miles of Cypress Tupelo Gum Bottomland Swamp situated in the northern portion of St. James Parish, Louisiana.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St. John the Baptist Parish, and then discharges into Lake Maurepas.

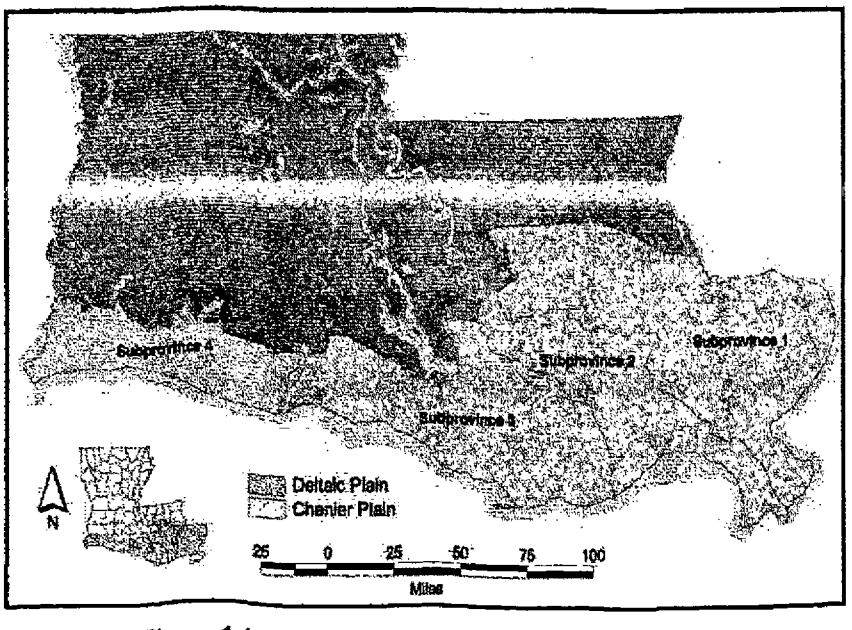


Figure 1.1: LCA Ecosystem Restoration Study, 2004

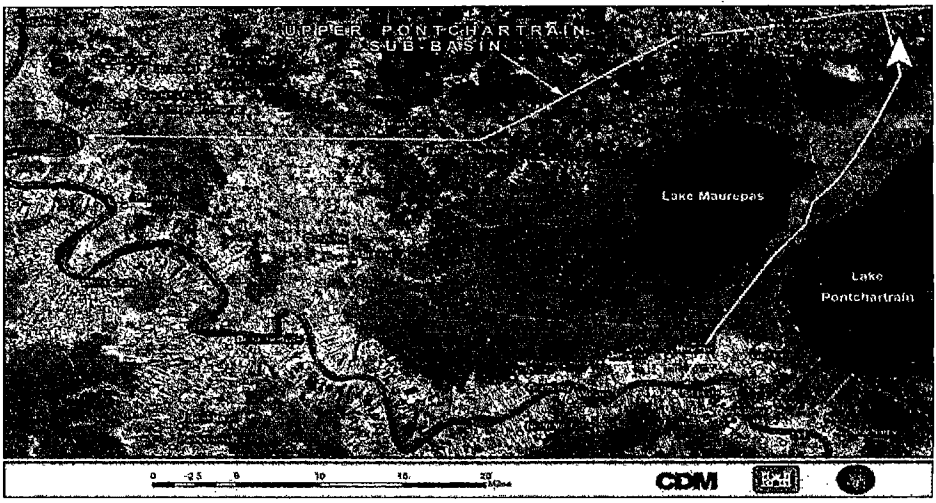


Figure 1.2: Upper Pontchartrain Sub-Basin

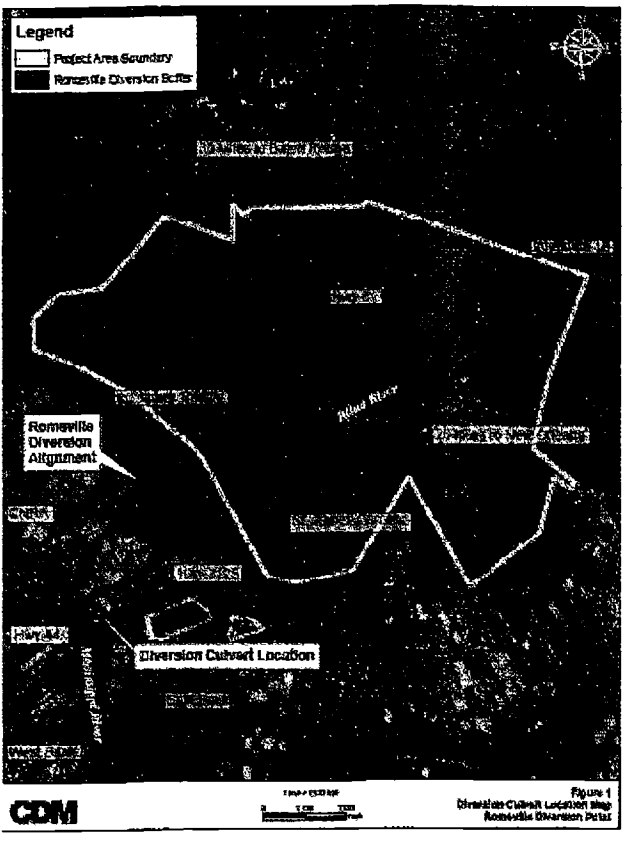


Figure 1-3: Project Area Map Change out

4. General Project Description:

The project intends to reverse the trend of degradation of the lands located in the southeastern portion of the Maurepas Swam p with the introduction of freshwater, sediments and nutrients, via a diversion canal. The project begins at the east bank of the Mississippi River. A transmission canal will transfer the diverted water approximately three miles from the diversion c ulvert fac ility to an existing dr ainage channel at the perimeter of the swamp. This canal is part of an interc onnected network of man-made drainage c hannels along the sout h and west bound ary of the distribution area, with several outfall channels dischar ging to t he Blind River. The drainage channels are maintained by St. James Parish. These c hannels are large, varying in size from approximately 30 to 100 feet wide at the top, and vary in depth from 6 to 12 feet.

The reintroduction of freshwater into the swamp and the sediments and nutrients will approximate the natural historic flooding cycle, interrupted by the current levee system, and assist in rebuilding the wetlands at a rate greater than the subsidence rate.

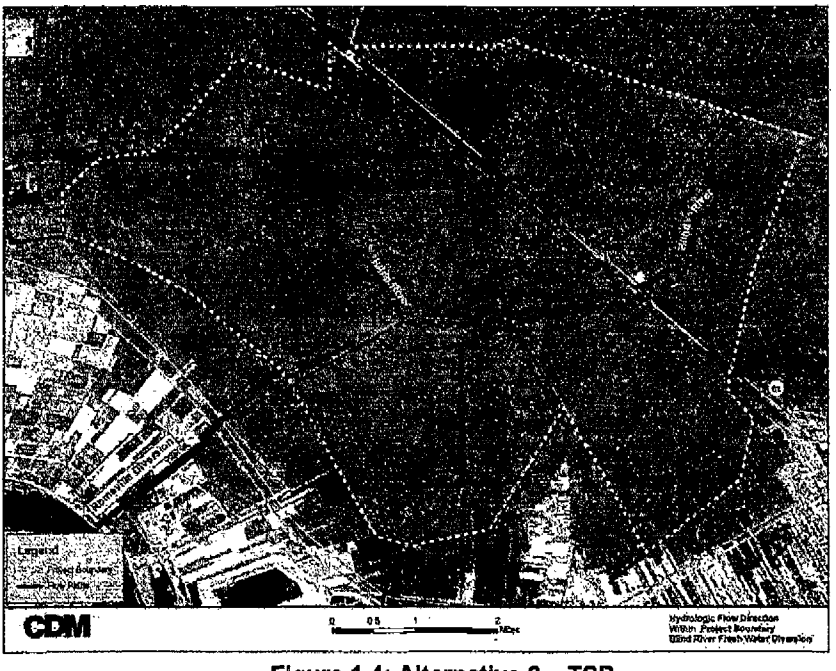


Figure 1.4: Alternative 2 – TSP

The Tentatively Selected Plan (TSP), depicted in Figure 1.4 would improve a total of 21,369 acres of bald cypress-tupelo swamp that are in various stages of deterioration. This TSP includes the construction of a 3,000 cfs diversion channel at Romeville, and has six major components: a diversion structure, a transmission canal, six control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along the U.S. Highway 61 corridor, and instrumentation.

Major elements of the construction include:

- **Diversion Structure**

  The diversion culvert facility will divert freshwater from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal.

LA 44 (River Road) is adjacent to the levee, and the box culvert will be extended under the road and discharge into the transmission canal approximately 100 feet east of the road.

- **Transmission Canal**

The transmission canal will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. Right-of-way for the canal will be 400 feet in width by 15,500 linear feet in length.

The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125. These will be temporarily relocated during the term of construction.

- **Control Structures**

The project will use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp. Up to six (6) control structures will be installed at key locations in the existing channels to perform this function.

- **Berm Gaps**

When the existing drainage channels were excavated in the swamp, the excavated material was cast to one side of the channel forming spoil banks.

New 500-foot wide berm gaps will be excavated in the spoil banks at an approximate spacing of 2,500 feet on center. The gaps will be excavated to the elevation of the adjacent swamp natural ground elevations, and the spoil will be disposed behind the existing spoil banks. Based on current information these cuts all are constructed on property owned by the Louisiana Department of Wildlife and Fisheries (LDWF). Therefore, no acquisition of real estate interests will be necessary for this feature.

- **Cross Culverts at the Highway 61 Corridor**

New culvert crossings will be added under the KCS RR and U.S. HWY 61 at four locations. This will be accomplished within existing road and railroad right-of-ways.

5. LER:

It will be necessary to acquire (175 +/- acres) of land in fee for the transmission channel and related improvements. There is one private ownership for the diversion channel, Parkview Land Company, LLC, the sole owner being Mr. Rickey Roussel. Mr. Roussel currently farms the subject property with sugar cane. Additional property in the ownership of the State of Louisiana includes Louisiana Department of Wildlife & Fisheries, the Pontchartrain Levee District, and LADOTD. All rights of ways required to construct this project in ownership of the State are to be acquired with agreements between the various public agencies. Additionally the Parish of St. James will grant permission for use of the Parish canal system to assist in water distribution for the TSP.

Diversion Facility

The owner of the batture and land under the levee is Rickey Roussel, the same owner as that of the l and needed for the tr ansmission canal. The existing levee will be temporarily removed at the box culvert crossing. The dirt will be stockpiled near the site. This stockpile site will be between the levee and the temporary LA 44 relocation.

The temporary levee and the limits for the existing levee removal extend past the right-of-way requirements for the permanently installed facilities. Temporary work area easements will be required for the levee work.

LA 44 and LA 3125 Temporary Relocation

A 50 foot by 300 foot temporary ROW will be needed outside of our 500 foot acquired ROW in both directions of the exist ing roads. The duration for this easement will be for 24 months from the start of project.

CN RR Temporary Relocation

The proposed transmission canal will ha ve a multi-cell concr ete box c ulvert installed under the CN RR tr acks by open-cut construction. The railroad will have to be temporarily relocated (shoofly) to accommodat e the construction. The final design requirements have not yet been obtained from the railroad but general parameters have been defined. It is likely that the shoofly will have to be designed to maintain full operating speeds, resulting in a long shoofly layout. The existing railroad right-of-way is 100 feet wide, and the shoofly mi ght be located totally in the existing right-of-way. For planning purposes, it is assumed that the shoofly will have to be at least partially outside of the right-of-way. Assume that the construction easement will be 4,600 feet long and 50 feet wide.

6. ESTATES:

It is important to note that the diversion of water from the Mississippi will be controlled to permit water to enter t he swamp on a periodic release d uring dry conditions. The flow will be restricted and terminated during periods of sev ere rainfall

and cyclical high water events. The discharge is not intended to significantly raise water levels bey ond the or dinary lev els of the areas wit hin the pr oject area. The water released into the canal system during low water and dry periods will allow flows into the swamp dur ing period that woul d ordinarily see minim al flo w. Based on th e hydraulic data, there is no indic ation of significant water level variations as a result of the project; therefore, flowage easements are not needed.

The non-federal sponsor has selected to acquire fee (excluding minerals) for the transmission channel rather than a channel easement to maintain control over access and maintenance of the project area during and after construction of the improvements. The value of a perpetual channel improvement easement is tantamount to fee value; therefore, it is in the agency's best interest to acquire fee (excluding minerals). Below is the language of the fee estate.

Fee Excluding Minerals
(With Restrictions on Use of the Surface)

(Standard Estate)

The fee s imple title t o (the land described in Sc hedule A) (Tracts Nos. ___, ___ and ___), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipe lines; exce pting and e xcluding from the taking a ll (coal) (oil and gas) in and under said land and all appurte nant ri ghts for the e xploration, development, production and removal of said (coal) (oil and gas), but without the right to enter upon or over the surface of said land for the purpose of drilling and extracting therefrom said (coal) (oil and gas).

An additional 9 acres are estimated to be needed for detours at the levee, LA Highway 44, LA Highway 3125, and the Canadian National Railroad. Dimensions of the actual temporary easements will be defined in the final desig n phase. A temporary work area easement will b e acquired for a 24 month period over areas neede d for detours. The language of the easement follows:

Temporary Work Area Easement

(Standard Estate)

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. _____, _____ and _____), for a period not to exceed _____, beginning with date possessi on of the land is granted to the United States, for use by the Unit ed States, its representatives, agents, and contractors as a (borrow area) (work area), including t he right to (borrow and/or deposit fill, spoil and waste material thereon) (mo ve, store and remove equipment an d supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the _____ Project,

together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

These are the anticipated estates for the construction and implementation of the project, however, it should be noted that this is a planning document and the necessary estates are subject to change dependant upon project needs.

7. Sponsor Land Acquisition Experience:

The Non-Federal sponsor for this project is the Coastal Protection and Restoration Authority of Louisiana (CPRA), through the Office of Coastal Protection and Restoration. As the non-federal sponsor, CPRA must provide all real estate interests required for the project, i.e., all lands, easements, rights-of-way, relocations, and any other interest, including suitable borrow and dredged or excavated material disposal areas (LERRDs).

The Non-Federal Sponsor is assessed to be fully capable to perform all acquisition activities associated with this project. The Sponsor has the capability to acquire and hold real estate as well as the ability to contract for real estate services to supplement its staff in order to meet project schedules. However, it must be recognized herein that CPRA is the non-federal sponsor for all New Orleans District coastal restoration projects and all hurricane risk reduction projects. Therefore, if all LCA projects and several hurricane risk reduction projects are authorized for construction under concurrent schedules, there is a possibility that CPRA may not be able to accomplish LER acquisition due to the massive amount of work required for such an undertaking. If that were the case, it is possible that CPRA may request that the Federal Government accomplish acquisition of LER on their behalf.

The Assessment of the Non-Federal Sponsor's Real Estate Acquisition Capabilities is attached as Exhibit II.

8. Utility Relocations:

A. <u>Entergy Louisiana, LLC</u>

1. La. Hwy. 44 - approximate station 5+56.

   230 kV Aerial Transmission Line.

2. Canadian National Railroad - approximate station 20+75.

   230 kV Aerial Transmission Line.

3. La. Hwy. 3125 - approximate station 99+75.

   115 kV Aerial Transmission Line.

B. **Verizon Communications, Inc.**

1. 24 F Count Fiber Optic Cable.

C. **Level 3 Communications, LLC**

1. 96 F Count Primary Fiber Optic Cable.
2. 170 F Count Primary Fiber Optic Cable.

D. **AT&T Corp.**

1. La. Hwy. 44 - approximate station 5+56.
   One or Two Overhead Telecommunication Cables.
2. Canadian National Railroad - approximate station 21+40.
   Overhead Telecommunication Cable.
3. La. Hwy. 3125 - approximate station 99+75.
   One or Two Overhead Telecommunication Cables.

E. **St. James Parish Government**

1. La. Hwy. 44 approximate station 5+56.
   One buried water pipeline.
2. La. Hwy. 3125 - approximate station 99+75.
   One buried water pipeline.

F. **PL Olefins LLC**

1. Near Canadian National Railroad
   One 6-inch Steel Ethylene Pipeline.
2. Approximate Stations 62+00 to 82+00
   One 6-inch Steel Ethylene Pipeline.
3. Approximately 200 feet East of La. 3125
   One 6-inch Steel Ethylene Pipeline.

G. **Williams Gas Marketing, Inc.**

1. Approximate Station 63+25
   One 12-inch Steel Natural Gas Pipeline.

H. **Gulf South Pipeline Company, LP**

1. Approximate Station 63+50
   One 18-inch Abandoned Steel Natural Gas Pipeline.
2. Approximate Station 63+75
   One 18-inch Steel Natural Gas Pipeline.

I. **Texas Brine Company, LLC**

1. Approximate Station 63+50

   One 14-inch Steel Brine Pipeline.

2. Approximate Station 63+75

   One 14-inch Steel Brine Pipeline.

J. **Marathon Pipe Line LLC**

1. Near Kansas City Southern Railroad and Highway 61

   One 20-inch Steel Pipeline.

K. **Air Liquide America L.P.**

1. Near Kansas City Southern Railroad and Highway 61

   One 12-inch Steel Nitrogen Pipeline.

2. Near Kansas City Southern Railroad and Highway 61

   One 12-inch Steel Oxygen Pipeline.

L. **Sorrento Pipeline Company, LLC**

1. Near Kansas City Southern Railroad and Highway 61

   One 8-inch Steel Pipeline.

M. **American Midstream (MIDLA), LLC**

1. Near Kansas City Southern Railroad and Highway 61

   One Pipeline.

An Attorney's Preliminary Investigation and Report of Compensable Interest was completed for the utility/facility relocations. The facilities affected by the project lay in areas where neither the Government, the local sponsor, nor another governmental body owns any right-of-way that is superior to that of the facility owners. These facilities, or portions thereof, are entitled to replacement by substitute facilities that will as nearly as practicable serve them in the same manner and reasonably as well as did the existing facilities. Anything provided over and above such construction at increased cost, unless required solely as a result of the relocation, must be considered a betterment and the payment of the cost thereof must be borne by the facility owner.

Should the facilities be relocated in new right-of-way outside of the project right-of-way, as part of the consideration of having its facilities relocated at project expense, the facility owner will have to release its rights to its old right-of-way. Should the facilities relocate within the new Project right of way, it will have to do so such that it will not interfere with the construction, operation and maintenance of the project, and the facility owner will have to subordinate its right of way to that of the Project.

Under the authorization for the Louisiana Coastal Area Program, the furnishing of lands, easements, rights-of-way and improvements for this project, including the relocation or alteration of interfering facilities, is an obligation of the local interests.

9. Public Law 91- 646 and Acquisition Schedule:

All acquisitions of private property for this project will be done in accordance with the provisions of Public Law 91- 646, as amended. All areas im pacted by construction are vacant; the projec t will not displa ce any persons, businesses or farms. It is the responsibility of the Non-Feder al Sponsor to acquire the l and, easements, and right of way for this project.

Subject to project approval and f unding, the acquisition proce ss will begin after the Project Partnering Agr eement (PPA) is signed. Th is start date has not been yet determined. Permits and agreement s (Grants of Particular Use) to satisfy the Public Agencies i.e.; Louisiana Depar tment of Wildli fe & Fisheries, Pontchartrain Levee District, LADOTD, an d St James Parish will ty pically require len gthy time frames and should be initiated as early in the schedule as possible. In addition, the agreement and construction of the C N RR "Sh oofly" will r equire an extend ed time consid eration an d should begin as soon as possible to avoid project delays.

Task	Task Duration
Obtain title information	60 days
Obtain mapping information	60 days
Obtain appraisals	90 days
Negotiate & issue right-of-entry	90 days
Highway Agreements for Detours and Crossings	120 days
Task	**Task Duration**
Utility Agreements	90 days
Railroad Agreements	270 days

These time frames assume amicable acquisitions, if condemnation proceedings are necessary, 12 – 16 months will be added to the schedule.

Time is allowed for the State agencies to enter into a Letter Agreeement and then issue a "Grant of Particular Use" to the Federal Government.

10. Acquisition Costs:

The estimated total Real Estat e cost s are $2,587,000.00. Real Estate costs have been outlined in the Chart of Accounts found in Exhibit II.

11. Landowner Attitude:

Owner contact, to date, has been limited. However conversations with t he primary private landowner on the project, Mr. Rickey Roussel, have been positive. While we were unable to provide project specifi cs, Mr. Roussel granted permission to field crews to conduct exploratory studies for the project on several oc casions and is aware of the potential of a pr oject in this area. Additionally adjacent property owners in the area feel the restoration of t he swamp for recreational activiti es is a positive element to the area.

12. Environmental Issues:

Phase I Environmental Site Assessment (ESA) was conducted on the study area in accordance with ER 1165-2-132. Ba sed upon the information reviewed, no recognized environmental conc erns were identified within southeastern Maurepas Swamp, the Blind River, or the proposed Romeville dive rsion route that would be expected to impact the subject property.

13. State / Federal Lands and Projects in the Plan Area:

Portions of the project benefit area include lands within the Maurepas Swamp Wildlife Management Area. This land is owned by the Louis iana Department of Wildlife and Fisheries (LDWF). Initial estimates, prov ided by LDWF, indic ate holdings in excess of 15,000 acres. No Federal lands were found in the project area.

The following federal and state projects are located in the vicinity of the subject project:

Mississippi River, Baton Rouge to the Gulf of Mexico - The Mississippi River, Baton Rouge to the Gulf of Mexico project currently provides a 45-foot deep draft channel between Baton Rouge and the Gulf of Mexico.

Mississippi River and Tributaries Project (MR&T) - The Mississippi River and Tributaries (MR&T) Project is a comprehensive project for flood control on the Lower Mississippi River below Cape Girardeau, Missouri.

LCA Small Diversion at Hope Canal - The LCA Small Diversion at Hope Canal is located east of the Convent/Blind River project, and this project is included in the Louisiana Coastal Area, Louisiana Report of the Chief of Engineers, dated 31 January 2005 in a list of five priority projects for implementation approval. The feasibility study is underway.

14. Timber / Mineral / Row Crop Activity:

TIMBER

The majority of the project area which c ontains timber is owned by the Louis iana Department of Wildlife and Fisheries. The area is designated as the Maurepas Wildlif e Management Area (WMA). The timber is m ostly cypress which is prevalent in swamps.

Timber harvesting is not customary in this area especially now that the area is a wildlife management area. The project is intended to benefit this habitat.

MINERALS

Data from the LDNR Strategic Online Natural Resources Information System (SONRIS) indicate that the southeastern Maurepas Swamp has undergone extensive oil and gas exploration activities, most of which occurred in the early to mid-twentieth century. Exploration efforts have occurred primarily to the north and south of the study area, with the north experiencing more concentrated activities. Based on data from SONRIS, 16 wells are within close proximity of the study area: twelve are abandoned, three are active, and one has an expired permit. Of these, only two wells are located within the project area and both are plugged and abandoned.

The portion of the Maurepas Swamp that is part of the project is owned by the Louisiana Department of Wildlife and Fisheries (LDWF). The LDWF acquired most of this property through a donation from the Richard King Mellon Foundation, a foundation whose focus is conservation of the environment. The outer boundaries of the WMA were acquired from private landowners. Because LDWF did not acquire mineral rights in the WMA, the underlying mineral rights holders could seek to utilize the surface of the WMA to drill and extract subsurface minerals. Such activities in the swamp are regulated under several state and Federal laws to minimize adverse environmental impacts.

The LDWF has established procedures for granting permits for exploratory activities on its WMAs. Below is a list of requirements from the LDWF.

The LDWF requires a request for permit be submitted in writing. A "Conditions of Letter of Permission to Conduct Seismic Activity in the State of Louisiana" form must be signed by the company proposing exploration. If the LDWF grants the permit in accordance with regulations, there are still other actions that must be taken prior to beginning exploration. The seismic company must request a Natural Heritage review and submit a Notification of Beginning of Seismic Exploration form. In addition, the company must hold a public meeting. Below are some additional requirements and restrictions that are typical for LDWF owned and managed areas:

1. Compensatory mitigation is required to offset unavoidable wetland impacts.
2. No activities will be allowed on emergent islands or vegetated wetlands.
3. The company must work closely with LDWF in conducting operations with the purpose of minimizing any adverse effects and protecting and preserving the fish, birds, animals and other wildlife, including reefs and oyster beds, in the area.
4. A compliance inspector, with proper qualifications acceptable to W&F will be funded by Grantee/Lessee to ensure that the geophysical provisions are met and to provide a weekly e-mail status report to LDWF and a final report of project activities.
5. All transportation equipment will require approval of LDWF prior to use.
6. The seismic project shall be supervised by a seismic agent or other LDWF representative.

In addition to these regulations in place by the LDWF, any activity in the marshes (wetlands) are regulat ed by Sect ion 404 of the Clean Water Act under the purview of the USACE.

Exploratory activities, if permitted, could have some localized adverse impacts on the project benefits area. Howe ver, it is our opinion that exploration would be highly unlikely given that there are no active we lls within the project area, despite pas t exploration activities, and that the major mi neral interest owner is a conservation foundation. In the event that mineral owners on the per imeter of the WMA obtained permits to explore for oil and/or gas, it is our opinion at this time that LDW F management practices and the applicable state and Federal r egulatory processes are adequate to safeguard the project's benefits.

Risk to project benefits from future activi ties within the WMA wil l continue to be evaluated during the public co mment period. Approaches t hat may be considered for further managing risk to proj ect benefits include the acqui sition of additional real property interests and the pre scribing and enforcing of additi onal state regulations to prevent encroachments or obstr uctions in the project benefit s area. Acquisitio n or subordination of mineral rights may be considered as part of this process.

ROW CROP

A portion of the land, on which the T SP is located , is curren tly in row crop cultivation for sugar c ane. It is assumed t hat landowners would be allowed to harvest mature crops prior to construction of the pl an. In that instance, compensation would be for the impact of the easement on the value of the property. The highest and best us e for this land is deter mined to be for indus trial use; therefore, no compensation for row crop will be included in the acquisition costs.

15. Induced Flooding:

Hydraulic analys is c ompleted in suppor t of the Blind Fresh Water Diversion Project was reviewed to determine if the pr oject will in crease water surface elevatio ns outside of the project ar ea. Multiple s imulations were p erformed for existing conditions and with project conditions.

The diversion of water from the Mississi ppi will be co ntrolled to permit water to enter the swamp on a periodic re lease during dry conditions. T he flow will be restricted and terminated during periods of sever rainfall and cyclic al high water events. The discharge is not intended to significantly raise water levels beyond the ordinary levels of the areas within the project ar ea. The wat er released into the canal system during low water and dry periods will allow flows in to the s wamp during periods that would ordinarily see minimal flow.

Based on the hydraulic data , there is no indication of significant water lev el variations as a result of the project; therefore, flowage easements are not needed.

For additional hydrologic analysis please refer to Section 3.9.3, "Integrated Feasibility Study and Environmental Impact Statement for the LCA Small Diversion at Convent/Blind River," Real Estate Requirements, located in the engineering report.

16. Zoning Ordinances:

No zoning ordinances will be enacted in lieu of construction of this project.

17. Relocation Assistance Benefits:

The project does not displace residential, commercial or industrial facilities. Therefore, the provisions of Title II of Public Law 91-646, as amended are not applicable.

18. Navigation Servitude:

Derived from the Commerce Clause of the U.S. Constitution, article 1, section 8, clause 3, the navigation servitude is the dominant right of the United States to use, control and regulate navigable waters and submerged lands. The applicability of the navigation servitude depends on both legal and factual determinations. If the legal determination supports assertion of the navigation servitude, then the second step is to determine the geographical area over which the servitude can be asserted. In tidal areas, the servitude extends to all lands below the mean high water mark, whereas in non-tidal areas, the servitude extends to all lands within the bed and banks of a navigable stream that lie below the ordinary high water mark.

There are no lands being acquired for this project which, would fall in this classification.

19. Acquisition Prior to PPA:

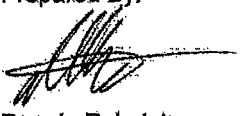
The non-federal sponsor is the author of this REP and is fully aware of the risks associated with acquisition of real estate rights prior to signing a Project Partnership Agreement.

20. Non-Federal Sponsor Owned LER:

The non-federal sponsor does not own any LER in the project area.

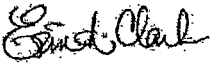
This report has been prepared by the undersigned in accordance with Chapter 12 of the ER405-1-12.

Prepared By:

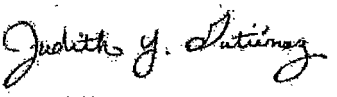


Ronnie Rabalais
SJB Group, LLC
Division Manager Real Estate Services
April 21, 2010

Reviewed By:



Erin A. Clark
USACE Appraiser
April 21, 2010



Judith Y. Gutierrez
USACE, Chief, Appr & Plang
April 21, 2010

Recommended for Approval:

_____

Linda C. LaBure
USACE, Chief Real Estate Div
April 21, 2010

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Exhibit I
Non-Federal Sponsor's Capability Assessment

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ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
Coastal Protection Restoration Authority (CPRA)
through the
Office of Coastal Protection and Restoration (OCPR)

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **YES**

b. Does the sponsor have the power of eminent domain for this project? **YES - But limited to expropriation.**

c. Does the sponsor have "quick-take" authority for this project? **NO - Although the sponsor does not have quick take authority, if this should be needed for the project, the sponsor may partner with a Levee District or Parish Government who has this authority (Act 225 RS38:301.1 and Act 320) if they agree.**

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? **NO**

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Unknown**

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **NO**

b. If the answer to II.a. is "yes," has a reasonable plan been developed to provide such training? **N/A**

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **YES**

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?
The office of OCPR is staffed with 3 Land Specialists and one Manager. Given current and projected workload, the in-house staff is not sufficient to accomplish acquisition of realty interests for this project.

e. Can the sponsor obtain contractor support, if required in a timely fashion? **Unknown, no schedule has been drafted. Contracting typically takes 12 to 18 months.**

f. Will the sponsor likely request USACE assistance in acquiring real estate?
Yes it is likely, but ultimately depends on the responsibilities as agreed upon in the PPA yet to be developed.

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site? **YES**

b. Has the sponsor approved the project/real estate schedule/milestones?

"A detailed schedule will be developed when the final ROW is determined. Normally, an estimate of one year is allowed to acquire ROW for a project." Once project designs are finalized, the sponsor will be requested to provide an acquisition schedule.

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects? **YES**

b. With regard to this project, the sponsor is anticipated to be: highly capable/fully capable/moderately capable/marginally capable/insufficiently capable.
Fully capable

V. Coordination:

a. Has this assessment been coordinated with the sponsor?
YES

b. Does the sponsor concur with this assessment?
YES

Prepared By:

Judith Y. Gutierrez 3/25/10
Judith Y. Gutierrez
USACE
Chief, Appraisal & Planning Branch

James L. Altman
James L. Altman
OCPR
Land Manager

Approved By:

Linda C. LaBure
Linda C. LaBure
Chief, Real Estate Division

Exhibit II

Chart of Accounts

CEMVN-RE-E
REAL ESTATE DIVISION

Chart of Accounts

March 8, 2010

				AMOUNT	CONTINGENCY	PROJECT COST
					ROUNDED	$2,587,000
TOTAL PROJECT COSTS				2,069,900	517,480	2,587,380
LANDS AND DAMAGES		CONTINGENCY	PROJECT COST	2,069,900	517,480	2,587,380
ACQUISITIONS						
BY GOVERNMENT	0	0	0			
BY LOCAL SPONSOR (LS)	12,000	3,000	15,000			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	3,000	750	3,750			
CONDEMNATIONS						
BY GOVERNMENT	0	0	0			
BY LS	0	0	0			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
APPRAISAL						
BY GOVT (IN HOUSE)	0	0	0			
BY GOVT (CONTRACT)	0	0	0			
BY LS	12,000	3,000	15,000			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	3,000	750	3,750			
PL 91-646 ASSISTANCE						
BY GOVERNMENT	0	0	0			
BY LS	0	0	0			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY						
BY GOVERNMENT	0	0	0			
BY LS	0	0	0			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
OTHER	0	0	0			
DAMAGE CLAIMS	0	0	0			
UTILITY RELOCATIONS (see note below)	50,000	12,500	62,500			
REAL ESTATE PAYMENTS						
LAND PAYMENTS						
BY GOVERNMENT	0	0	0			
BY LS	1,875,900	468,980	2,344,880			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
PL 91-646 ASSISTANCE PAYMENTS						
BY GOVERNMENT	0	0	0			
BY LS	0	0	0			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
DAMAGE PAYMENTS						
BY GOVERNMENT	0	0	0			
BY LS	114,000	28,500	142,500			
BY GOVT ON BEHALF OF LS	0	0	0			
REVIEW OF LS	0	0	0			
OTHER	0	0	0			
LERRD CREDITING						
ADMINISTRATIVE COSTS		0	0			

Utility relocation expenses are to negotiate the agreements to make the vertical adjustments on piplines crossing the channel six(6), AT&T lines at Hwy 44 and Hwy 3125, a fiberoptic cable at the CNRR, the CNRR shoofly, LDOTD detours, a levee off-set, Overhead power lines, water and gas lines at the highways, etc .

Exhibit III

Quality Control Plan Checklist

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Quality Control Plan Checklist

Real Estate Plans

And other similar Feasibility-Level Real Estate Planning Documents

ER 405-1-12, Section 12-16, Real Estate Handbook, 1 May 1998

A Real Es tate Plan (REP) is pr epared in support of a de cision document for full-Federal or cost shared specific ally authoriz ed or continuing author ity projects. It identifies and describes la nds, easements and rights-of-way (LER) requir ed for the construction, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of a proposed project including requirements for mitigat ion, relocations, borrow material, and dredged or ex cavated material disposal. It also identifies and describes facility/utility relocations, LER value, and th e acquisition process. The REP does not just cover LER to be acquired by the non-Federal sponsor (NFS) or Government. The report covers all LER ne eded for the project, including LER already owned by the NFS, Federal Government, ot her public entities, or subject to the navigation servitude.

The REP must contain a detailed discussion of the fol lowing 20 topics, as set out in Section 12-16 of the ER, inc luding sufficient descrip tion of the r ationale supporting each conclusion pres ented. If a topic is not applicable to the project, this should be stated in the REP. The pages of a REP should be numbered.

PROJECT **Convent/Blind River Small Diversion Canal**

REPORT TITLE **Real Estate Plan**

Date of Report **March 16, 2010**

Date of REP **December 25, 2009**

1. **Purpose of the REP.** __√___
   a. Describe the purpose of the REP in relation to the project document that it supports.
   b. Describe the project for the Real Estate reviewer.
   c. Describe any previous REPs for the project.

2. **Describe LER.** __√____
   a. Account for all lands, easements, and rights-of-way underlying and required for the construction, OMRR&R of the project, including mitigation, relocations, borrow material and dredged or excavated material disposal, whether or not it will need to be acquired or will be credited to the NFS.

b. Provide description of total LER required for each project purpose and feature.

c. Include LER already owned by the Government, the NFS and within the navigation servitude.

d. Show acreage, estates, number of tracts and ownerships, and estimated value.

e. Break down total acreage into fee and the various types and durations of easements.

f. Break down acreage by Government, NFS, other public entity, and private ownership, and lands within the navigation servitude.

3. **NFS-Owned LER.** __√____

a. Describe NFS-owned acreage and interest and whether or not it is sufficient and available for project requirements.

b. Discuss any crediting issues and describe NFS views on such issues.

4. Include any proposed **Non-Standard Estates.** __√___

a. Use Standard Estates where possible.

b. Non-standard estates must be approved by HQ to assure they meet DOJ standards for use in condemnations.

c. Provide justification for use of the proposed non-standard estates.

d. Request approval of the non-standard estates as part of document approval.

e. If the document is to be approved at MSC level, the District must seek approval of the non-standard estate by separate request to HQ. This should be stated in the REP.

f. Exception to HQ approval is District Chiefs of RE approval of non-standard estate if it serves intended project purposed, substantially conforms with and does not materially deviate from the standard estates found in the RE Handbook, and does not increase cost or potential liability to the Government. A copy of this approval should be included in the REP. (See Section 12-10c. of RE 405-1-12)

g. Although estates are discussed generally in topic 2, it is a good idea to also state in this section which standard estates are to be acquired and attach a copy as an appendix. The duration of any temporary estates should be stated.

5. **Existing Federal Projects.** __√___

a. Discuss whether there is any existing Federal project that lies fully of partially within LER required for the project.

b. Describe the existing project, all previously-provided interests that are to be included in the current project, and identify the sponsor.

c. Interest in land provided as an item of local cooperation for a previous Federal project is not eligible for credit.

d. Additional interest in the same land is eligible for credit.

6. **Federally-Owned Lands** _√____
   a. Discuss whether there is any Federally owned land included within the LER required for the project.
   b. Describe the acreage and interest owned by the Government.
   c. Provide description of the views of the local agency representatives toward use of the land for the project and issues raised by the requirement for this land.

7. **Navigation Servitude.** __√___
   a. Identify LER required for the project that lies below the Ordinary High Water Mark, or Mean High Water Mark, as the case may be, of a naviga ble watercourse.
   b. Discuss whether navigation servitude is available
   c. Will it be exercised for project purposes? Discuss why or why not.
   d. Lands over which the navigation servitude is exercised are not to be acquired nor eligible for credit for a Federal navigation or flood control project or other project to which a navigation nexus can be shown.
   e. See paragraph 12-7 of ER 405-1-12.

8. **Map** _√____
   a. An aid to understanding
   b. Clearly depicting project area and tracts required, including existing LER, LER to be acquired, and lands within the navigation servitude.
   c. Depicts significant utilities and facilities to be relocated, any known or potential HTRW lands.

9. **Induced Flooding** can create a requirement for real estate acquisition. ___√___
   a. Discuss whether there will be flooding induced by the construction and OMRR&R of the project.
   b. If reasonably anticipated, describe nature, extent and whether additional acquisition of LER must or should occur.
   c. Physical Takings Analysis (separate from the REP) must be done if significant induced flooding anticipated considering depth, frequency, duration, and extent of induced flooding.
   d. Summarize findings of Takings Analysis in REP. Does it rise to the level of a taking for which just compensation is owed?

10. **Baseline Cost Estimate** as described in paragraph 12-18. __√___
   a. Provides information for the project cost estimates.
   b. Gross Appraisal includes the fair market value of all lands required for project construction and OMRR&R.
   c. PL 91-646 costs
   d. Incidental acquisition costs
   e. Incremental real estate costs discussed/supported.
   f. Is Gross Appraisal current? Does Gross Appraisal need to be updated due to changes in project LER requirements or time since report was prepared?

11. **Relocation Assistance Benefits** Anticipated. __√___
    a. Number of persons, farms, and businesses to be displaced and estimated cost of moving and reestablishment.
    b. Availability of replacement housing for owners/tenants
    c. Need for Last Resort Housing benefits
    d. Real Estate closing costs
    e. See current 49 CFR Part 24

12. **Mineral Activity**. __√___
    a. Description of present or anticipated mineral activity in vicinity that may affect construction, OMRR&R of project.
    b. Recommendation, including rationale, regarding acquisition of mineral rights or interest, including oil or gas.
    c. Discuss other surface or subsurface interests/timber harvesting activity
    d. Discuss effect of outstanding 3rd party mineral interests.
    e. Does estate properly address mineral rights in relation to the project?

13. **NFS Assessment** _√____
    a. Assessment of legal and professional capability and experience to acquire and provide LER for construction, OMRR&R of the Project.
    b. Condemnation authority
    c. Quick-take capability
    d. NFS advised of URA requirements
    e. NFS advised of requirements for documenting expenses for credit.
    f. If proposed that Government will acquire project LER on behalf of NFS, fully explain the reasons for the Government performing work.
    g. A copy of the signed and dated Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability (Appendix 12-E) is attached to the REP.

14. **Zoning** in Lieu of Acquisition __√___
    a. Discuss type and intended purpose
    b. Determine whether the proposed zoning proposal would amount to a taking for which compensation will be due.

15. **Schedule** __√___
    a. Reasonable and detailed Schedule of land acquisition milestones, including LER certification.
    b. Dates mutually agreed upon by Real Estate, PM, and NFS. _____

16. **Facility or Utility Relocations** __√___
    a. Describe the relocations, identity of owners, purpose of facilities/utilities, whether owners have compensable real property interest.
    b. A synopsis of the findings of the Preliminary Attorney's Investigation and Report of Compensable Interest is included in the REP as well as statements required by Sections 12-17c.(5) and (6).

c. Erroneous determinations can affect the accuracy of the project cost estimate and can confuse Congressional authorization.

d. Eligibility for substitute facility
   1. Project impact
   2. Compensable interest
   3. Public utility or facility
   4. Duty to replace
   5. Fair market value too difficult to determine or its application would result in an injustice to the landowner or the public.

e. See Sections 12-8, 12-17, and 12-22 of ER 405-1-12.

17. **HTRW** and Other Environmental Considerations __√____
   a. Discussion the impacts on the Real Estate acquisition process and LER value estimate due to known or suspected presence of contaminants.
   b. Status of District's investigation of contaminants.
   c. Are contaminants regulated under CERCLA, other statues, or State law?
   d. Is clean-up or other response required of non-CERCLA regulated material?
   e. If cost share, who is responsible for performing and paying cost of work?
   f. Status of NEPA and NHPA compliances
   g. See ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects.

18. **Landowner Attitude.** _√____
   a. Is there support, apathy, or opposition toward the project?
   b. Discuss any landowner concerns on issues such as condemnation, willing seller provisions, estates, acreages, etc.?

19. A statement that the **NFS has been notified in writing about the risks of acquiring LER before the execution of the PPA**. If not applicable, so state. _√____

20. **Other Relevant Real Estate Issues**. Anything material to the understanding of the RE aspects of the project. ___√____

A copy of the completed Checklist is attached to the REP. _√___

I have prepared and thoroughly reviewed the REP and all information, as required by Section 12-16 of ER 405-1-12, is contained in the Plan.

Preparer — Date: 4/18/2010

A copy of the Real Estate Internal Technical Review Guide for Civil Works Decision Documents is attached and signed by me as the Reviewer

RE Internal Technical Reviewer — Date: 4/21/10

The REP has been signed and dated by the Preparer and the District Chief of Real Estate. ___√_____

Volume IV
APPENDIX K:
Benefit/Cost-Incremental Cost Analysis and WVA Report

Also included herein:

1) **WVA Report**
2) **Response to Comments on WVA Certification**

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As a result of the plan formulation and screening process presented in Section 3.0 of the main report, four alternatives, including the no action, were identified and each was assessed for ecosystem restoration benefits using the Wetland Value Assessment (WVA) to determine habitat values, The resulting habitat values along with preliminary engineering costs were used as inputs for the IWR Planning Suite to compare the alternatives in terms of outputs and costs as further described below.

Cost effectiveness and incremental cost analyses (CE/ICA) reveal information about good financial investments given the dollar costs and non-dollar outputs ("benefits") of alternative investment choices. The analyses are conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen-out those that do not. US Army Corps of Engineer (USACE) Regulation 1105-2-100 requires cost effectiveness and incremental cost analyses to support recommendations for ecosystem restoration through implementation of the IWR Planning Suite (IWR). IWR takes user-defined solutions to planning problems and externally-generated estimates of each solution's effects and can formulate all possible combinations of those solutions, considering user-defined relationships between solutions. IWR will then identify which combinations are the best financial investments through cost effectiveness and incremental cost analyses. Each combination of solutions is an alternative plan and the use of IWR assists in identifying which plans are the best investments.

Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of output considered. The resulting least cost alternative plans are then compared to identify those that would produce greater levels of output at the same cost, or at a lesser cost, as other alternative plans. Alternative plans identified through this comparison are the cost effective alternative plans. Next, the cost effective alternative plans are compared to identify the most economically efficient alternative plans, that is, the "Best Buy" alternative plans that would produce the "biggest bang for the buck." Finally, the additional costs for the additional amounts of output ("incremental cost") produced by the Best Buy alternative plans are calculated. The results of all the calculations and comparisons of costs and outputs provide a basis for addressing the decision question "Is it worth it?" i.e., are the additional outputs worth the costs incurred to achieve them?

In practice, USACE ecosystem restoration studies typically measure the ecosystem benefits of alternative plans in terms of physical dimensions (number of acres of wetlands, for example), or population counts (number of wading birds, for example), or various habitat-based scores ("habitat units" based on the U.S. Fish & Wildlife Service's *Habitat Evaluation Procedures*, or "HEP", or Wetland Value Assessment "WVA" for example).

The performance measures evaluated and selected by the PDT for this project were habitat units (HUs). Habitat units are the metric that best integrate information regarding the quality and quantity of improved habitat for various representative species and/ or communities within the project benefit area.

Habitat unit (HU) output, or the performance of each of four alternative plans in the final array, was evaluated by the U.S. Fish & Wildlife Service based on the Wetland Value Assessment (WVA); the WVA methodology and resulting HU determinations are described in detail in **Section 3.5 of the main report**. The WVA is an accepted method used to determine HUs for restoration projects in coastal Louisiana. Preliminary detailed total costs were also developed for each of the final four alternatives and considered construction costs, engineering and design, supervision and administration, and real estate costs. Details for preliminary cost development are also presented in Section 3.5 of the main report and in Appendix L. Annualized costs were calculated, and a comparison of average annual cost to HU output for each of the four alternatives in the final array was conducted. Cost and HU output comparisons are summarized and illustrated in Figure K-1 below:

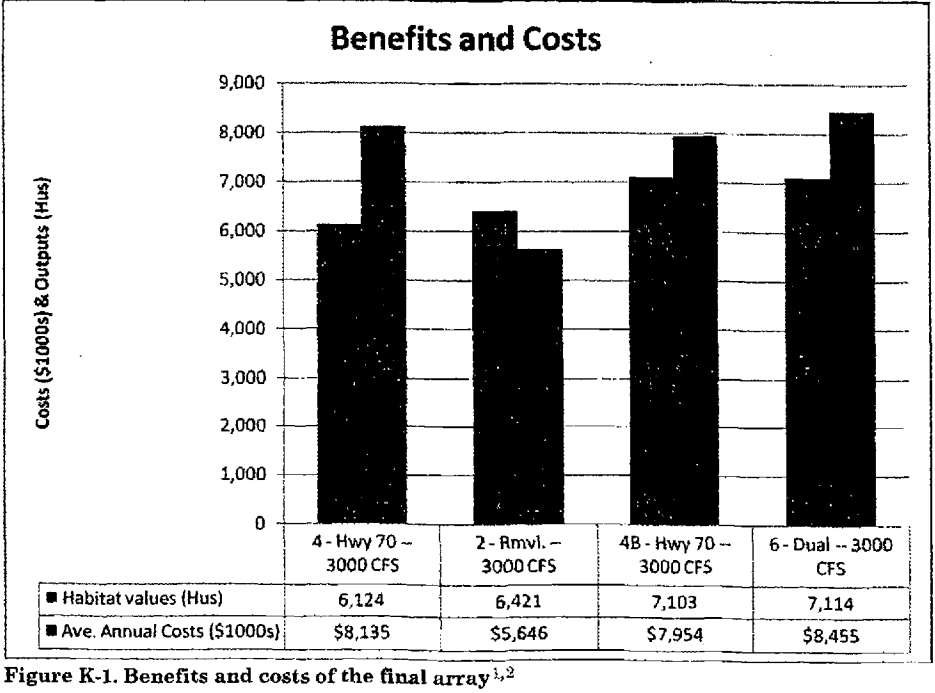


Figure K-1. Benefits and costs of the final array[1,2]

[1] All costs are in October 2009 prices

The cost-effectiveness of the alternatives is presented in table K-1 and figure K-2. The analysis indicates that Alternative 4 has lower benefits and higher costs than alternative 2 and is not a cost-effective solution. Therefore Alternative 4 will not be considered further. Alternates 2, 4B, and 6 are all cost-effective and are also best buy alternatives and will be considered further through an incremental cost analysis. However, it should be pointed out that Alternative 6 produces significant AAHUs at an extreme cost per habitat unit when compared to the other two alternatives. This is explained further in the following paragraphs.

	Alternative 4 South Bridge, 3000 cfs	**Alternative 2** Romeville, 3000 cfs	**Alternative 4B** South Bridge (split flow)	**Alternative 6** Dual Diversion
HUs	6124	6421	7103	7114
Cost ($1,000s)	$8,135	$5,646	$7,954	$8,455
Cost-effective	No	Yes	Yes	No
Best Buy	No	Yes	Yes	Yes

Table K-1. Cost-effectiveness analysis of the final array[3,4]

[2] First costs were annualized using a discount rate of 4-3/8% over a 50-year period
[3] All costs are in October 2009 prices
[4] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

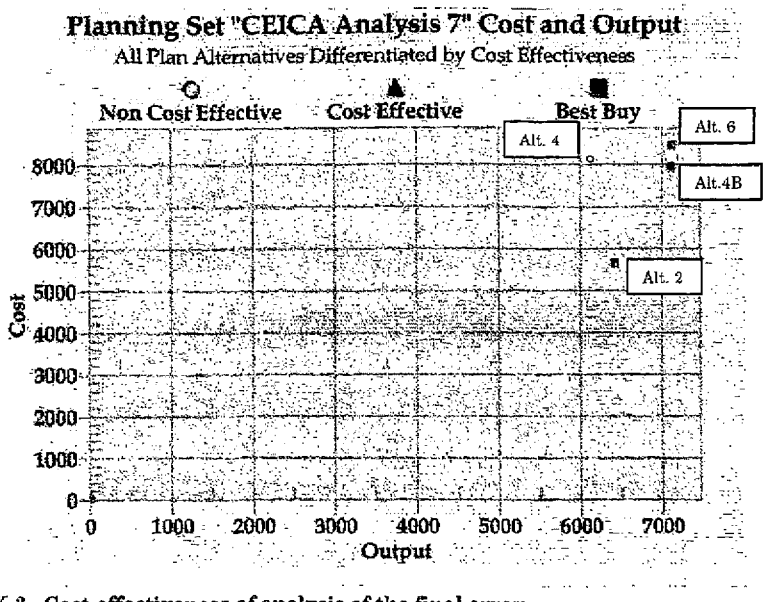


Figure K-2. Cost-effectiveness of analysis of the final array

Table K-2 and Figure K-3 below summarize the incremental analysis of the cost-effective alternative plans. Of the tree alternatives, Alternative 2 provides the lowest increase in average annual habitat units when compared to the future without-project condition. By delivering 3000 cfs of freshwater, sediments, and nutrients to the Southeast portion of the Maurepas Swamp drainage in the swamp would improve, there would be more dry periods to promote seed germination and sapling survival, and there would be a decrease in persistent inundation, short circuiting drainage patterns, and ponding and stagnation. Nutrients and sediment diverted and pulsed to the swamp will be more widely distributed in the swamp and that would result in increased nutrient assimilation and vegetative productivity as well as improved water quality in Blind River. Implementation of Alternative 2 would reverse the existing trend of swamp deterioration. The sediment diverted to the swamp and the increased productivity will increase accretion (soil building) and offset subsidence and sea level rise and reduce the decrease in the ground surface elevation in the swamp and reduce persistent inundation. Because of this strong contribution to the planning objectives, the $5,646,000 annual cost for Alternative 2 to produce 6421 average annual habitat units at a per unit cost of $880 is considered justified. The increment from Plan 2 to Plan 4b produces an additional 682 average annual habitat units at a cost of $2,309,000 or $3,384 per average annual habitat unit and the increment from Plan 4b to Plan 6 produces an additional 11 habitat units at a cost of $501,000 or $45,530 per average annual

habitat unit. Alternative 2 provides over 90 percent of the benefits for about 67% of the cost of Alternative 6, the cost per AAHU is much lower for Alternative 2 that for the other two alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Due to the high incremental cost per habitat unit for the increments above Alternative 2 these increments are not considered to be justified. Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the National Ecosystem Restoration Plan.

	Alt. 2 – Romeville	Alt. 4B 0 South Bridge (Split flows)	Alt. 6 – Dual Diversion
AAHUs	6,421	7,103	7,114
AA Cost ($1,000s)	$5,646	$7,954	$8,455
			Yes
Δ AAHU	6,421	682	11
Δ AACost ($1000s)	$5,646	$2,309	$501
Δ AA Cost/AAHUs ($1000s)	$0.88	$3.39	$45.53

Table K-2. Incremental cost analysis of the final array[5,6]

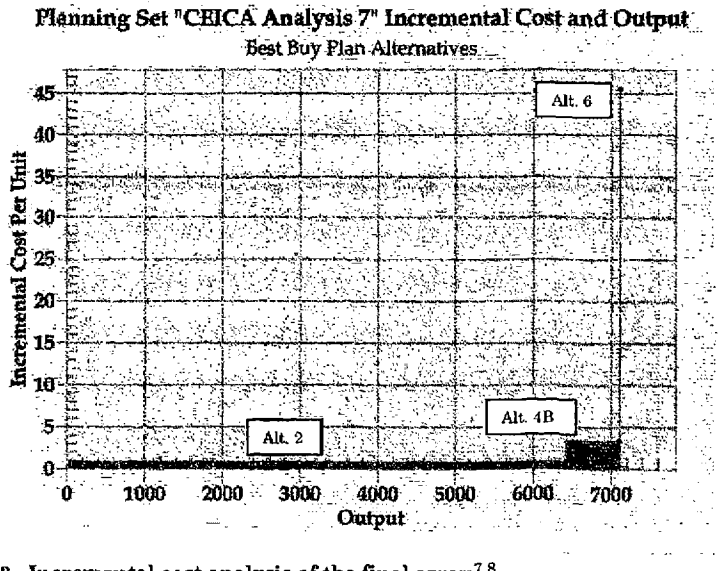


Figure K-3. Incremental cost analysis of the final array[7,8]

[5] All costs are in October 2009 prices

[6] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

It should also be noted that benefits in addition to creating HUs include improved recreational value. The existing recreation benefits within the project area were estimated using the Unit Day Value (UDV) method, employed in compliance with the USACE Economics Guidance Memorandum, 09-03.

The natural and built resources of the project site were analyzed and assigned points based on five criteria:

- Recreation Experience: Based on the number of activities available at the site and whether they are unique to the site;
- Availability of Opportunity: Based on how many other areas for fishing and hunting are within 30 minutes, 45 minutes, 1 hour and 2 hours travel time of the study site;
- Carrying Capacity: Based on a rating of the facilities on site: minimum, basic, adequate, optimum and ultimate;
- Accessibility: Based on a rating of the accessibility to the site and within the site: limited; fair and good; and
- Environmental: Based on aesthetic factors such as geology, topography, water and vegetation, air pollution, water pollution, poor climate, and adjacent views.

This same method was used to determine UDVs for each of the four alternatives.

The following table demonstrates the guidelines for assigning points within the UDV method.

Guidelines for assigning points within the Unit Day Value Method.

Criteria	**Judgment Factors**				
Recreation experience Total Points: 30	Two general activities	Several general activities	Several general activities; one high quality value activity	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Point Value: 13	0-4	5-10	11-16	17-23	24-30
Availability of opportunity Total Points 18	Several within one hour travel time; a few within 30 minutes travel time	Several within one hour travel time; none within 30 minutes travel time	One or two within one hour travel time; none within 45 minutes travel time	None within one hour travel time	None within 2 hour travel time

[7] All costs are in October 2009 prices

[8] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

Point Value: 6	0-3	4-6	7-10	11-14	15-18
Carrying capacity Total Points 14	Minimum facility for development for public health and safety	Basic facility to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource of activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Point Value: 8	0-2	3-5	6-8	9-11	12-14
Accessibility Total Points: 18	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access to good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Point Value: 11	0-3	4-6	7-10	11-14	15-18
Environmental Total Points: 20	Low aesthetic factors that significantly lower quality	Average aesthetic quality; factors exist that lower quality to minor degree	Above average aesthetic quality; any limiting factors can be reasonably justified	High aesthetic quality; no factors exist that lower quality	Outstanding aesthetic quality; no factors exist that lower quality
Point Value: 8	0-2	3-6	7-10	11-15	16-20

The dollar values determined for the project area was based on the unit day values (UDVs) calculated for each alternative; the UDVs were the same for Alternative 2 and Alternative 4, both of which were assigned a UDV value of 37. The dollar values calculated for Alternative 6 and Alternative 4B were also the same, with an assigned UDV value of 41. The associated annual dollar revenues based on UDVs were $35,129 for Alternatives 2 and 4A, and $36,406 for Alternatives 6 and 4B. While these UDVs can be subjective based on limited available user data, it can be said that a positive increase in opportunities for recreation would be provided with the primary recreation activities that include fishing, hunting, boating, and bird watching. These are wildlife-dependent recreation activities that would at the very least be maintained with either of the alternatives and with respective increase in HUs. Without implementation of one of these alternatives, swamp degradation

would eventually impact recreational use adversely. In summary, recreational benefits are realized with each of the alternatives; however, the recreational benefits were not used to discriminate between alternatives as were HUs. For additional detailed information on recreational use and UDV evaluation, refer to Section 5.15 in the main report.

Wetland Value Assessment Project Information Sheet
Comparing Final Array of Alternatives

September 8, 2010

Prepared for:
U.S. Army Corps of Engineers
and
Louisiana Department of Natural Resources

Prepared by
U.S. Fish and Wildlife Service

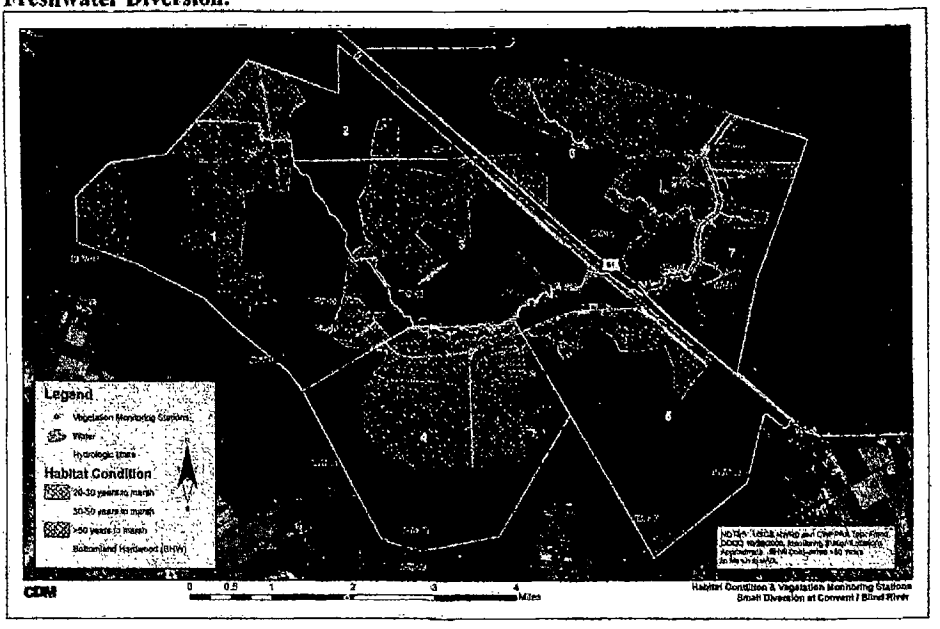
Project Name: Louisiana Coastal Area – Small Freshwater Diversion at Convent/Blind River

Project Type(s): Freshwater diversion and hydrologic restoration within swamp habitat

Project Area: The project area is within the Maurepas Swamp west of Lake Pontchartrain and predominantly within St. James Parish with a small portion of the northern extent in Ascension Parish, LA (LCA Sub-province 1). The U.S. Interstate 10 corridor defines the northern boundary with the remaining project boundary being defined by several parish drainage canals. The cities and towns that flank the Mississippi River extend further to the southeast, south, and southwest of the project area. The Maurepas swamp is one of the largest remaining tracts of coastal fresh water swamp in Louisiana. Including Lake Maurepas, the Maurepas Swamp area comprises an area that totals approximately 232,928 acres, most of which is swamp with some isolated areas of bottomland hardwood forest and fresh marsh. The Blind River flows from St. James Parish, through Ascension and Saint John the Baptist Parishes, and then discharges into Lake Maurepas. Much of the project area is situated within the Louisiana Department of Wildlife and Fisheries, Maurepas Swamp Wildlife Management Area.

For planning and hydrologic modeling purposes, the project area was divided into three benefit areas (i.e., benefit area 1, 2, and 3) and within those benefit areas are several sub-basins. Benefit areas and sub-basins are defined by topographic high areas (e.g., spoil banks, relict railroad grade, road embankments) or channels, natural or artificial (e.g., rivers, canals, channels, intermittent tributaries) that would serve to impede or intercept hydrologic flows. The area south and southwest of Blind River is defined as benefit area 1 (i.e., 100 sub-basin series). The area north of Blind River and west of U.S. Highway 61 is benefit area 2 (i.e., 200 sub-basin series), and the area north of Blind River and east of U.S. Highway 61 is benefit area 3 (i.e., 300 sub-basin series). For the purposes of the Wetland Value Assessment (WVA) the sub-basins are grouped into hydrologic units (Figure 1), or units that are considered to be under the same hydrological influences.

Figure 1. Hydrologic Units and Habitat Condition Classes for the Convent/Blind River Freshwater Diversion.



Problem: Since the construction of the Mississippi River flood control levees, the Maurepas Swamps have been virtually cut off from any freshwater, sediment, or nutrient input. Thus, the only soil building has come from organic production within the wetlands. Preliminary evaluations suggest that productivity in the stressed Maurepas Swamps may be substantially depressed compared to normal conditions. With minimal soil building and moderately high subsidence, there has been a net lowering of ground surface elevation, leading to a doubling in flood frequency over the last four decades (Thomson 2000), so that now the swamps are either permanently or semi-permanently flooded. With minimal ability to drain and persistent flooding, the typical seasonal drying of the swamp does not usually occur. Cypress and tupelo trees are able to grow in flooded conditions. Apparently, tupelo trees are more competitive in permanently flooded conditions (Conner et al. 1981, Dicke and Tolliver 1990), a condition that may explain the recent dominance of tupelo in the south Maurepas swamps and the project area. However, a high mortality of tupelo trees also has occurred in the last few years within the Maurepas study area possibly as a result of salinity spikes. Neither cypress nor tupelo seeds can germinate when flooded. Seeds of both species remain viable when submerged in water and can germinate readily when floodwaters recede (Kozlowski 1984). The potential for re-establishment seems to be hindered by the relatively low numbers of viable seeds observed in swamp seed banks, as well as by flooding (Conner et al. 1986). Storm surge and accompanying episodic saltwater intrusion has also exacerbated degradation resulting in lack of tree regeneration and substrate accretion.

It is expected that without restoration, the factors and processes that are contributing to stress and deterioration of the south Maurepas Swamps will continue and result in loss of the swamp, with succession to open water (Shaffer et al. 2001). The Coast 2050 Report estimated wetland loss rates for the Amite/Blind Rivers mapping unit for 1974-90 to be 0.80 percent per year for swamp and fresh marsh habitat combined. Based on these rates, approximately 50 percent of swamp and 1.2 percent of fresh marsh will be converted to open water within 60 years. Nearly 69,500 acres of swamp (50% of the 1990 total) and 40 acres of marsh are projected to be lost by 2050 (LCWCRTF 1999).

U.S. Army Corps of Engineers guidance requires project performance to be assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. Using the rate of 9.20 mm/yr, a starting year of 2011, and a 50-year project life, a sea-level rise of 1.5 feet is projected for the year 2061 (Table 1). A historic rate considered to be representative of the project area is calculated using the West End at Lake Pontchartrain gauge (85625). The rate of 9.20 mm/yr is considered to include both the eustatic and local subsidence contributions to the estimated total sea-level rise.

In order to estimate the local subsidence rate for the project area, the global eustatic rate (1.7 mm/yr) is subtracted from the local sea level rate or:

Local subsidence rate = 9.20 mm/yr – 1.7 mm/yr = 7.50 mm/yr.

Table 1. Summary of total sea level rise (i.e., considers subsidence) for each scenario.

Project year	Scenario 1, Low Rate (feet)	Scenario 2, Intermediate Rate (feet)	Scenario 3, High Rate (feet)
2011	0.0	0.0	0.0
2016	0.2	0.2	0.2
2021	0.3	0.3	0.5
2026	0.5	0.5	0.8
2031	0.6	0.7	1.1
2036	0.8	0.9	1.4
2041	0.9	1.1	1.7
2046	1.1	1.3	2.0
2051	1.2	1.5	2.4
2056	1.4	1.7	2.8
2061	1.5	1.9	3.2

The estimate for the local subsidence rate is used in conjunction with estimates for the eustatic rates using NRC curves I and III to determine the intermediate and high projections of sea level rise for the project area. The following formula is used to estimate the total rise in eustatic sea level for the project life for the intermediate and high rate scenarios of sea level rise:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,
t_1 is the time in years between the project's construction date and 1986,
and
t_2 is the time between a future date at which one wants an estimate for sea-level rise and 1986.

These eustatic estimates are added to the local subsidence estimate to get the total sea-level rise for the intermediate and high rate scenarios. For the purposes of hydrologic modeling for this project the intermediate rate was used.

Project Goal: Reverse the trend of degradation in the southeast portion of the Maurepas Swamp, so as to contribute toward achieving and sustaining a coastal ecosystem that can support and protect the environment, economy, and culture of southern Louisiana and thus contribute to the well-being of the Nation.

Objectives:

1. Promote water distribution in the swamp which, in turn, will increase freshwater throughput and nutrient input thereby increasing swamp productivity and wetland assimilation.
2. Facilitate swamp building: by increasing swamp productivity and sediment input by up to 1000 g/sq meter per year to decrease the annual subsidence rate (or accretion deficit).
3. Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and seed germination and survival. This is proposed by decreasing flood duration for high flood events within the swamp, increasing the length of dry periods in the swamp, and increasing the number of cypress and tupelo saplings per acre from existing conditions.
4. Improve fish and wildlife habitat in the swamp and in Blind River by increasing sediment and nutrient input, freshwater flow, and dry periods which will contribute to an increase in swamp productivity. This will result in a diversity of stand structure components (tree species composition and a combination of herbaceous, midstory and overstory vegetation), thus improving fish and wildlife habitat needs. Direct project related benefits fish and wildlife resources (i.e., swamp habitat) are quantified by acreage and habitat quality using the Wetland Value Assessment, and are defined by average annual habitat units or AAHUs.

Alternatives:

No Action Alternative (Future without Project Conditions)
Alternative - 2 – 3,000 cfs Diversion at Romeville (Gated Culvert System)
Alternative - 4 – 3,000 cfs Diversion at South Bridge (Gated Culvert System)
Alternative - 4B – 3,000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
Alternative - 6 – Two 1,500 cfs (3,000 cfs combined) Diversions at Romeville and South Bridge (Siphons)

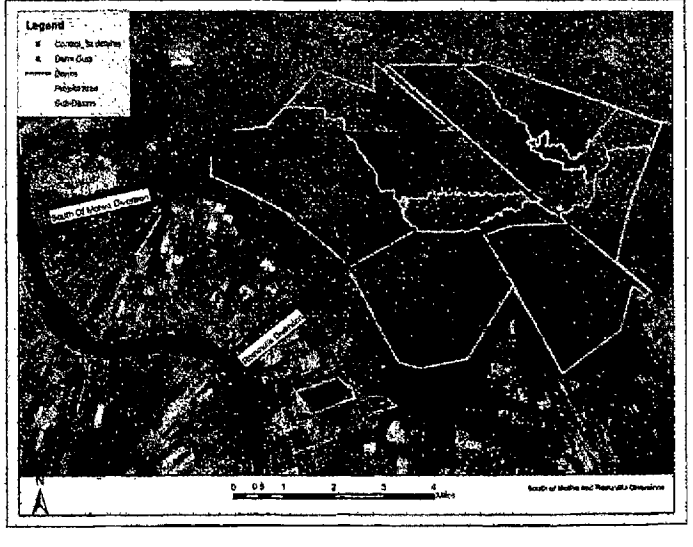
Alternative 2 – 3,000 cfs Diversion at Romeville
This alternative adds a gated culvert system and transfer canal along the Romeville alignment, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4 – 3,000 cfs Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Alternative 4B – 3,000 Split Diversion at South Bridge
This alternative adds a gated culvert system and transfer canal along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to six control structures at strategic locations in the swamp, and adds 3 new culverts under U.S. Highway 61. This alternative includes a modification to the distribution of the diversion provided by Alternative 4 by sending 1,500 cfs to the south through the St. James Parish Canal in order to achieve a similar distribution to Alternative 6.

Alternative 6 – 3,000 cfs Dual Diversion at Romeville and South Bridge
This alternative adds a gated culvert system- and a transfer canal- along the Romeville alignment and a gated culvert system- and transfer canals along the "Cox" alignment located south of the U.S. Highway 70 Bridge, restores and improves the 160 existing berm cuts, adds 30 new 500-foot wide berm cuts, builds up to 6 control structures at strategic locations in the swamp and adds 3 new culverts under U.S. Highway 61.

Figure 2. Alternative Diversion Locations and Water Management Measures.



HEC-RAS and HEC-HMS Modeling

The Hydrologic Engineering Centers - River Analysis System (HEC-RAS) is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels to determine hydrologic flow simulation, sediment transport, and water quality analysis. The HEC - Hydrologic Modeling System (HEC-HMS) is designed to simulate the precipitation-runoff processes of dendritic watershed systems. It is designed to be applicable in a wide range of geographic areas for solving the widest possible range of problems including large river basin water supply and flood hydrology, and small urban or natural watershed runoff. Hydrographs produced by the program are used directly or in conjunction with other software for studies of water availability, urban drainage, flow forecasting, future urbanization impact, flood damage reduction, floodplain regulation, and systems operation.

Preliminary HEC-RAS and HMS modeling has been conducted by the contractor, CDM. The HEC-RAS was simulated over an average year, 2003 being the representative average water year. HEC-HMS used a 15-year simulation period from 1989-2004. One of the major constraints with directing freshwater into the study area is the efficiency of the Blind River to remove water from the system greatly reducing the exchange and widespread distribution of water throughout the system. A diversion directed to the southern portion of the project area and within benefit area 1 has limited influence on the other benefit areas because Blind River acts as a hydrologic barrier, and vice versa.

Modeling for this project, as well as the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) River Reintroduction into Maurepas Swamp Project (PO-29) has revealed that the Maurepas Swamps are often lower in elevation than Lake Maurepas. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput (EPA 2001).

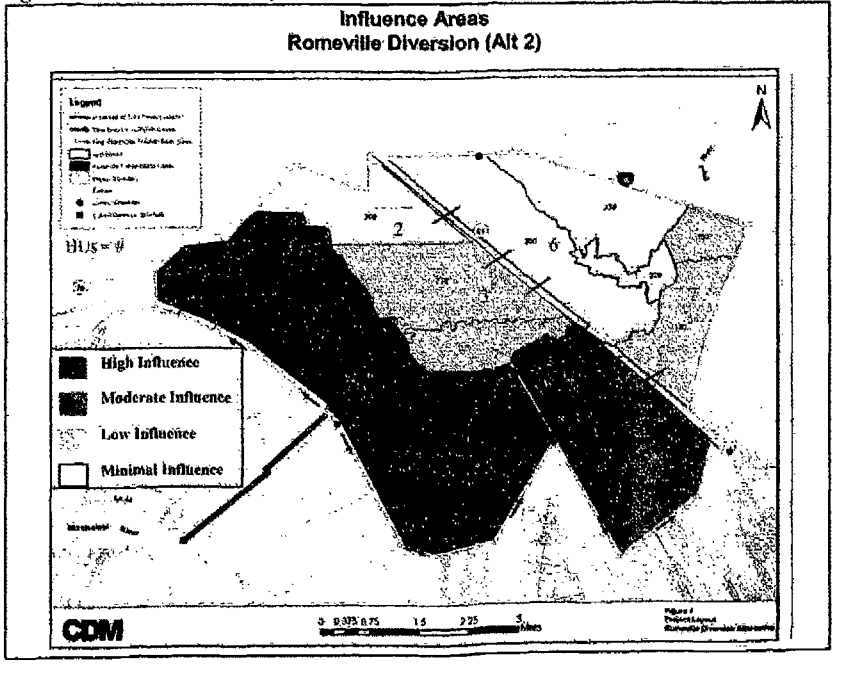
Investigations into diversion capacity determined that changes related to swamp productivity within the system require a minimum diversion flow of 1,000 cubic feet per second (cfs), and 1,500 cfs is required to prevent backflow from Lake Maurepas into the Blind River and swamps. Modeling results also indicate that hydrologic benefits within the system (described by modeling reports as average water depth, water depth exceedence, frequency above Lake Maurepas, and average annual freshwater inflow) either stabilize or do not see incremental benefits as a diversion flow magnitude exceeds 3,000 cfs. Another constraint affecting diversion operations is the availability of water from the Mississippi River. To meet design flow rates Mississippi River water elevations need to be at a minimum of 11 feet; the Mississippi River is at or above that elevation 60 % of the year. It was determined that a 3,000 cfs diversion would be required to provide enough water when available to offset unavailability during low flow periods in the Mississippi River.

Table 2. Diversion Influence for Each Alternative by Habitat Condition Class (construction impacts considered).

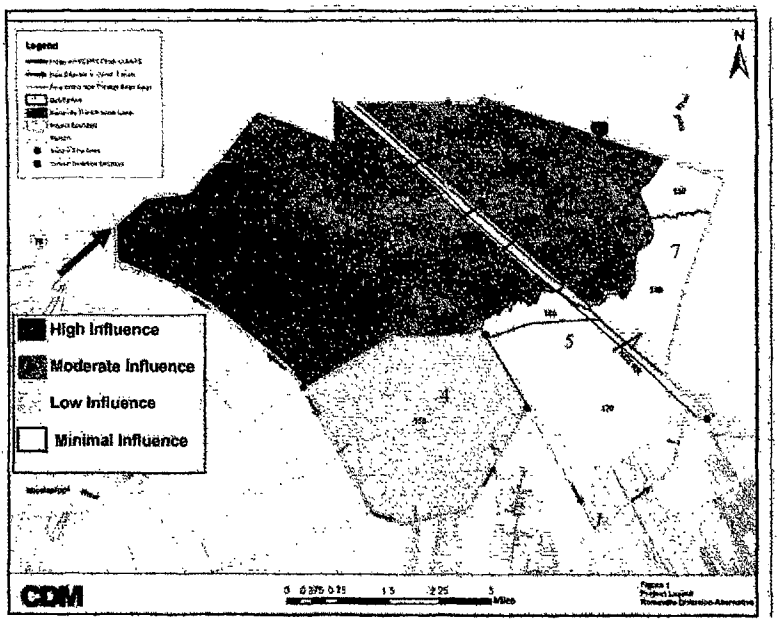
	Degree of Diversion Influence	20-30 Years to Marsh[1]		30-50 Years to Marsh		>50 Years to Marsh	
		HUs[2]	acres	HUs	acres	HUs	acres
Alternative 2 (Romeville)	High	1,4	169	1,4	3364	1,4	4555
	Moderate	5	204	5	604	5	2607
	Low	3,7	2397	3,7	1669	3	469
	No /Minimal	2,6	525	2,6	2297	2,6	2509
Alternative 4 (Hwy 70 Bridge)	High	1,2	169	1,2	1827	1,2	3550
	Moderate	6,3	1837	6,3	2972	6,3	2070
	Low	4	0	4	2013	4	1799
	No /Minimal	5,7	1289	5,7	1073	5	2607
Alternative 6 (Total Div)	High	1,2,4	169	1,2,4	3848	1,2,4	5361
	Moderate	3,5,6	2041	3,5,6	3579	3,5,6	4691
	Low	7	1985	7	469	--	0
	No /Minimal	--	0	--	0	--	0

[1]Habitat Classes as defined under Habitat Assessment Method [2]Hydrologic Units (see Figure 1)

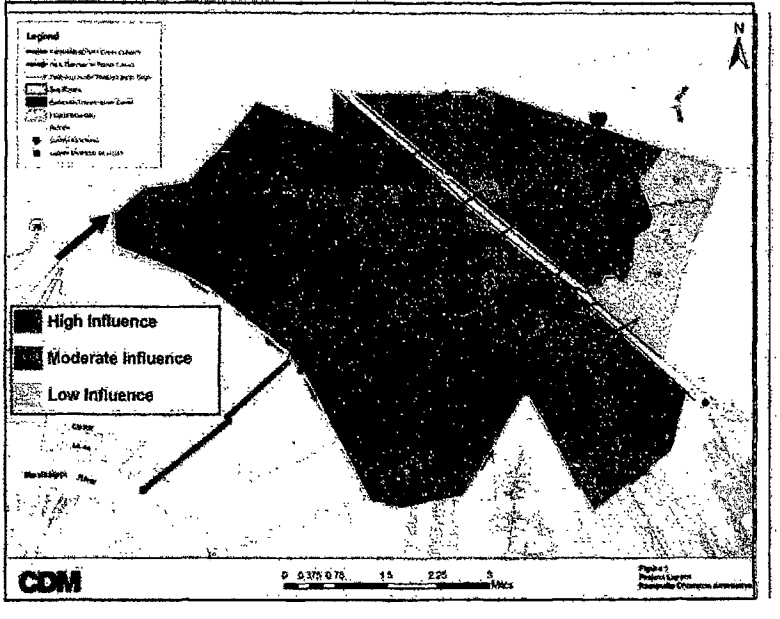
Figure 3. Diversion Influence Areas for Each Alternative.



Influence Areas
Sunshine Bridge Diversion (Alt 4)
(Original – No split southward)



Influence Areas
2 Diversions (or entry points)
(Alts 4b, 6)



Habitat Assessment Method

The procedure for evaluating project benefits on swamp habitats, the WVA swamp model, uses a series of variables that are intended to capture the most important conditions and functional values of a swamp. Values for these variables are derived for existing conditions and are estimated for conditions projected into the future if no restoration efforts are applied (i.e., future-without-project), and for conditions projected into the future if the proposed diversion project is implemented (i.e., future-with-project), providing an index of quality or habitat suitability of the swamp for the given time period. The habitat suitability index (HSI) is combined with the acres of swamp to get a number that is referred to as "habitat units". Expected project benefits are estimated as the difference in habitat units between the future-with-project (FWP) and future-without project (FWOP). To allow comparison of WVA benefits to costs for overall project evaluation, total benefits are averaged over a 50-year period, with the result reported as Average Annual Habitat Units (AAHUs).

Existing and Future without Project Conditions

To characterize existing conditions CDM established 28 vegetation monitoring stations throughout and adjacent to the project area during four separate field trips from March through September of 2009. A trend apparent to Shaffer et al. (2003) in the Maurepas swamp was increasing habitat degradation with proximity to Lake Maurepas. Therefore, two vegetation stations were positioned outside of the project area, closer to Lake Maurepas, to reference and track the progression of more degraded habitat conditions and to suggest potential future conditions for the project area under the no-action alternative. Data was collected on hydrology, wildlife, vegetation, community structure, composition, and health (per WVA methodology) at all vegetation monitoring stations. Soils data were also recorded at most monitoring stations.

On October 7, 2009, the team met with Dr. Gary Shaffer [Southeastern Louisiana University, (SELU)] and Bernard Wood (Research Assistant, SELU) to inspect the project area and compare habitat quality and swamp degradation to other areas of the Maurepas swamp that they are currently studying. Based on observations made during that field trip, data collected during previous field trips, knowledge of the habitat condition of the entire Maurepas swamp by Dr. Shaffer and Mr. Wood, and aerial photography, a habitat condition class map was then developed to categorize the different areas of swamp habitat (levels of degradation) according to classifications used by Dr. Shaffer at other areas within the Maurepas swamp (Figure 1). The intersection of diversion influence and habitat condition class defines the different areas that would require a separate WVA for each alternative (32 WVAs, not including WVAs for construction related impacts).

Three levels of habitat condition class were defined within the project area: 20-30 years-to-marsh, 30-50 years-to-marsh, and greater than 50-years-to-marsh. Data obtain from representative vegetation monitoring stations were then summarized according to each habitat class to get a representative value for each habitat class for the WVA. Because we can not accurately determine when these swamps will convert to marsh or open water, these habitat condition classifications are meant to define the level or rate of degradation and not necessarily

the target years that the habitats will be removed from the habitat assessment or converted to marsh habitat.

Variable V_1 - Stand Structure (Table 3)

Most swamp tree species do not produce hard mast; consequently, wildlife foods predominantly consist of soft mast, other edible seeds, invertebrates, and vegetation. Because most swamp tree species produce some soft mast or other edible seeds, the actual tree species composition is not usually a limiting factor. More limiting is the presence of stand structure to provide resting, foraging, breeding, nesting, and nursery habitat and the medium for invertebrate production. This medium can exist as herbaceous vegetation, scrub-shrub/midstory cover, or overstory canopy and preferably as a combination of all three. This variable assigns the lowest suitability to sites with a limited amount of all three stand structure components, the highest suitability to sites with a significant amount of all three stand structure components, and mid-range suitability to various combinations when one or two stand structure components are present.

Conversion of forested wetlands to open water or marsh within the project area has not been observed during field investigations. Minimal windthrow of canopy trees was observed; however, light to moderate crown damage and windthrow of midstory trees was evident and likely occurred from recent hurricanes and tropical storm events. Similar damage was observed throughout Maurepas swamp, with data suggesting that midstory windthrow was inversely related to canopy density (Effler et al. 2007, Shaffer personal communication per DEIS). Decreasing canopy is also indicative of stress due to prolonged inundation and/or stagnant water conditions. Decreased vigor may increase susceptibility of trees to tropical storm damage.

Plant diversity in baldcypress-tupelo swamps is typically low due to low light penetration into the understory and the extended hydroperiod, which limit the establishment and survival of understory vegetation. Baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) are common codominant canopy species in this habitat, with swamp red maple (*Acer rubrum var. drummondii*) predominant and green ash (*Fraxinus pennsylvanica*) codominant, in the midstory and understory strata. Common herbaceous species include arrow arum (*Peltandra virginica*), pennywort (*Hydrocotyle* spp.), smartweed (*Polygonum punctatum*), and lizard's tail (*Saururus cernuus*). Salvinia (*Salvinia* spp.), a non-native invasive aquatic fern, is prolific in many areas. Savanna panicum (*Phanopyrum gymnocarpon*), thought to be an indicator of flow and nutrients, was also observed in the higher quality swamps. A complete list of species and existing habitat conditions at each vegetation monitoring station is provided in CDM's October 2, 2009, "Existing Environmental Condition of Project Area" Memorandum.

Stand Structure for 20-30 Years-to-Marsh

Existing – The 20-30 years-to-marsh habitat class is characterized by having 23 percent canopy cover, 33 percent midstory cover, and 80 percent herbaceous or ground cover (Class 1). Of the overstory canopy cover, 81 percent is tupelo and other species, and the remaining 18 percent is cypress, with some monitoring sites being comprised of 100 percent tupelo. While basal area averages 113.85 ft^2/ac (moderately dense), one monitoring site has a basal area of 34.52 ft^2/ac

which is considered open, and one site is 64.43 ft²/ac which is considered to be moderately open. One aspect of stand structure that is not reflected in the data is crown damage or loss of tree tops. While this is localized within the project area it is expected to be a common characteristic in the future as conditions deteriorate which is evident in other areas of Maurepas swamp. Crown damage also contributes to the low canopy cover phenomenon in an area were basal area is moderately dense, which consequently results in a high herbaceous cover. Water tolerance by tupelo has allowed the swamp stand structure to be dominated by tupelo in those areas experiencing prolonged flooding. Coupled with occasional salinity spikes, some tupelo dominated areas are experiencing either canopy top-off or complete canopy die off.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover will persist below 33 percent (Table 3).

FWP – Depending on the location of this habitat class within the influence of the diversion, the 20-30 years to marsh is expected to see some benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. According to FWP modeling of "existing conditions with berm cuts", the project area is expected to be constantly inundated with an average annual water depth throughout the project area of 1.01 feet by target year 20 and 1.75 feet by target year 50. Additional flows from a 3,000 cfs diversion would only increase flood duration. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest period of drying. With the diversion average, annual water depths are predicted to be in some areas as high as 3.71 feet (Alternative 6, hydrologic sub-basin series 200) and 5.82 feet (Alternative 4, hydrologic sub-basin series 200) during operation of the diversion. Therefore, the stand structure class was reduced at target year 50 (Table 3) to reflect prolonged inundation and a reduced herbaceous and midstory component.

Areas not affected by the diversion should see some benefits of increased hydrologic flow/throughput as a result of the in-swamp management measures. However, these benefits are short term as total sea level rise contributes to these areas returning to a persistent flooding regime by target year 20. It is projected that those areas of 20-30 years-to-marsh habitat class within areas not influenced by the diversion will not have enough time and benefits to regenerate and maintain a healthy forested stand, and, therefore, returns to a Class 1 by target year 30.

Table 3. Future-with and Future-without Project Stand Structure Conditions.

FWOP

Habitat Condition Class	TY0					TY1	TY20				TY30				TY50			
		%O	%M	%H	Class	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh		23	33	80	1	1	<33			1	<33			1	<33			1
30-50 yrs. to marsh		38	39	51	5	5	33<50	<33	<33	2	33<50	<33	<33	2	<33			1
>50 yrs. to marsh		64	46	22	4	4	50<75	>33	<33	4	50<75	>33	<33	4	33<50	<33	<33	3

FWP

Habitat Condition Class	Level of Influence	TY0				TY1				TY20				TY30				TY50			
		%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class	%O	%M	%H	Class
20-30 yrs. to marsh	High Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	50<75	>33	<33	4
	Moderate Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	50<75	>33	<33	4
	Low Influence	23	33	80	1	23	33	80	1	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	3
	No Influence**	23	33	80	1	23	33	80	1	33<50	>33	>33	5	<33			1	<33			1
30-50 yrs. to marsh	High Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	≥50	>33	>33	6	≥50	>33	<33	4
	Moderate Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	≥50	>33	>33	6	≥50	>33	<33	4
	Low Influence	38	39	51	5	38	39	51	5	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	3
	No Influence**	38	39	51	5	38	39	51	5	33<50	>33	>33	5	33<50	>33	>33	5	33<50	>33	<33	3
>50 yrs. to marsh	High Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	Moderate Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	Low Influence	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	4
	No Influence**	64	46	22	4	64	46	>33	6	≥50	>33	>33	6	50<75	>33	<33	4	50<75	>33	<33	3

Stand Structure for 30-50 Years-to-Marsh

Existing – The 30-50 years-to-marsh habitat class is characterized by having 38 percent canopy cover, 39 percent midstory cover, and 51 percent herbaceous or ground cover (Class 5). Of the overstory canopy cover, 85 percent is tupelo and other species and the remaining 15 percent is cypress. Similar to the 20-30 years-to-marsh habitat class, several of the monitoring vegetation sites were 100 percent tupelo. Basal area varied from 133.42 ft^2/ac to 320.79 ft^2/ac, or moderately dense to dense; however, light penetration appears to be suitable enough to support a midstory and herbaceous cover component.

FWOP – Conditions are expected to continue to degrade as lack of nutrients, accretion, and freshwater, and an increase in sea level rise, subsidence, episodic salt water intrusion, and storm events all take a toll on the swamp. As a result of these deteriorating conditions, tree mortality, especially to tupelo, will continue resulting in lower tree density. The canopy will continue to thin, and canopy cover is predicted to drop below 33 percent by target year 50.

FWP – High to moderate influenced areas are predicted to see benefits as a result of increased sediments, nutrients, and/or freshwater. Increased throughput is also expected to provide benefits as a result of berm cuts and other in-swamp management measures. Consequently, canopy, midstory and herbaceous cover is projected to increase through time. As noted above, flood duration is expected to increase as total sea level rise increases, resulting in an eventual decrease in herbaceous cover by target year 50.

Areas that are not affected (no influence areas) or are minimally affected (low influence areas) by the diversion see no increase in stand structure, but rather maintain the existing stand structure until target year 50. Consistent with the previously mentioned hydrologic conditions, stand structure is reduced at target year 50 as a result of a reduced herbaceous component.

Stand Structure for Greater than 50 Years-to-Marsh

Existing – The greater than 50 years-to-marsh habitat class is characterized by having 64 percent canopy cover, 46 percent midstory, and 22 percent herbaceous or ground cover. Of the overstory canopy cover, 44 percent is tupelo and other species and 56 percent is cypress. While the percentage indicates an even distribution, the individual monitoring vegetation sites were dominated by either one or the other species. Basal area and percent canopy cover is considered optimal, or dense, with an average basal area of 256.09 ft^2/ac. The midstory is also considered suitable; however, herbaceous cover is less than optimal likely due to lack of light penetration and nutrients.

FWOP – In comparison to other areas of the Maurepas swamp, this habitat class is considerably healthier and is expected to maintain a Class 4 stand structure through much of the FWOP life. By target year 50 conditions will begin to deteriorate and the canopy begins to thin.

FWP – This habitat class is expected to see benefits as a result of increased sediments, nutrients, and freshwater from the diversion, and due to increased throughput as a result of in-swamp management measures. Consequently, an increase in herbaceous cover is expected within the short term for all areas of influence. However, as canopy closure becomes even more prevalent

and as flood duration is expected to increase as total sea level rise increases, a decrease in herbaceous cover by target year 30 is predicted.

Variable V_2 - Stand Maturity (Table 8)

The suitability graph for this variable assumes that snags, cavities, downed treetops, and invertebrate production are present in suitable amounts when the average diameter-at-breast height (DBH) of canopy-dominant and canopy-codominant trees is above 16 inches for baldcypress and above 12 inches for tupelogum and other species. Therefore, stands with those characteristics are considered optimal for this variable (SI = 1.0).

Another important component of this variable is stand density, measured in terms of basal area. A scenario sometimes encountered in mature swamp ecosystems is an overstory consisting of a very few, widely-scattered, mature baldcypress. If stand density was not considered, but only average DBH, then those stands would receive a high SI for this variable without providing many of the important habitat components of a mature swamp ecosystem, specifically an adequate number of trees for nesting, foraging, and other habitat functions. Therefore, the SI for this variable is dependent on average DBH and basal area which is used as a measure of stand density.

Existing Conditions

Seven vegetation monitoring stations were identified that were representative of the 20-30 years-to-marsh class. Basal area averaged 113.85 ft^2/acre. The average DBH measured 11.21 inches for cypress and 13.08 inches for tupelo and other canopy co-dominant species. Even though this is the most degraded habitat, class basal area is still considered to be moderate.

Six vegetation monitoring stations were identified that were representative of the 30-50 years-to-marsh class. Basal area averaged 222.73 ft^2/acre. The average DBH measured 14.71 inches for cypress and 14.20 inches for tupelo and other canopy co-dominant species.

Nine vegetation monitoring stations were identified that were representative of the greater-than 50 years-to-marsh class. Basal area averaged 256.09 ft^2/acre. The average DBH measured 15.76 inches for cypress and 13.97 inches for tupelo and other canopy co-dominant species.

FWOP

Numerous bald cypress and tupelo growth rates have been documented in deep water swamp habitats and are summarized by Visser and Sasser (1995). For FWOP conditions we assumed mean annual growth rates documented by Dr. Shaffer (unpublished) (Table 4) for target years 1-20. These assumptions are similar to what was used for the LCA, Amite River Diversion Channel Modification project. Since subsidence, total sea level rise and associated stresses are expected to continue mean annual growth rates were reduced for target years 20-50.

Increase in basal area was estimated by species and habitat condition class by calculating and projecting the increase in basal area using the predicted growth rates and tree mortality. Percent composition of canopy trees in the FWOP was estimated based on best professional judgment of expected mortality of tupelo among the habitat condition classes taking into consideration

Table 4. Cypress and Tupelo Annual Growth Rates FWOP

	Cypress (inches)	Tupelo et al (inches)
TY 0-20		
20-30 yrs to marsh	0.11	0.08
30-50 yrs to marsh	0.15	0.1
>50 yrs to marsh	0.15	0.1
TY 20-50		
20-30 yrs to marsh	*0.064	**0.073
30-50 yrs to marsh	*0.064	0.08
>50 yrs to marsh	*0.064	0.08

*Visser and Sasser (1995) ** Day (1985) from Visser and Susser (1995)

assumptions made for the CWPPRA River Reintroduction into Maurepas Swamp Project. The CWPPRA River Reintroduction into Maurepas Swamp Project estimated that 50% of tupelo would die over the 20 year FWOP life, but that actual mortality of cypress would be minimal. Because habitat conditions within the Convent/Blind River project area are more favorable and are not at the same stage of degradation we assumed a reduced tupelo mortality rate for the first 20 years and for higher quality habitat condition classes (Table 5). Because tupelo is more flood tolerant highly degraded areas have become dominated by tupelo. Those areas have also experienced continued degradation as a result of seasonal salinity spikes and are seeing increased tupelo mortality and reduced vigor. In order to be conservative only tupelo mortality was assumed when determining FWOP mortality and projected project benefits because lower quality habitats were dominated by tupelo.

Table 5. Tupelo Mortality FWOP

	TY 20	*TY 50
20-30 yrs to marsh	50%	50%
30-50 yrs to marsh	25%	50%
>50 yrs to marsh	25%	25%

*percent mortality is of the TY 0 (existing) stand

Table 6. Tupelo Mortality FWP

	TY 1	TY 20	TY 50	Total Mortality
High Influence				
20-30 yrs to marsh	0%	0%	5%*	5%
30-50 yrs to marsh	0%	0%	5%*	5%
> 50 yrs to marsh	0%	0%	0%	0%
Moderate Influence				
20-30 yrs to marsh	0%	0%	10%*	10%
30-50 yrs to marsh	0%	0%	10%*	10%
> 50 yrs to marsh	0%	0%	0%	0%
Low Influence				
20-30 yrs to marsh	0%	0%	20%*	20%
30-50 yrs to marsh	0%	0%	20%*	20%
> 50 yrs to marsh	0%	0%	10%*	10%
No Direct Influence				
20-30 yrs to marsh	0%	40%*	40%*	80%
30-50 yrs to marsh	0%	10%*	40%*	50%
> 50 yrs to marsh	0%	10%*	20%*	30%

*% of existing stand @ TY0

ible 8. Future-with and Future-without Project Stand Maturity Conditions.

Future Without Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft^2/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	FWOP	baldcypress	11.87	13.96	14.60	15.88	10.42	18.87	18.87	100.00	122.35	82.98	90.81	18.42
		tupelo et al.	13.56	15.08	15.81	0.00	89.58	81.13	81.13	0.00				
30-50 yrs. to marsh	FWOP	baldcypress	15.61	18.46	19.10	20.38	17.57	22.13	22.13	46.02	241.96	247.88	269.12	157.24
		tupelo et al.	14.80	16.70	17.50	19.10	82.43	77.87	77.87	53.98				
>50 years to marsh	FWOP	baldcypress	16.66	19.51	20.15	21.43	41.51	48.62	48.62	58.67	280.03	320.24	345.15	338.32
		tupelo et al.	14.57	16.47	16.47	18.87	58.49	51.38	51.38	41.33				

Future With Project:

Habitat Condition Class	Level of Influence	Species Group	AVERAGE DIAMETER (inches) TY1	TY20	TY30	TY50	% Contribution by Number of Individuals TY1	TY20	TY30	TY50	BASAL AREA (ft^2/ac) TY1	TY20	TY30	TY50
20-30 yrs. to marsh	High Influence	baldcypress	11.98	16.16	17.25	18.91	10.42	10.42	10.42	10.91	123.80	185.60	213.14	247.37
		tupelo et al.	13.64	16.68	17.92	19.82	89.58	89.58	89.58	89.09				
	Moderate Influence	baldcypress	11.95	15.50	16.33	17.61	10.42	10.42	10.42	11.44	123.37	174.97	195.25	208.04
		tupelo et al.	13.62	16.20	17.15	18.61	89.58	89.58	89.58	88.56				
	Low Influence	baldcypress	11.91	14.62	15.26	16.54	10.42	10.42	10.42	12.69	122.79	161.30	176.18	170.34
		tupelo et al.	13.59	15.56	16.29	17.75	89.58	89.58	89.58	87.31				
	No Influence**	baldcypress	11.87	13.96	14.60	15.88	10.42	16.23	16.23	36.76	122.35	96.67	105.81	54.07
		tupelo et al.	13.56	15.08	15.81	17.27	89.58	83.77	83.77	63.24				
30-50 yrs. to marsh	High Influence	baldcypress	15.56	21.26	22.35	24.01	17.57	17.57	17.57	18.32	241.69	383.85	435.66	500.91
		tupelo et al.	14.80	18.60	19.96	22.04	82.43	82.43	82.43	81.68				
	Moderate Influence	baldcypress	15.52	20.36	21.19	22.47	17.57	17.57	17.57	19.15	240.70	359.05	397.06	423.01
		tupelo et al.	14.77	18.00	19.04	20.64	82.43	82.43	82.43	80.85				
	Low Influence	baldcypress	15.46	19.16	19.80	21.08	17.57	17.57	17.57	21.04	239.40	327.36	355.08	348.08
		tupelo et al.	14.73	17.20	18.00	19.60	82.43	82.43	82.43	78.96				
	No Influence**	baldcypress	15.41	18.26	18.90	20.18	17.57	19.15	19.15	29.89	238.42	280.58	305.05	232.82
		tupelo et al.	14.70	16.60	17.40	19.00	82.43	80.85	80.85	70.11				
>50 yrs. to marsh	High Influence	baldcypress	16.81	22.51	23.60	25.27	41.51	41.51	41.51	41.51	275.69	454.73	510.25	601.75
		tupelo et al.	14.67	18.47	19.83	21.91	58.49	58.49	58.49	58.49				
	Moderate Influence	baldcypress	16.77	21.61	22.45	23.73	41.51	41.51	41.51	41.51	274.46	423.36	464.05	530.56
		tupelo et al.	14.64	17.87	18.91	20.51	58.49	58.49	58.49	58.49				
	Low Influence	baldcypress	16.71	20.41	21.05	22.33	41.51	41.51	41.51	44.09	272.83	383.33	412.97	450.44
		tupelo et al.	14.60	17.07	17.87	19.47	58.49	58.49	58.49	55.91				
	No Influence**	baldcypress	16.66	19.51	20.15	21.43	41.51	44.09	44.09	50.34	271.61	336.31	363.08	372.21
		tupelo et al.	14.57	16.47	17.27	18.87	58.49	55.91	55.91	49.66				

**NO INFLUENCE GROWTH RATES SET AS FWOP.

FWP

The proposed diversion is expected to substantially stimulate productivity, and so stimulate growth of the cypress and tupelo (as well as other species). The amount of stimulation is assumed to be related to level of influence of the diversion. Depending on the alternative diversion location certain hydrologic units will receive different levels of influence. Those areas within the high influence area will receive freshwater, nutrients, and sediments; so it is assumed those hydrologic units will see the greatest increase in growth. Results of studies by John Day in wetlands receiving secondary treated sewage suggest that introduction of nutrients as well as sediments from river water could stimulate production by 3-5 fold (EPA 2001). Comparison of productivity in swamps that are either managed, have more favorable hydrology, and/or are receiving nutrient enrichment suggest that the existing levels of productivity in Maurepas are ½ to ¼ of average values (EPA 2001). Southeast Louisiana University study sites within the Maurepas swamp that receive non-point source runoff (i.e., containing nutrients and sediment) have documented an average 1 centimeter of diameter increase per year. When sewage effluent is involved some study sites average 1.5 cm of growth per year close to such a source (Bernard Wood, personal communication). As a very conservative projection, a 2-fold increase in growth rate (i.e., 200% of growth rates listed in Table 4) was applied to the high influence areas for the first 19 years to capture the anticipated stimulation of growth from the diversion. Reduced growth rates were assumed as the level of influence decreased and as the area returned to a more semi-permanent flooding regime (Table 7). DBH and basal area in the FWP were estimated as for FWOP, by applying the increased growth rates and mortality rates.

Table 7. Percent Increase in DBH growth rate based on Level of Diversion Influence (50 yr project life) FWP

	TY 1	TY 20	TY 30
High Influence Area	200%	170%	130%
Moderate Influence Area	170%	130%	100%
Low-Direct Influence Area	130%	100%	100%

Areas not affected by the diversion may still experience benefits as a result of the berm cuts and in-swamp management modifications. Tupelo mortality was assumed based on flood duration and existing stand health. Flood duration was estimated based on hydrologic modeling data presented for "berm cuts without diversions" scenario assuming that the diversion would be operated to mimic the natural historic Mississippi River overbank flooding cycle and would allow for the longest possible dry out period in some years.

Variable V_3 - Water Regime (Table 9)

The optimal water regime is assumed to be seasonally flooded with abundant and consistent riverine/tidal input and water flow-through (SI=1.0). Seasonal flooding with periodic drying cycles is assumed to contribute to increased nutrient cycling (primarily through oxidation and decomposition of accumulated detritus), increased vertical structure complexity (due to growth of other plants on the swamp floor), and increased recruitment of dominant overstory trees. In addition, abundant and consistent input and water flow-through is optimal, because under that regime the full functions and values of a swamp in providing fish and wildlife habitat are assumed to be maximized. Temporary flooding is also assumed to be desirable. Habitat

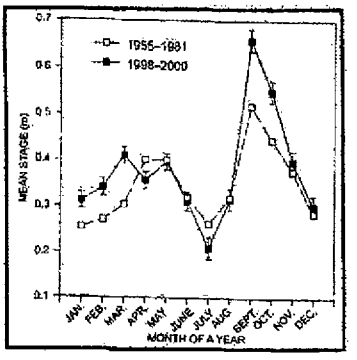
suitability is assumed to decrease as water exchange between the swamp and adjacent systems is reduced. The combination of permanently flooded conditions and no water exchange (e.g., an impounded swamp where the only water input is through rainfall and the only water loss is through evapotranspiration and ground seepage) is assumed to be the least desirable (SI=0.1). Those conditions can produce poor water quality during warm weather, reducing fish use and crawfish production (WVA Procedure Manual).

Existing

Hydrologic modeling for this project, as well as hydrologic investigations for the CWPPRA River Reintroduction into Maurepas Swamp project, has revealed that the Maurepas swamp floor elevations [i.e., 1.12 feet NAVD per the CWPPRA, Coastwide Reference Monitoring System (CRMS) station 5167] are often lower than Lake Maurepas bottom elevations. This results in swamp water levels and dry-out periods being dependent on the water levels in Lake Maurepas, and essentially, flooding is semi-permanent with low to very low water exchange and throughput. The observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with swamp elevations lower than lake elevations suggests that the duration of inundation within the project area has drastically increased over the last fifty years. Moreover, flood durations within the project area swamps are influenced by adjacent urban storm water runoff of areas to the northwest (i.e., Baton Rouge and surrounding cities) and the hydrologic impoundments caused by major transportation corridors. Adjacent urban storm water drainage projects force storm water runoff via large drainage canals into the Blind River. These storm waters bypass the floodwater storage capabilities of adjacent forested wetlands and increase the water levels in Blind River resulting in back water flooding conditions upstream of the waterways confluence. Being that the project area is located at the headwaters of the Blind River and is impounded by several major hydrologic barriers [i.e., U.S. Interstate 10, U.S. Highway 61, and Kansas City Southern Railroad (KCSRR)]; flood waters within the project area are the last to recede from the basin. It is appears that within hydrologic unit 3 interior elevations are low enough to allow ponding of water for longer periods of time, and is, therefore, considered permanently flooded with low water exchange.

Lunar tidal fluxes in Maurepas swamp average 30 cm but are typically overwhelmed by meteorological tidal fluxes. Wind is also a significant forcing agent for water level in Maurepas swamp and may exhibit daily and seasonal variability. During the summer and early fall, storms and prevailing winds from the southeast raise water levels in the swamp as they push Gulf water into the system. Conversely, during the winter months, continental fronts with prevailing winds from the northeast often lower water levels in the swamp as they push water out of the system and towards the Gulf. Fluctuations in water level are generally expected to be similar throughout Maurepas swamp, acknowledging slight variability associated with landscape position and elevation. Within any given year, water stage is characterized by a bimodal hydrograph (Figure 4). Water level rises in the spring, then falls to its lowest level during the summer, rises to its highest level in the fall, and again falls to low levels in the winter (Thomson 2000, Keddy et al. 2007). The intensity of peaks and troughs is typically associated with those meteorological events.

Figure 4. Intra-annual variability of montly mean stage comparing the periods 1955-1981 (historical) and 1998-2000 (drought period). The duration of flooding (percentage of the year that the marshes by Schleider's Ditch flood) more than doubled over the period of record for the USACE tide gage (from Thomson 2000, referenced in Keddy 2007)



Water exchange between the project area swamps and adjacent swamps is reduced to what the Blind River and other small tributaries can exchange across the embankments of the three transportation corridors (i.e., U.S. Interstate 10, U.S. Highway 61, and KCSRR). These embankments act as hydrologic barriers and reduce flow-through across the project area swamp. Within the project area interior drainage and hydrologic exchange has been altered by the construction of drainage canals and associated berms, pipeline and transmission line rights-of-way, and remnant logging infrastructure (i.e., roads, pull boat ditches, and temporary railroad track embankments). Historically, seasonal overbank flooding over the natural Mississippi River levees facilitated hydrologic exchange and freshwater input on average every three to five years. Today the only additional freshwater input is through rainwater runoff, and even those contributions can by-pass the wetland system through the many storm water drainage canals that direct floodwaters directly into Blind River and Lake Maurepas. The project area swamp habitat has been altered and disrupted to a point that adequate water exchange does not exist, and is considered to have low water exchange.

FWOP

Future without project conditions flood durations are expected to worsen as sea level rise and subsidence continues and storm water control projects continue to force storm water into an already flooded system. It is assumed that the entire project area swamp habitat will become permanently flooded and continue to have low flow exchange.

Table 9. Summary for Average Annual Water Depth (ft)

No Sea Level Rise (existing conditions)

Alternatives	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.90	1.73	1.83	2.09	1.34	1.53	1.61	1.72
	Existing Conditions; With Berm Cuts	0.78	0.74	0.69	0.82	0.55	0.58	0.65	0.69
2	Romeville Diversion	2.13	0.74	1.30	2.18	0.55	0.59	0.66	1.16
4	South of Highway 70 Bridge Diversion	1.79	3.40	1.62	0.85	0.54	0.59	0.65	1.35
6	Total Diversion	1.82	2.08	1.47	1.54	0.55	0.59	0.65	1.24

20-year Sea Level Rise

	Scenario/Sub-basin	HU1 100	HU2 200	HU3 210, 220	HU4 110	HU5 120, 160	HU6 300, 320, 330	HU7 140, 150	Total Project Site Average
	Existing Conditions	1.92	1.76	1.84	2.11	1.37	1.56	1.65	1.75
	Existing Conditions; With Berm Cuts	1.10	1.08	0.99	1.20	0.81	0.89	1.02	1.01
2	Romeville Diversion	2.75	1.08	2.03	2.93	0.82	0.90	1.02	1.65
4	South of Highway 70 Bridge	2.42	4.66	2.46	1.27	0.81	0.89	1.02	1.93
6	Total Diversion	2.44	2.84	2.30	2.13	0.81	0.90	1.02	1.78

30-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions	1.95	1.82	1.87	2.14	1.42	1.61	1.71	1.79
	Existing Conditions; With Berm Cuts	1.29	1.30	1.17	1.42	0.98	1.08	1.26	1.21
2	Romeville Diversion	2.99	1.30	2.38	3.21	0.99	1.12	1.27	1.89
4	South of Highway 70 Bridge	2.77	5.13	2.91	1.54	0.98	1.09	1.26	2.24
6	Total Diversion	2.76	3.16	2.70	2.45	0.99	1.10	1.27	2.06

50-year Sea Level Rise

	Scenario/Sub-basin	100	200	210, 220	110	120, 160	300, 320, 330	140, 150	Total Project Site Average
	Existing Conditions;	2.15	2.07	2.04	2.33	1.64	1.83	2.02	2.01
	Existing Conditions; With Berm Cuts	1.83	1.88	1.68	1.96	1.48	1.58	1.86	1.75
2	Romeville Diversion	3.49	1.88	3.06	3.73	1.51	1.68	1.88	2.46
4	South of Highway 70 Bridge	3.52	5.82	3.83	2.16	1.48	1.60	1.85	2.90
6	Total Diversion	3.42	3.71	3.47	3.16	1.51	1.69	1.88	2.69

FWP

Depending on the location of the hydrologic unit within the watershed in relation to the diversion outfall it was assumed that certain hydrologic units would receive different levels of influence (i.e., high, moderate, low, or no influence). However, all HUs see increased benefits in the form of dry-out frequency as a result of the berm cuts assuming the diversion would be operated to maximize dry-out frequency. At this time an operational plan has not been developed. In target year 1 (defined as "existing conditions with berm cuts" in Table 9), without a diversion water depths are lower than existing conditions throughout all hydrologic units for all alternatives, and below swamp floor elevations in most hydrologic units (Table 9).

Hydrologic data indicates that by TY 20 water levels within all areas are at or above swamp floor elevations. Within areas of high influence sediment accretion is expected and should keep up with total sea level rise. Nutrient input into areas moderately influenced would facilitate increased growth rates contributing to above ground biomass. While this has been taken into

consideration, accretions rates have not been predicted or analyzed at this time. As displayed in Table 10, FWP water regime was evaluated by each hydrologic unit for each alternative and grouped according to level of influence by the diversion.

Table 10. Future With Project Water Regime Conditions.

	TY0		TY1		TY20		TY30		TY50	
	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI	duration-exchange	SI
Alternative 1										
high influence	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm-low	0.45	seasonal-high	1.00	semipermanent-high	0.75	semiperm-high	0.75	semiperm-high	0.75
low	semiperm/perm-low	0.40	seasonal-moderate	0.85	semiperm-moderate	0.65	perm/semiperm-moderate	0.55	perm/semiperm-moderate	0.55
no influence	semiperm-low	0.45	seasonal-low	0.70	semiperm-low	0.45	semiperm-low	0.45	semiperm-low	0.45
Alternative 2										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	semiperm/-low	0.45	seasonal-moderate	0.85	semiperm-moderate	0.65	semiperm-moderate	0.65	semiperm-moderate	0.65
no influence	perm-low	0.30	seasonal-low	0.70	semiperm-low	0.45	perm-low	0.30	perm-low	0.30
Alternative 3										
high influence	semiperm-low	0.45	seasonal-high	1.00	semiperm-high	0.75	semiperm-high	0.75	semiperm-high	0.75
moderate	semiperm/perm-low	0.40	seasonal-high	1.00	semiperm-high	0.75	semiperm/perm-high	0.70	semiperm/perm-high	0.70
low	permanent-low	0.30	semiperm-moderate	0.65	semiperm-moderate	0.65	permanent-moderate	0.45	permanent-moderate	0.45
no influence	-	-	-	-	-	-	-	-	-	-

Variable V_4 - Mean high salinity during the growing season.

Swamps can tolerate increased salinities; however increased salinity spikes coupled with prolonged flooding has been shown to be detrimental to those forested swamps. Baldcypress is able to tolerate higher salinities compared to other swamp species such as tupelogum and many herbaceous species which are salinity-sensitive. Salinity recorded at Pass Manchac during the 1999-2000 drought spiked at 8 parts-per-thousand (ppt) and averaged around 5 ppt until heavy rains in July 2000 ended the drought (Keddy et al. 2007). For the Swamp WVA optimal conditions for salinity are assumed when mean high salinities during the growing season are equal to or less than 1.0 ppt. Habitat suitability is assumed to decrease rapidly at mean high salinities in excess of 1.0 ppt.

For the CWPPRA River Reintroduction into Maurepas Swamp project the lowest existing salinities documented were 1.53 ppt for the "Hope" station group (EPA 2001). The Convent/Blind River Diversion project area is located further inland from the "Hope" station group and is landward of several hydrologic barriers (i.e., I-10, US 61, KCSRR), thereby being protecting from the higher salinity waters coming from the Gulf. Because of these barriers it is likely salinity levels remain relatively consistent throughout the project area and do not fluctuate within the project area. While salinity spikes still affect the project area through the hydrologic

connectivity of Blind River and other small tributaries, those salinity spikes are not representative of typical salinities and are not represented in this variable. For 2008, average salinities during the growing season recorded at CRMS stations (0065 and 5167) located west of U.S. Hwy 61 were measured at 0.25 ppt. The highest salinity measured during the growing season was 0.33 ppt. Salinities have been collected periodically in Blind River at US Hwy 61 by LDEQ (LA040403), and average annual salinities taken from 1981 to 1998 were 0.95 ppt. Average salinities recorded during the growing season at that station range from 0.15 ppt in 1996 to 0.70 ppt in 1995. However, those values were only obtained from the months of April, June, August, and October. For two CRMS stations located west of U.S. Hwy 61 and in the project area average salinities in the growing season were measured at 0.35 ppt (CRMS0039) and 0.53 ppt (CRMS5167), slightly higher than the interior sites.

According to the data available for the entire project area it appears that mean high salinity during the growing season is less than 1.0 ppt. Should coastal restoration and protection projects (e.g., MRGO Ecosystem Restoration Project and features of the Federal Hurricane and Storm Damage Risk Reduction System) proposed for the Lake Pontchartrain Basin not be implemented, it is highly likely that the project area will continue to see slight increases in average salinities and a greater frequency in salinity spikes. This is evident from the salinity trends observed in the forested swamps to the east and closer to Lake Maurepas. However, average high salinities during the growing season are not expected to exceed 1.0 ppt over the project life. The suitability index for salinities 1.0 ppt or less is 1.0.

It is assumed that the project area can be subdivided into two salinity regions. Areas east of U.S. Hwy 61 and south of Interstate 10 experience slightly higher salinity levels as a result of being closer to the lake. Areas further inland and west of U.S. Hwy 61 are slightly fresher due to the hydrologic barriers impeding the salinity gradient and the contribution of freshwater run-off from the adjacent upland areas.

Existing conditions for areas east of U.S. Hwy 61 are estimated based on the CRMS data for 0065 and 5167. Salinities were consistent throughout the 2008 growing season so mean high salinities were not calculated. Because of freshwater runoff and the hydrologic barriers, average mean high salinities are not expected to increase; however, salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes. Average high salinities during the growing season are not expected to exceed 1.0 ppt over the 50-year future without project life.

Existing conditions for areas west of U.S. Hwy 61 are estimated using data from the two CRMS stations (0039 and 5167) within the area. It is likely that in the 50-year future without project life the area will experience a slight increase in salinities, but will still be within the optimal range. Project area salinities are greatly influenced by adjacent storm water and agricultural freshwater runoff, and hydrologic barriers prevent high saline waters from entering the swamps. Salinity will still be a detrimental factor to swamp sustainability in the form of seasonal and drought induced salinity spikes.

Modeling conducted for the closure of the MRGO at Bayou La Loutre showed that salinities would decrease within the adjacent marshes and associated waterways on the order of 1.0 to 3.0 ppt as a result of that closure (Draft IER 11 Tier 2 Pontchartrain 2009). Higher saline waters that

commonly entered through the MRGO into the southern end of Lake Pontchartrain have been cut off as a result of that closure and the Lake Borgne surge barrier currently being constructed.

Summary/Results

According to initial results from the hydrologic modeling, benefits are achieved through gapping spoil banks and modifying other hydrologic barriers to allow the redistribution of hydrologic flow throughout the swamp system. Because in-swamp management is a feature of all three alternatives, all three alternatives see considerable WVA benefits in the first 20 years as a result of those features; therefore, the difference in AAHUs between alternatives is minimized. The analysis then becomes a comparison of diversion influence areas. Based on preliminary hydrologic modeling results which at this stage of the study has focused on transfer of flow between benefit areas, the Romeville diversion alternative (Alternative 2) directly influences a larger area (i.e., HUs 1 and 4) compared to Alternative 4, the South of Hwy 70 Bridge diversion alternative (i.e., HUs 1 and 2). The "Total diversion" alternative (i.e., Alternative 6 and 4b) consequently has the highest benefits because sediments, nutrients, and freshwater are influencing a larger receiving area. Another observation in the analysis is that basal area throughout most of the project area is considered to be within the optimal range (i.e., >161 sq. ft./ac) to support wildlife habitat. The WVA, therefore, does not show a distinction (or change in suitability indices) between habitat classes and between FWP and FWOP for this variable. Because of these factors, alternative evaluations have placed an emphasis on stand structure and water regime. The project area is semi-permanently flooded and future-with-project modeling projections indicates that the flooding regime within most of the project area will return to pre-project conditions by target year 20 as a result of total sea level rise. However, hydrologic flow will be improved and will provide additional benefits by increasing forest stand vigor, accretion, water quality and back flow prevention.

Data Gaps and Additional Information Needs for Analyzing Benefits of the Tentatively Selected Plan (TSP)

Because of the expedited schedule, limited data was available at the time of this analysis. Therefore, the intent of this habitat analysis is to provide a comparison of alternative benefit areas and potential direct impacts associated with project construction to support the selection of a TSP. To fully evaluate the benefits of the TSP the following additional information and actions will be required:

- Additional results of hydrologic modeling efforts that better identify/quantify influence areas and how water (sediment and nutrients) moves through the system and within each hydrologic unit.
- Water levels and swamp floor elevations need to be determined on a refined scale and incorporated into the hydrologic modeling.
- Salinity predictions need to be re-evaluated and changes, if necessary, be undertaken.
- Diversion operations need to be developed by alternative and incorporated into the hydrologic modeling.
- Accretion rates need to be determined and incorporated into the hydrologic modeling (e.g., flood durations and depths should decrease). Benefits cannot be fully addressed without including this in the analysis.

IMPACTS

For each alternative, impacts to swamp habitat are associated with the transmission channel from the Mississippi River to the outfall area (benefit area) and with transmission canal construction and modification within the outfall area (Tables 11 & 12). For FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed alternative.

Table 11. Forested Wetland Impacts (Acres)

	Alternative 2 Romeville 3000cfs	**Alternative 4** Southbridge 3000cfs	**Alternative 4B** Southbridge 3000 cfs split flows	**Alternative 6** Romeville 1500 cfs Southbridge 1500 cfs
Diversion Channel	53	107	107	160
Northern Transmission Canal	-	163	126	126
Widening of St James Canal	-	-	72	-
Total	**53**	**270**	**305**	**286**

Impacts associated with the transmission channel were quantified using the highest quality habitat (i.e., greater than 50 years-to-marsh) variable assumptions from the WVA assessing benefits. Field data was not obtained along the proposed transmission channels due to limited time associated with the expedited schedule; therefore, variable assumptions were made to give advantage to the forested resources being impacted (e.g., stand structure and maturity were assumed to have the highest suitability index value). Forested areas closer to, and associated with, the natural levee of the Mississippi River are at higher elevations, and prolonged inundation is not expected. Therefore, for areas where water regime is currently classified as seasonal or temporary, stand structure class is expected to increase through the 50-year project life. Water regime was determined using classifications by National Wetlands Inventory 1988. Forested habitat at higher elevations along the natural levee of the Mississippi River is not expected to experience marked salinity influences through the project life. See WVA worksheets for the discrete variable assumptions.

The proposed northern transmission canal (i.e., Alternatives 4A, 4B, and 6) traverses through the "benefit area" and the associated acreage was previously included in the habitat analyses evaluating benefits. Those analyses were revised, and the associated acres impacted were subtracted from the respective analysis by habitat condition class. The associated impacts were then evaluated using the same variable assumptions from those previous habitat analyses assessing benefits for FWOP. Again, for FWP, all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Alternative 4B would include expanding the St. James Parish Canal and constructing channel berms to achieve a head differential sufficient to move diverted water to the southern portion of the project area. While additional indirect impacts would be associated with impounding areas of swamp by constructing these berms, only direct impacts to wetlands were evaluated. Much of this area was already classified in the habitat condition class and the same variable assumptions for FWOP were used. Again, for FWP all habitat suitability index (HSI) values are 0.0 to reflect the removal of forested habitat as a result of the proposed project.

Figure 5. Forested Impacts Associated with the Romeville Diversion Channel (Alts. 2 & 6)



Figure 6. Forested Impacts Associated with the South Bridge Transmission Channel (Alternative 4A and 6)

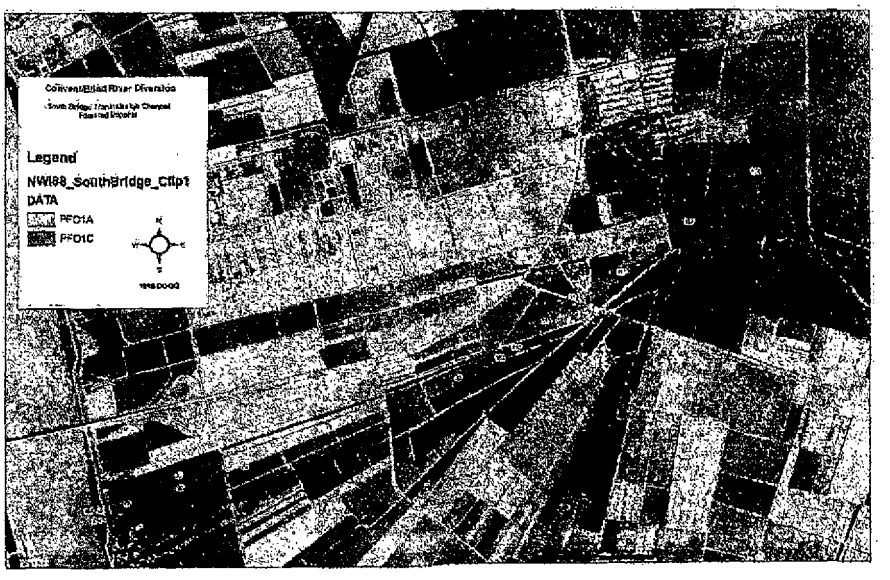


Figure 7. Forested Impacts Associated with the Outfall Canal (Alternatives 4A, 4B, & 6).

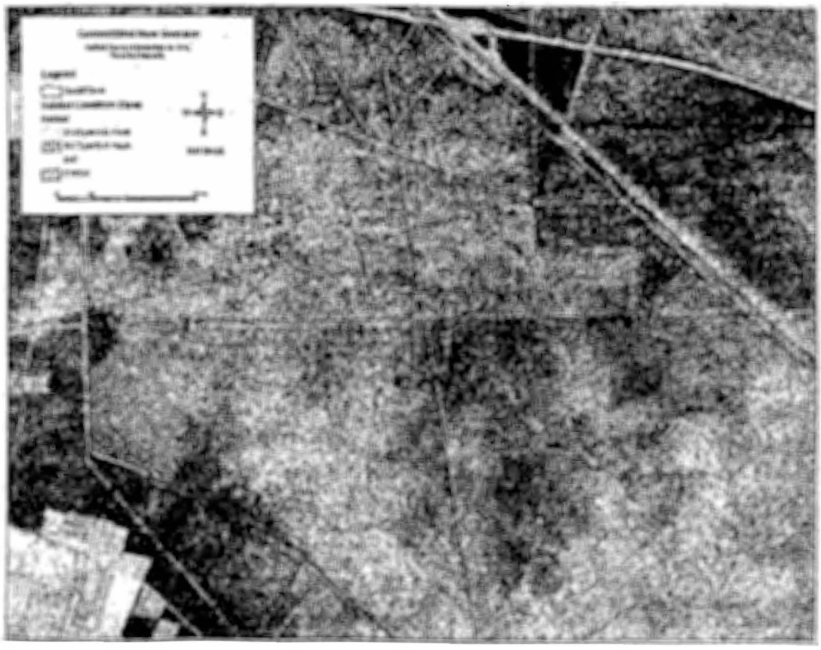


Figure 8. Forested Impacts Associated with Widening St. James Parish Canal (Alt. 4B)

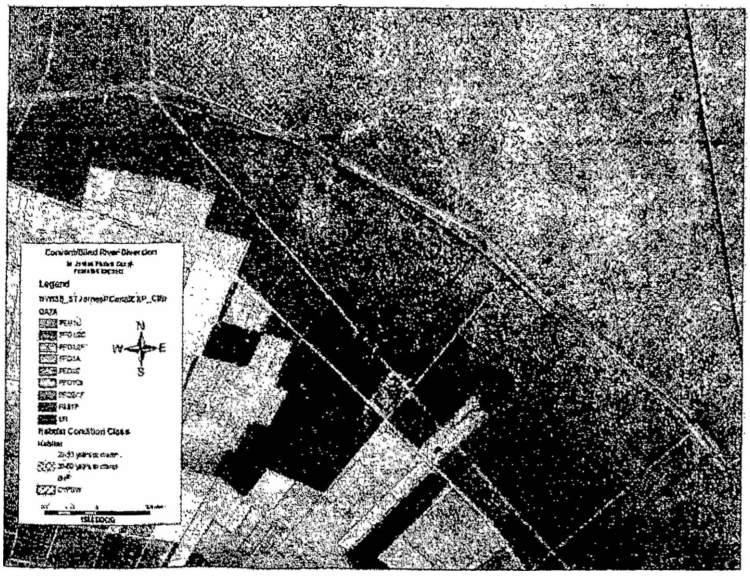


Table 12. Summary of Total Acres Benefited and Impacted.

	Acres			
Benefits	Alternative 2	Alternative 4A	Alternative 6,	4B
High IA, 20-30 years to marsh	169	169	169	169
High IA, 30-50 years to marsh	3364	1827	3848	3848
High IA, >50 years to marsh	4555	3550	5361	5361
Moderate IA, 20-30 years to marsh	204	1837	2041	2041
Moderate IA, 30-50 years to marsh	604	2972	3579	3579
Moderate IA, >50 years to marsh	2607	2070	4691	4691
Low IA, 20-30 years to marsh	2397	0	1085	1085
Low IA, 30-50 years to marsh	1669	2013	469	469
Low IA, >50 years to marsh	469	1799	0	0
No IA, 20-30 years to marsh	525	1289	0	0
No IA, 30-50 years to marsh	2297	1073	0	0
No IA, >50 years to marsh	2509	2607	0	0
Benefits Total	21,369	21,206	21,243	21,243
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	36	28	28
High IA, >50 years to marsh	0	52	40	40
Moderate IA, 30-50 years to marsh	0	13	10	10
Moderate IA, >50 years to marsh	0	62	48	48
Transmission Channel				
FWetlands, Seasonally Flooded	31	39	70	39
FWetlands, Temporarily Flooded	2	69	71	69
FWetlands, Semipermanent Flooded	20	0	20	0
St. James Parish Canal Modificaitons				
FWetlands, Seasonally Flooded	0	0	0	22
FWetlands, Semipermanent Flooded	0	0	0	50
Impacts Total	53	271	287	306
Combined Total Acres	21,422	21,477	21,530	21,549

Table 13. Summary of Total AAHUs.

	Average Annual Habitat Units (AAHUs)			
Benefits	Alternative 2	Alternative 4A	Alternative 6	4B
High IA, 20-30 years to marsh	77	77	77	77
High IA, 30-50 years to marsh	1350	733	1545	1545
High IA, >50 years to marsh	1293	1014	1532	1532
Moderate IA, 20-30 years to marsh	93	828	919	919
Moderate IA, 30-50 years to marsh	243	1182	1423	1423
Moderate IA, >50 years to marsh	745	585	1325	1325
Low IA, 20-30 years to marsh	935	0	354	354
Low IA, 30-50 years to marsh	527	663	137	137
Low IA, >50 years to marsh	110	447	0	0
No IA, 20-30 years to marsh	72	163	0	0
No IA, 30-50 years to marsh	585	237	0	0
No IA, >50 years to marsh	431	373	0	0
Benefits Total	**6,462**	**6,302**	**7,313**	**7,313**
Impacts				
Outfall Area				
High IA, 30-50 years to marsh	0	-17.07	-13.28	-13.28
High IA, >50 years to marsh	0	-30.19	-23.22	-23.22
Moderate IA, 30-50 years to marsh	0	-6.09	-4.69	-4.69
Moderate IA, >50 years to marsh	0	-35.69	-27.63	-27.63
Transmission Channel				
FWetlands, Seasonally Flooded	-25.87	-32.55	-58.43	-32.55
FWetlands, Temporarily Flooded	-1.67	-56.33	-57.96	-56.33
FWetlands, Semipermanent Flooded	-13.50	0	-13.5	0
St. James Parish Canal Modifications				
FWetlands, Seasonally Flooded	0	0	0	-18.36
FWetlands, Semipermanent Flooded	0	0	0	-33.76
Impacts Total	-41.04	-177.92	-198.71	-209.82
Combined Total AAHUs	6,421	6,124	7,114	7,103

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CONVENT/BLIND RIVER DIVERSION PROJECT WVA MODEL JUSTIFICATION

1. Starting the SI curves for all variables at 0.1 is problematic because even habitat with no ecological value appears to have some ecological value.

The WVA swamp model has only two graphs. One of them, V2 - Stand Maturity, has a zero intercept. The other, Salinity, does not. However, McKay and Fischenich (1) did a sensitivity analysis on the Barataria Barrier Shoreline WVA. Their study showed that the application of the zero slope intercept instead of 0.1 as in the model did not affect the relative rankings of any of the alternatives. The same is likely to be true for the Convent/Blind River diversion project.

3. The number of target years should be increased to improve the predictive ability of the models given that changes are often non-linear.

For the Convent/Blind River diversion project, different alternatives were analyzed using target years depending upon various assumptions such as the health of the vegetation relative to similar vegetation in the Swamp outside of the project area as reflected in the habitat classification map (20-30 years to marsh, 30-50 years to marsh, and >50 years to mash). The target years used for the Convent/Blind River diversion project were TY0, TY1, TY20, TY30, and TY 50.

For the WVA Certification additional text has been provided in the Procedural Manual to guide users on the selection of target years. A Table has been added summarizing, by project type, the use of specific target years to reflect aspects of project evolution. Suggestions have been made for ensuring the justification for the selection of Target years is added to the Project Information Sheet.

4. In the spreadsheet for the marsh model, open water and emergent marsh AAHUs are incorrectly combined and should be added rather than taking the arithmetic mean.

The marsh models were not used in the Convent/Blind River diversion project.

6. Sea level is an important driver and relative sea level rise and climate change should be included in the models.

For the Convent/Blind River diversion project relative sea level and subsidence were accounted for in the land loss rates calculated for each project area. Data in the literature indicated that the rate of accretion will offset sea level rise and subsidence. The hydrologic modeling that was used to evaluate WVA metrics for the Convent/Blind River used the intermediate rate of sea level rise.

For WVA Certification, a new section 'Climate Change' has been added to the Procedural Manual to provide guidance on how to consider sea-level rise and other climate change effects in the evaluation. Suggestions have been made to document in the Project Information Sheet how these factors are considered in the evaluation.

10. For some model variables, policy decisions appear to supersede the biology of the relationships for developing the Suitability Index (SI) curves.

This comment referred to a problem that the reviewers had with the marsh models. The marsh models were not used in the Convent/Blind River diversion project.

11. The spreadsheets for the models as created are likely to lead to errors in maintenance and use.

The USFWS Habitat Evaluation Team (HET) member for the Convent/Blind River diversion project is experienced in the use of WVA spreadsheets. To ensure that "% cover" and "class", as well as other spreadsheet numbers were entered correctly the spreadsheet entries have been and will be reviewed by several members of the HET (e.g., agency representatives).

For WVA Certification, the spreadsheets have been corrected as Battelle suggested correction of calculation errors, improvement of the spreadsheet user interface, to decrease the likelihood of user errors.

12. Several inaccuracies were identified in the model spreadsheets that should be corrected.

As explained above, the USFWS HET member is experienced in the use of WVA spreadsheets and the HET reviewed all spreadsheets, According to model developers, the spreadsheet works correctly for the Swamp WVA V2.

For WVA Certification, the spreadsheets have been corrected as suggested by Battelle to correct calculation and specification errors.

15. The WVA method should be expanded to handle risk and uncertainty in areas exposed to episodic events.

Risk and uncertainty are already incorporated into the WVA model used for the Convent/Blind River diversion project. Risk and uncertainty are also addressed in Section 3.10 of the Integrated Feasibility Study and Environmental Impact Statement and include hydrologic, environmental, and construction and economic uncertainties.

For WVA Certification, suggestions have been made to add a section to the Project Information Sheet to describe how risk and uncertainty are considered in the evaluation.
i

16. The WVA method should be updated, taking into account new GIS data, LIDAR, and other new data sources as well model formats/presentation (visualization tools, HGM).

The WVA model used for the Convent/Blind River diversion project included use of the most recent imagery and land loss data available from the USGS as well as the most appropriate historic imagery to determine land loss and habitat conversion. The habitat classification map was developed by scientists with the most knowledge about the condition of wetlands in Maurepas Swamp in conjunction with the most recent available imagery from the USGS.

For WVA Certification, the Procedural Manual has been updated to reflect current use and to provide appropriate guidance on available data sources.

18. The use of the geometric mean may be more appropriate than the arithmetic mean to derive some HSIs. Provide scientific basis for the decision.

The WVA Swamp Model used for the Convent/Blind River diversion project uses a geometric mean to derive HSI's.

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Volume IV

APPENDIX L:

Engineering

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TABLE OF CONTENTS

Convent/ Blind River Small Diversion Final Feasibility Report
Appendix L - Engineering Investigation and Opinion of Estimated Costs

L1 SUMMARY 1
L1.1 Project Scope and Objectives 1
L1.2 Alternatives Analyzed 2
L1.3 Analysis Approach 2
L1.4 Analysis Results 3
L2 HYDROLOGY, HYDRAULICS, AND WATER QUALITY 5
L2.1 Introduction 5
L2.2 Model Study Methodologies 6
L2.2.1 HEC-HMS 6
L2.2.2 HEC-RAS 8
L2.2.3 EFDC 9
L2.2.4 Engineering Calculations 16
L2.3 Watershed Hydrology and Hydraulics 22
L2.3.1 Climatology and Physical Data 23
L2.3.2 Blind River and Swamp System 27
L2.3.3 Lake Maurepas 28
L2.3.4 HEC-HMS 29
L2.3.5 HEC-RAS 36
L2.3.6 Engineering Calculations 44
L2.4 Swamp Hydroperiod Analysis and Alternatives Screening 60
L2.4.1 Hydroperiod Characteristics 60
L2.4.2 Management Measures to Enhance Hydroperiod Characteristics 61
L2.4.3 Water Management Enhancements 62
L2.4.4 Screening Analysis for Diversion Location and Capacity 64
L2.4.5 Consideration of Sea Level Rise 68
L2.4.6 Effects of Mississippi River Water Level on Diversion Capacity 68
L2.4.7 Conclusions 71
L2.5 Hydrodynamic Analysis 73

L2.5.1 Flow and Stage Boundary Conditions 73
L2.5.2 Temperature Boundaries 76
L2.5.3 Sediment Boundaries 77
L2.5.4 Water Quality Boundaries 78
L2.5.5 Wetland Vegetation and Bottom Resistance 81
L2.5.6 Meteorological Forcing 83
L2.5.7 EFDC Model Testing 83
L2.5.8 Existing Condition Simulation 83
L2.6 Hydraulic Analysis of Romeville Diversion and Transmission Components 92
L2.6.1 Mississippi River Stage Analysis at Romeville 93
L2.6.2 Romeville Hydraulic Grade Line 99
L2.6.3 Diversion and Transmission System Flow Line Profile 102
L2.6.4 Romeville Diversion Culvert 102
L2.6.5 Romeville Diversion Siphon 108
L2.6.6 Romeville Transmission Canal Analysis 117
L2.7 Hydraulic Analysis of South Bridge Diversion and Transmission Components 123
L2.7.1 Development of the South Bridge Diversion Alignment 123
L2.7.2 Mississippi River Stage Analysis at River Mile 167.0 126
L2.7.3 South Bridge Hydraulic Grade Line 127
L2.7.4 Diversion and Transmission System Flow Line Profile 131
L2.7.5 South Bridge Diversion Culvert 131
L2.7.6 South Bridge Diversion Siphon 131
L2.7.7 South Bridge Transmission Canal 132
L2.7.8 North Distribution Canal 138
L2.7.9 Existing Drainage Channel Improvements 142
L2.8 Swamp Distribution System Analysis 142
L2.8.1 Berm Gaps/Cuts 142
L2.8.2 Control Structures 145
L2.8.3 Culverts and Bridges 148
L2.9 Swamp Flow Outlet Control Analysis 148
L2.9.1 Lake Maurepas 148

L2.9.2 Sea Level Rise 153
L2.9.3 Application of Relative Sea Level Rise Projection 159
L2.10 Project Alternatives Analysis 160
L2.10.1 Alternative 2 161
L2.10.2 Alternative 4 183
L2.10.3 Alternative 4B 187
L2.10.4 Alternative 6 191
L2.10.5 Summary and Recommendations 195
L2.11 Hydrologic Uncertainties 201
L3 SURVEYING, MAPPING AND GEOSPATIAL DATA REQUIREMENTS 211
L3.2 Ground Topographic Surveys 211
L3.2.1 Vertical and Horizontal Control Data 211
L3.2.2 Cross Section Locations 211
L3.2.3 Profile Alignment and Orientation 211
L3.3 Bathymetric Survey 212
L3.3.1 Vertical and Horizontal Control Data 212
L3.3.2 Cross Section Locations 212
L3.3.3 Profile Alignment and Orientation 212
L4 GEOLOGY 212
L4.1 Geology of St James Parish 212
L5 GEOTECHNICAL INVESTIGATIONS AND DESIGN 213
L5.1 Project Description 213
L5.2 Purpose and Scope 214
L5.3 Existing Site Conditions 214
L5.4 Subsurface Investigations 215
L5.5 Laboratory Testing Program 219
L5.6 Subsurface Conditions 220
L5.7 Groundwater 220
L5.8 Variation in Subsurface Conditions 220
L5.9 Closure 220
L6 ENVIRONMENTAL ENGINEERING 221
L6.1 Incorporation of Environmental Compliance Measures into Project Design 221

L6.2 Incorporation of Environmental Sensitivity 221

L7 CIVIL DESIGN 221
L7.1 Diversion Culvert Facility 222

L7.1.1 Description – Diversion Culvert 222

L7.1.2 Civil Design – Diversion Culvert 223

L7.1.3 Geotechnical Coordination 224

L7.2 Transmission Canal 225

L7.2.1 Description – Transmission Canal 225

L7.2.2 Civil Design – Transmission Canal 225

L7.2.3 Geotechnical Coordination 226

L7.3 Control Structures 227

L7.3.1 Description – Control Structures 227

L7.3.2 Civil Design – Control Structures 228

L7.3.3 Geotechnical Coordination 229

L7.4 Berm Gaps 229

L7.4.1 Description – Berm Gaps 229

L7.4.2 Civil Design – Berm Gaps 229

L7.4.3 Geotechnical Coordination 230

L7.5 Cross Culverts at the Highway 61 Corridor 230

L7.5.1 Description – Cross Culverts 230

L7.5.2 Civil Design – Cross Culverts 230

L7.5.3 Geotechnical Coordination 231

L7.6 Instrumentation 232

L7.6.1 Description - Instrumentation 232

L7.6.2 Civil Design – Instrumentation 233

L7.6.3 Geotechnical Coordination 233

L8 STRUCTURAL DESIGN 233
8.1 Codes and Standards 233

8.1.1 Governing Code 233

8.1.2 Supplemental Codes and Standards. 233

8.2 Design Loads and Serviceability 234

8.2.1 Scope 234

8.2.2 Dead Loads 234
8.2.3 Live Loads 234
8.2.4 Environmental Loads 236
8.2.5 Process Liquid Loads 236
8.2.6 External Earth and Groundwater Loads and Freeboard 236
8.2.7 Combination of Loads 237
8.2.8 Serviceability 237
8.3 Foundation Design 238
8.3.1 Scope 238
8.3.2 Shallow Foundation Support 238
8.3.3 Deep Foundation Support 238
8.3.4 Buoyancy 238
L9 ELECTRICAL POWER SYSTEM DISTRIBUTION 239
L9.1 Codes, Standards and References 239
L9.2 General Power Distribution 240
L9.3 Utility Power Services 240
L9.4 Standalone Power Services 241
L9.5 Exterior Lighting 242
L9.6 Transient Voltage Surge Suppressors (TVSS) 242
L9.7 Wire and Conduit 242
L10 OPERATION, CONTROL, AND INSTRUMENTATION 243
L10.1 Diversion System Operation 243
L10.2 Diversion System Control 244
L10.2.1 Primary Hydraulic System Control 245
L10.2.2 Secondary Controls and Monitoring 245
L10.2.3 Hydrologic Data Collection 247
L10.2.4 Environmental 247
L10.2.5 Others - Security, Motors, Mechanical, Electrical Systems, etc. 247
L10.3 Instrumentation and Control 247
L10.4 Instrumentation and Control Requirements for Power Supply Systems 247
L10.5 Instrumentation and Control Design for Romeville Diversion Facility 248
L10.6 Instrumentation and Control Design for Romeville Transmission System 248

L10.7 Instrumentation and Control Design for Swamp Control Structures 248
L11 CONSTRUCTION PROCEDURES 249
L11.1 Diversion Culvert Facility 250
L11.2 Transmission Canal 254
L11.3 Control Structures 257
L11.4 Berm Gaps 259
L11.5 Cross Culverts 260
L11.6 Instrumentation and Communication 263
L12 OPERATION AND MAINTENANCE 263
L12.1 Maintenance Dredging 263
L12.1.1 Regular Maintenance Dredging 263
L12.1.2 Costs for Regular Maintenance Dredging 264
L12.1.3 Single 3000 cfs Culvert Diversion O&M at Romeville or South Bridge 264
L12.2 Facilities Operations Plan 265
L12.2.1 Operating Assumptions 265
L12.2.2 Anticipated Operational Sequencing 265
L12.2.3 Expected Operating Setpoints 267
L12.3 Long-Term Monitoring Plan 267
L12.4 Operation and Maintenance Costs 268
L12.4.1 3000 cfs Culvert Diversion O&M Costs 268
L12.4.2 3000 cfs Transfer Canal O&M Costs 268
L12.4.3 Distribution Canal O&M Costs 268
L12.4.4 Control Structure O&M Costs 268
L12.4.5 Gap and Culvert O&M Costs 269
L12.4.6 Total O&M Cost for 3000 cfs Diversion 269
L12.5.1 3000 cfs Culvert Diversion RR&R Costs 269
L12.5.2 3000 cfs Transfer Canal RR&R Costs 269
L12.5.3 Distribution Canal RR&R Costs 269
L12.5.4 Control Structure RR&R Costs 270
L12.5.5 Gap and Culvert RR&R Costs 270
L12.5.6 Total RR&R Cost for 3000 cfs Diversion 270
L13 PRELIMINARY OPINION OF ESTIMATED COSTS 270

L13.1 Background Information 271
L13.2 Preliminary Construction Opinion of estimated costs 273
L13.3 Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas 277
L13.4 First Costs (Capital Costs) 278
L13.5 O&M Opinion of estimated costs 278
L13.6 Total Project Costs 279
L13.7 Cost Comparisons and Evaluations 279
L13.8 Cost Risk Analysis 283
L13.8.1 Cost Risks 283
L14. SCHEDULE FOR DESIGN AND CONSTRUCTION 288
L14.1 Design Schedule 288
L14.2 Construction Schedule 289
L15 REAL ESTATE AND RIGHT-OF-WAY REQUIREMENTS 289
L15.1 Scope of Requirements 289
L15.2 Permanent Real Estate Acquisition Requirements 291
L15.2.1 Diversion Facility 291
L15.2.2 Transmission Canal 291
L15.2.3 Control Structures 291
L15.2.4 Cross Culverts and Interconnecting Channels at KCS RR/ Highway 61 Corridor 292
L15.3 Temporary Construction Easements 292
L15.3.1 Diversion Facility 292
L15.3.2 Transmission Canal 292
L15.3.3 LA 44 Temporary Relocation 292
L15.3.4 CN RR Temporary Relocation 293
L15.3.5 LA 3125 Temporary Relocation 293
L15.3.6 Control Structures 293
L15.3.7 Cross Culverts at Highway 61 293
L15.3.8 Interconnecting Channel at KCS RR/Highway 61 Corridor 293
L16 INFRASTRUCTURE RELOCATIONS 294
L16.1 Purpose and Scope 294
L16.2 Underground Utilities and Pipelines 297

L16.2.1 Descriptions 297
L16.2.2 Conflict Analysis and Proposed Relocations 299
L16.3 Overhead Utilities 301
L16.3.1 O/H Utility Descriptions 301
L16.3.2 Conflict Analysis and Proposed Relocations 302
L16.4 Transportation Facilities 302
L16.4.1 Transportation Descriptions 302
L16.4.2 Conflicts and Proposed Temporary Relocations 302
L16.5 Construction Coordination 304
L16.6 Opinion of estimated costs 304

Annexes

Annex L-1 Detailed Construction Opinion of estimated costs for Studied Alternatives
Annex L-2 Detailed Hydrologic and Hydraulic Results
Annex L-3 Geotechnical Engineering Data for Design of Facilities
Annex L-4 Survey Data
Annex L-5 Engineering Plates
Annex L-6 Control Structure Memorandum
Annex L-7 Cost
Total Project Cost Summary
MCACES MII Cost Estimate
Project Cost and Schedule Risk Analysis Report

Figures

Figure L1.4-1 Hydrographic Areas 4
Figure L2.2.1-1 HEC-HMS Model Schematic 7
Figure L2.2.2-1 HEC-RAS Model Schematic 10
Figure L2.2.3-1 Blind River Freshwater Diversion Feasibility Study – Project Area and Boundary 12
Figure L2.2.3-2 Blind River Freshwater Diversion Feasibility Study – Topography of the Project Area 13
Figure L2.2.3-3 Blind River Freshwater Diversion Feasibility Study – Model Grid 14
Figure L2.2.3-4 Schematic of the Existing Canals/Blind River and Equivalent Channel 15
Figure L2.2.4-1 Functional Diagram for Water Balance Calculations 19
Figure L2.2.4-2 Basic Rainfall-Runoff Representation 19
Figure L2.3.1-1 Existing Precipitation and Evaporation Station Locations 24
Figure L2.3.4-1 Soil Classification 31
Figure L2.3.4-2 Land Use Classification 32
Figure L2.3.5-1 Influence of Lake Maurepas on Blind River System Stages 39
Figure L2.3.5-2 Blind River Flow at I-10 40
Figure L2.3.5-3 Typical Flow Patterns 41
Figure L2.3.6-1 Contributing Watershed Surrounding the Study Area 46
Figure L2.3.6-2 South Bridge Canal Runoff (Sub-basin 590) 47
Figure L2.3.6-3 St. James Parish Canal Runoff (Sub-basins 570, 580) 48
Figure L2.3.6-4 Romeville Canal Runoff (Sub-basins 550, 560) 48
Figure L2.3.6-5 External Drainage Canal 1 Runoff (Sub-basins 490, 500, 510, 520, 530, 540) 49
Figure L2.3.6-6 External Drainage Canal 2 Runoff (Sub-basins 470, 480) 49
Figure L2.3.6-7 External Drainage Canal 3 Runoff (Sub-basins 420, 430, 440, 450, 460) 50
Figure L2.3.6-8 Southeast US 61 Canal Runoff (Sub-basin 410) 50
Figure L2.3.6-9 Watershed Runoff (Sub-basin 400) 51
Figure L2.3.6-10 Watershed Runoff (Sub-basins 700, 740, 750, 760) 51
Figure L2.3.6-11 Watershed Runoff (Sub-basins 710, 720) 52
Figure L2.3.6-12 Watershed Runoff (Sub-basins 600, 610) 52
Figure L2.3.6-13 Conway Canal 2 Runoff (Sub-basin 730) 53
Figure L2.3.6-14 Comparison of Swamp Fill and Drain Dynamics in Sub-basin 100 54
Figure L2.3.6-15 Map of Comparative USGS Stream Flow Gages 56
Figure L2.3.6-16 Comparison of Precipitation near Blind River and Natalbany River 57
Figure L2.3.6-17 Comparison of Scaled Flow at Natalbany with Calculated Blind River Flow 58
Figure L2.4.3-1 Representative Hydroperiod Modifications from Berm Gaps 63
Figure L2.4.4-1 HEC-RAS Simulations with Multiple Diversion Flow Rates 64
Figure L2.4.4-2 Sensitivity of Hydrologic Metrics to Diversion Capacity 66
Figure L2.4.6-1 Upstream and Downstream Boundary Condition Water Levels 69

Figure L2.4.6-2	Rating Curve for Romeville Diversion Culvert	69
Figure L 2.4.6-3	Diversion Time Series for 2003 with Capacity Constraints	70
Figure L2.5.1-1	Blind River Freshwater Diversion Feasibility Study – Locations of the EFDC Flow and Stage Boundaries	74
Figure L2.5.1-2a	Boundary Inflows (Locations 1 to 10)	75
Figure L2.5.1-2b	Boundary Inflows (Locations 11 to 21)	75
Figure L2.5.1-3	Downstream Boundary Stage	76
Figure L2.5.2-1	Mississippi River Daily Water Temperature (2003)	77
Figure L2.5.3-1	Monthly Average Mississippi River Suspended Sediment Concentration (2003)	78
Figure L2.5.5-1	Blind River Freshwater Diversion Feasibility Study – Vegetation Type and Distribution	82
Figure L 2.5.8-1	Simulated Water Depth	85
Figure L2.5.8-2	Simulated Water Elevations (Day 300)	86
Figure L2.5.8-3	Simulated Flow Velocity (Day 300)	87
Figure L2.5.8-4	Simulated Dye Concentration (Blind River at I-10)	88
Figure L2.5.8-5	Model Simulated Hydraulic Residence Time (Day 300)	89
Figure L2.5.8-6	Cumulative Sediment Deposition and Erosion	90
Figure L2.5.8-7	Measured Blind River Water Temperature (November-December 2009)	91
Figure L2.5.8-8	Measured Blind River DO Concentrations (November-December 2009)	91
Figure L2.6-1	Romeville Diversion Project Layout	92
Figure L2.6.1-1	Interpolated Stage Data (Romeville Diversion)	93
Figure L2.6.1-2	Percent Chance Exceedance Curve (Romeville Diversion)	96
Figure L2.6.1-3	Total Stage Histogram – All Data	98
Figure L2.6.1-4	Stage Histogram – Spring	98
Figure R 2.6.1-5	Stage Histogram – Summer-Fall	99
Figure L2.6.2-1	Hydraulic Grade Line Profile (Romeville Diversion)	101
Figure L2.6.4-1	Romeville Diversion Culvert Profile	103
Figure L2.6.4-2	Culvert Flow Characteristics (Romeville Diversion)	107
Figure L2.6.4-3	Rating Curves for Romeville Diversion Culvert	107
Figure R 2.6.5-1	Siphon Profile (Over Mississippi River Levee)	109
Figure L2.6.5-2	Siphon Profile (Over River Road)	110
Figure L2.6.5-3	Siphon Profile (Through the Mississippi River Levee)	109
Figure L2.6.5-4	Summary of 72" Siphon Barrels in Operation	115
Figure L2.6.5-5	Actual Flow Rate of 72" Siphon	116
Figure L2.6.6-1	Romeville Transmission Canal Rating Curves	120
Figure L2.6.6-2	Romeville Transmission Canal Velocity Plots	121
Figure L2.7-1	South Bridge Diversion Project Layout (Alternative 4A)	124
Figure L2.7-2	South Bridge Diversion Project Layout (Alternative 4B)	124
Figure L2.7.3-1	System Hydraulic Grade Line (South Bridge Diversion)	130
Figure L2.7.5-1	System Hydraulic Grade Line (South Bridge Diversion Culvert)	132
Figure L2.7.7-1	Rating Curves for South Bridge Transmission Canal	136
Figure L2.7.7-2	Velocity Plots for South Bridge Transmission Canal	136
Figure L2.8.1-1	Existing Berm Gaps	143

Figure L2.8.1-2	Proposed Berm Gaps	144
Figure L2.8.2-1	Control Structure Locations	146
Figure L2.8.2-2	Control Structure Isometric View	150
Figure L2.8.3-1	Locations of Culverts, Cross-Sections, and Bridges	150
Figure L2.9.1-1	Pass Manchac Stage Analysis	154
Figure L2.9.1-2	Lake Pontchartrain Stage Analysis	155
Figure L2.9.1-3	Stage Percent Exceedance at Pass Manchac	155
Figure L2.9.1-4	Tidal Influence at Pass Manchac Gage	157
Figure L2.10.1-1	Alternative 2 Layout	163
Figure L2.10.1-2	Freshwater Throughput and Backflow for the Final Array of Alternatives	166
Figure L2.10.1-3	Alternative 2 EFDC Flow Velocity	168
Figure L2.10.1-4	Alternative 2 EFDC Simulated Dye Concentration for Blind River at I-10	169
Figure L2.10.1-5	Alternative 2 EFDC Hydraulic Residence Time	169
Figure L2.10.1-6	Alternative 2 EFDC Sediment Deposition and Erosion	170
Figure L2.10.1-7	Spatial distribution of NO3 concentration at Day 300 for Alternative 2	172
Figure L2.10.1-8	Spatial distribution of TN concentration at Day 300 for Alternative 2	173
Figure L2.10.1-9	Spatial distribution of TP concentration at Day 300 for Alternative 2	173
Figure L2.10.1-10	Alternative 2 EFDC Hydraulic Residence Time with Sea Level Rise (50 years)	175
Figure L2.10.1-11	Alternative 2 EFDC Sediment Deposition and Erosion with Sea Level Rise (50 years)	176
Figure L2.10.1-12	Average Water Depth for Final Array of Alternatives	178
Figure L2.10.1-13	Backflow Prevention for Final Array of Alternatives	179
Figure L2.10.1-14	Average Dry-Out Frequency for Final Array of Alternatives	181
Figure L2.10.1-15	Diversion Frequency for Final Array of Alternatives	182
Figure L2.10.1-16	TSS Loading for Final Array of Alternatives	182
Figure L2.10.2-1	Alternative 4 Layout	184
Figure L2.10.3-1	Alternative 4B Layout	189
Figure L2.10.4-1	Alternative 6 Project Layout	193
Figure L2.10.5-1	Alternative 2 Hydrologic Influence Areas	196
Figure L2.10.5-2	Alternative 4 Hydrologic Influence Areas	198
Figure L2.10.5-3	Alternative 4B Hydrologic Influence Areas	198
Figure L2.10.5-4	Alternative 6 Hydrologic Influence Areas	199
Figure L2.11-1	Throughput and Backflow with Projected Relative Sea Level Rise	206
Figure L2.11-2	Average Water Depth with Projected Relative Sea Level Rise	207
Figure L2.11-3	Backflow Prevention with Projected Relative Sea Level Rise	208
Figure L2.11-4	Dry-Out Frequency with Projected Relative Sea Level Rise	209
Figure L2.11-5	TSS Loading with Projected Relative Sea Level Rise	210
Figure L5.2-1	Boring Location Plan Romeville Diversion – Blind River Fresh Water Diversion	215

Figure L5.2-2	Boring Location Plan Project Boundary Area – Blind River Fresh Water Diversion	216
Figure L11.1-1	Davis Pond Diversion Photo	253
Figure L13.7-1	Romeville Diversion Structure Options Comparison of Siphon and Culvert Construction Costs	280
Figure 13.7-2	Romeville Transmission Canal – Comparison of Construction Costs for Design Alternatives	281
Figure L13.7-3	Romeville Diversion Culvert – Design for MR Stage 5 vs. 11 Construction Costs	282
Figure L16.1-1	Utilities and Pipelines in Project Area	295
Figure L16.1-2	Pipelines at East End of Transmission Canal	295
Figure L16.1-3	Utilities and Pipelines at the KCS RR/Hwy 61 Corridor	296

Tables

Table L2.2.1-1 HEC-HMS Attribute Methodology 8
Table L2.2.2-1 HEC-RAS Attribute Methodology 9
Table L2.3.1-1 Available Precipitation Data 25
Table L2.3.1-2 Design Rainfall Depths 26
Table L2.3.1-3 Monthly Evaporation Values 26
Table L2.3.4-1 Hydrologic Land Cover Percentages 33
Table L2.3.4-2 HEC-HMS Model Parameters 34
Table L2.3.4-3 HEC-HMS Validation Summary 35
Table L2.3.4-4 HEC-HMS Plan Summary 36
Table L2.3.5-1 HEC-RAS Peak Water Surface Elevations 42
Table L2.3.5-2 HEC-RAS Average Water Surface Elevations 42
Table L2.3.5-3 HEC-RAS Net Freshwater Throughput Volumes 43
Table L2.3.5-4 HEC-RAS Backflow Volumes 43
Table L2.3.6-1 Soil Type Comparison 57
Table L2.3.6-2 Average Annual Water Depths (Existing Conditions) 60
Table L2.3.6-3 Average Annual Dry-Out Frequency (Existing Conditions) 60
Table L2.4.4-1 Preliminary Alternatives Identified Through Screening 67
Table L2.4.4-2 Final Array of Alternatives 68
Table L2.5.4-1 Runoff Water Quality Concentrations 79
Table L2.5.4-2 Runoff Load Summary 80
Table L2.5.4-3 Diversion Flow Water Quality Concentrations 80
Table L2.5.4-4 Nutrient Loads for 3,000 cfs Diversion Flow 81
Table L2.5.5-1 Average Tree Diameters and Densities by Condition Class 81
Table L2.5.8-1 Average EFDC Results by Hydrologic Response Unit 84
Table L2.5.8-2 Key Sediment Parameters and Assigned Model Values 89
Table L2.6.1-1 Gage Data Summary 94
Table L2.6.1-2 Standard Statistics for Stage 96
Table L2.6.1-3 Stage vs. Percent Exceedance 97
Table L2.6.1-4 Summary Stage Statistical Values 99
Table L2.6.4-1 Mississippi River Design Stage and Unit Flow Rate 105
Table L2.6.4-2 Mississippi River Design Stage and Unit Flow Rate 105
Table L2.6.4-3 Recommended Culvert Configurations for Alternate Design Flow Rates 107
Table L2.6.5-1 Siphon Profiles versus Minimum Operating WSEL in Mississippi River 110
Table L2.6.5-2 Siphon Barrels Required versus Design Flow Rate (Mississippi River WSEL = 11 ft) 114
Table L2.6.5-3 Siphon Barrels Required versus Design Flow Rate (Mississippi River WSEL = 17 ft) 114
Table L2.6.5-4 Recommended Siphon Configurations for Alternate Design Flow Rates 116
Table L2.6.6-1 Recommended Channel Design Sections 119

Table L2.6.6-2	Freeboard Summary	120
Table L2.6.6-3	Culvert Data at Transportation Crossings	122
Table L2.6.6-4	Proposed Culvert Sizes at Transportation Crossings	122
Table L2.7.2-1	Standard Statistics for Stage	126
Table L2.7.2-2	Stage vs. Percent Exceedance	126
Table L2.7.2-3	Summary Stage Statistical Values	127
Table L2.7.3-1	Hydraulic Grade Line Data for Alternatives 4A and 4B	130
Table L2.7.7-1	Recommended Channel Design Sections	135
Table L2.7.7-2	Freeboard Data	135
Table L2.7.7-3	Transportation Crossing Data	137
Table L2.7.7-4	Proposed Culvert Sizes	137
Table L2.7.8-1	Recommended Channel Design Sections	140
Table L2.7.8-2	Transportation Crossing Data	141
Table L2.7.8-3	Proposed Culvert Sizes	142
Table L2.8.2-1	Structure Summary Table	145
Table L2.8.3-1	Field Survey of Bridges along HWY 61 and Culvert along I-10	149
Table L2.9.1-1	Downstream Gage Summary	151
Table L2.9.1-2	Observed Water Surface Elevation Statistics	152
Table L2.9.2-1	Summary of Estimated Total Sea Level Rise for 50-Year Project Life	159
Table L2.10.1-1	Alternative 2 HEC-RAS Net Freshwater Throughput Volumes	167
Table L2.10.1-2	Alternative 2 HEC-RAS Backflow Volumes	164
Table L2.10.1-3	Alternative 2 EFDC Summary Results	167
Table L2.10.1-4	Average Concentration in Each HRU and Overall Removal Efficiency of TP, TN, and Nitrate	172
Table L2.10.1-5	Alternative 2 EFDC Flow Velocity with Sea Level Rise	174
Table L2.10.1-6	Alternative 2 EFDC Hydraulic Residence Time with Sea Level Rise	175
Table L2.10.1-7	Alternative 2 EFDC Sediment Transport Summary with Sea Level Rise	176
Table L2.10.1-8	Summary of Average Water Depth and Backflow Prevention (No Sea Level Rise) for Existing Conditions and Alternative 2	177
Table 2.10.1-9	Summary of Average Dry-Out Frequency (No Sea Level Rise) for Existing Conditions and Alternative 2	180
Table L2.10.2-1	Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 4	186
Table L2.10.3-1	Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 4B	191
Table L2.10.4-1	Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 6	195
Table L5.4-1	Test Borings Information	217
Table L12.2.3-1	Expected Blind River Diversion Operating Setpoints	267
Table L13.2-1	Estimates for Components Sized for the Diversion Flow Rate	274
Table L13.2-2	Estimates for Water Distribution and Water Management Elements	275
Table L13.2-3	Construction Costs for Final Array of Alternative Plans	276
Table L13.4-1	Project First Costs	277
Table L13.5-1	Diversion Alternative O&M Opinion of estimated costs	278
Table L13.6-1	Total Project Costs	278
Table L16.1-1	Underground Utilities and Pipelines	304
Table L16.1-2	Overhead Utilities	306

L1 SUMMARY

L1.1 Project Scope and Objectives

The Blind River Fresh water diversion Project is to divert water from the Mississippi river for a distance of approximately 3 miles to the St. James Parish drainage system that will be modified to allow the diverted flows to provide freshwater, nutrients and sediment to the Maurepas swamp. The project area is approximately 35 square miles and extends from the St. James Parish drainage system which is north and parallel to LA 3125 to Interstate 10 on the north. The Blind river flows east and then north through the project area.

The engineering components to complete the project include:

- Intake structure with screens on the bank of the Mississippi river
- Culverts with motor operated sluice gates through the flood control levee and under LA 44
- Earthen diversion channel from north of LA 44 to the St. James Parish Drainage System.
- Relocation and reconstruction of the Canadian National Railroad and LA 1325 to cross the transmission channel
- Swamp modifications to include gapping existing berms to allow distribution of flow through the swamp
- St. James parish channel modifications to distribute flows and to restrict flow from short circuiting directly to the Blind River
- Control structures to allow distribution options within the St. James drainage system

The overall objective of the Small Diversion at Convent/Blind River Project was to reverse the trend of deterioration of southeast Maurepas Swamp and Blind River.

Specific Project Objectives

- **Objective 1: Promote water distribution in the swamp**

  Target for Objective 1: Increase the area of freshwater inundation for low to average flood events by 10 to 25% from existing conditions to increase swamp productivity and wetland assimilation. Increase nutrient input to the swamp to increase swamp productivity as measured by a 5 to 10% annual increase in the diameter at breast height (dbh) of bald cypress and tupelo from existing conditions, and increase wetland assimilation as measured by a 10 to 25% decrease in the average TN and TP in Blind River and a 5 to 10% increase in the average dissolved oxygen in Blind River from existing conditions.

- **Objective 2: Facilitate swamp building** at a rate greater than swamp loss due to subsidence and sea level rise.

  Target for Objective 2: Increase swamp productivity, as described above and by increasing sediment input by up to 1,000 grams per square meter per year in order to decrease the annual subsidence rate 50 to 100% in the swamp.

- **Objective 3: Establish hydroperiod fluctuation in the swamp** to improve bald cypress and tupelo productivity and their seeding germination and survival.

  Target for Objective 3: Decrease flood duration in the swamp by 10 to 25% for high flood events, increasing the length of dry periods in the swamp (no standing water) by 10 to 25%, and by increasing the number of bald cypress and tupelo saplings per acre by 25 to 50% from existing conditions.

- **Objective 4: Improve fish and wildlife habitat in the swamp and in Blind River**

  Target for Objective 4: Increase the existing Wetland Value Assessment (WVA) Habitat Suitability Index (HSI) in the swamp by 10 to 25% five years after project implementation and by a 5 to 10% increase in the average dissolved oxygen in Blind River from existing conditions.

L1.2 Alternatives Analyzed

There were 5 major alternatives analyzed after screening down from an initial array of 15 alternatives. The final array of alternatives is described as follows:

- No Action (required to establish baseline conditions and the need for a diversion)
- Alternative 2 – 3000 cfs Diversion at Romeville (Gated Culvert System)
- Alternative 4 – 3000 cfs Diversion at South Bridge (Gated Culvert System)
- Alternative 4B – 3000 cfs Diversion at South Bridge with split flows (Gated Culvert System)
- Alternative 6 – Two 1500 cfs Diversions at Romeville and South Bridge (Siphons)

L1.3 Analysis Approach

The approach to the analysis was to focus on the project objectives and to develop a system to analyze the diversion flow quantity, quality and distribution to determine the effects on the swamp. The analysis involved analyzing existing conditions and then applying the alternatives at various flow rates to determine the effectiveness of each alternative at specific flow rates.

After the first round of analysis it was determined that the most cost effective flows for final analysis was approximately 3000 cfs. The Tentatively Selected Plan (TSP) is based on the 3000 cubic feet per second flow rate.

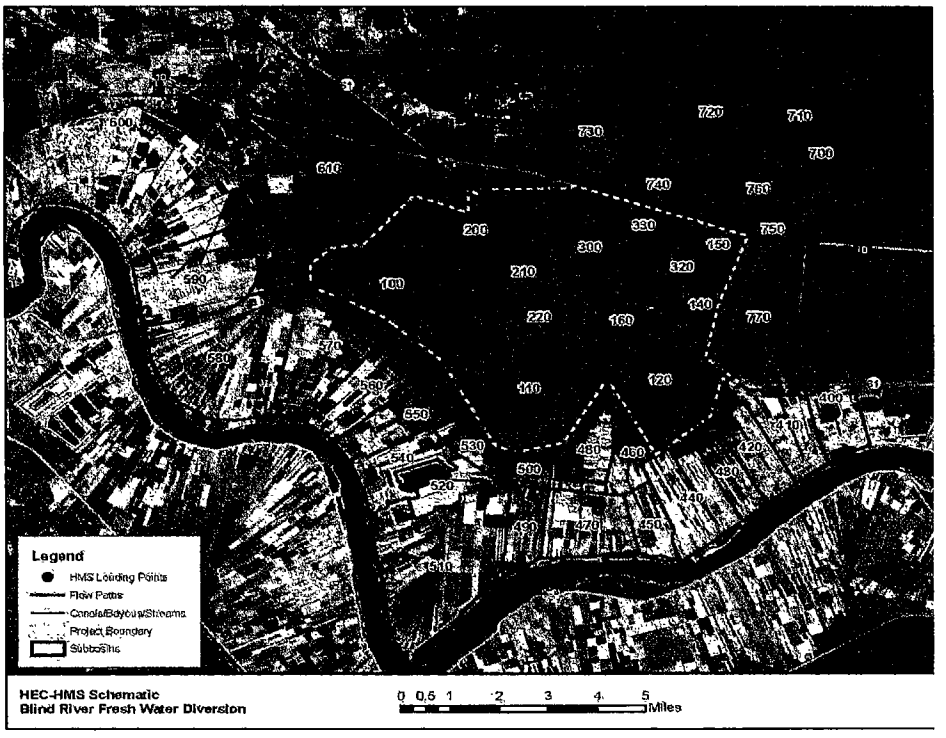
The alternatives in the final array were compared based on benefits, costs, and impacts. Alternative 2 is the least expensive with a first cost of about $102 million. Alternative 6 is the most expensive at over $155 million. Alternatives 4 and 4B are slightly less expensive than Alternative 6 at $152.2 million and $146.9 million, respectively.

Although Alternative 6 provides the greatest number of environmental benefits in terms of AAHUs estimated using the WVA process. Alternative 2 provides over 90% of the benefits for about 67% of the cost of Alternative 6. The cost per AAHU is much lower for Alternative 2 that for the other three alternatives and the incremental cost per habitat unit in going from Alternative 2 to Alternative 4B and/or Alternative 6 is quite high. Another factor to consider is that Alternative 2 impacts the smallest number of wetland acres. Accordingly, Alternative 2 is the alternative that reasonably maximizes ecosystem restoration benefits compared to costs and is designated as the National Ecosystem Restoration Plan and the Tentatively Selected Plan.

L1.4 Analysis Results

The results of the analysis yielded flow volumes that are distributed through specific hydrologic areas of the swamp. The following sections contain the results by each of the hydrographic areas shown in **Figure L1.4-1.**

Figure L1.4.1 Hydrographic Units



L2 HYDROLOGY, HYDRAULICS, AND WATER QUALITY

L2.1 Introduction

The objective of the Convent/Blind River Small Diversion project is to introduce freshwater, sediment, and nutrients from the Mississippi River into the southeast portion of the Maurepas swamp to improve biological productivity that will facilitate organic deposition in the swamp, and prevent further deterioration. In order to determine the most feasible solution to meeting the above objective, the existing hydrologic, hydraulic, and water quality characteristics have been compared to proposed future conditions (alternatives evaluation). To complete this task, CDM has applied the following tools:

- *Hydrologic Engineering Center River Analysis System (HEC-RAS)* – A dynamic hydraulic model used to calculate flow routing through the drainage canals and swamp storage within the study area. The HEC models work in tandem with HEC-HMS providing flow inputs to HEC-RAS, which simulates dynamic flow and storage through the study area. Results from HEC-RAS were utilized in a variety of ways to support the project analyses, including evaluation of swamp hydroperiod, evaluation of potential project improvements, and confirmation that the project will not adversely impact flooding outside of the project boundary.
- *Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS)* – A model used to quantify surface water hydrology for the project area and tributary watershed by simulating and calculating the rainfall-runoff process. From a systems perspective, the watershed runoff process is a portion of the hydrologic cycle, and the primary focus for quantifying water that flows through elements of the study area such as drainage canals and stream channels.
- *Environmental Fluid Dynamics Code (EFDC)* – A two dimensional (2D) hydrodynamic and water quality model used to analyze the effects of the freshwater diversion to the Blind River and associated wetlands with consideration of nutrients.
- *Engineering Calculations* – A set of standard engineering equations for daily runoff estimation and water balance was developed for evaluating long-term conditions in a networked system. The engineering calculations were further used as a supplemental way of cross checking of the HEC models by reproducing similar trends for runoff and water level dynamics using independent techniques and reasonable parameterization.

These analyses were used to evaluate different levels of detail to support feasibility and design level decisions as well as allow for quality management checking and evaluation of different flow rate capacities, diversion locations, and operational scenarios. The following eleven subsections are included in support of the hydrologic, hydraulic, and water quality evaluations performed for existing conditions as well as future project alternative conditions:

- Model Study Methodologies (Section L2.2);

- Watershed Hydrology and Hydraulics Analysis (Section L2.3);
- Swamp Hydroperiod Analysis (Section L2.4);
- Hydrodynamic and Water Quality Analysis (Section L2.5);
- Hydraulic Analysis of Romeville Diversion and Transmission Components (Section L2.6);
- Hydraulic Analysis of South Bridge Diversion and Transmission Components (Section L2.7);
- Swamp Distribution System Analysis (Section L2.8);
- Swamp Flow Outlet Control Analysis (Section L2.9);
- Project Alternative Analysis (Section L2.10); and
- Hydrologic Uncertainties (Section L2.11).

L2.2 Model Study Methodologies

The following subsections describe the methodologies used in developing the project-specific tools (HEC-HMS, HEC-RAS, EFDC, and Engineering Calculations) used to evaluate existing conditions and future project alternative conditions in support of the Convent/Blind River Small Diversion project.

L2.2.1 HEC-HMS

Hydrologic analysis was completed for the project using the USACE Hydrologic Modeling System Version 3.3 (HEC-HMS). HEC-HMS quantifies surface water hydrology for the project area and tributary watershed by simulating and calculating the rainfall-runoff process resulting from user defined precipitation input. From a systems perspective, the watershed runoff process is a portion of the hydrologic cycle, and the primary focus for quantifying water that flows through elements of the study area such as drainage canals and stream channels.

The use of HEC-HMS to simulate surface water runoff was paired with the USACE River Analysis System (HEC-RAS) software, a one-dimensional hydraulic model. Results from the HEC-HMS model were used to generate the inflow to the HEC-RAS model, which was used to calculate flow routing through the drainage canals and swamp storage within the study area. The models represent approximately 165 square miles of tributary area and include the Blind River from its headwaters to approximately four miles downstream of I-10 near the confluence of the Blind River and Amite River. The models also represent a complex network of drainage canals and stream reaches that include the St James Parish canals (e.g., St. James Parish Canal, East St. James Parish Canal, Lateral 4 Canal, Latitude 3D Canal, Old New River, Canals parallel to US-61, Bayou Fusil, Romeville Canal, Bayou Des Acadie, and Pipeline Canals), and Ascension Parish canals (Conway Canal, and Canal Parallel to US-61). The HEC-HMS model schematic is presented on **Figure L2.2.1-1**.

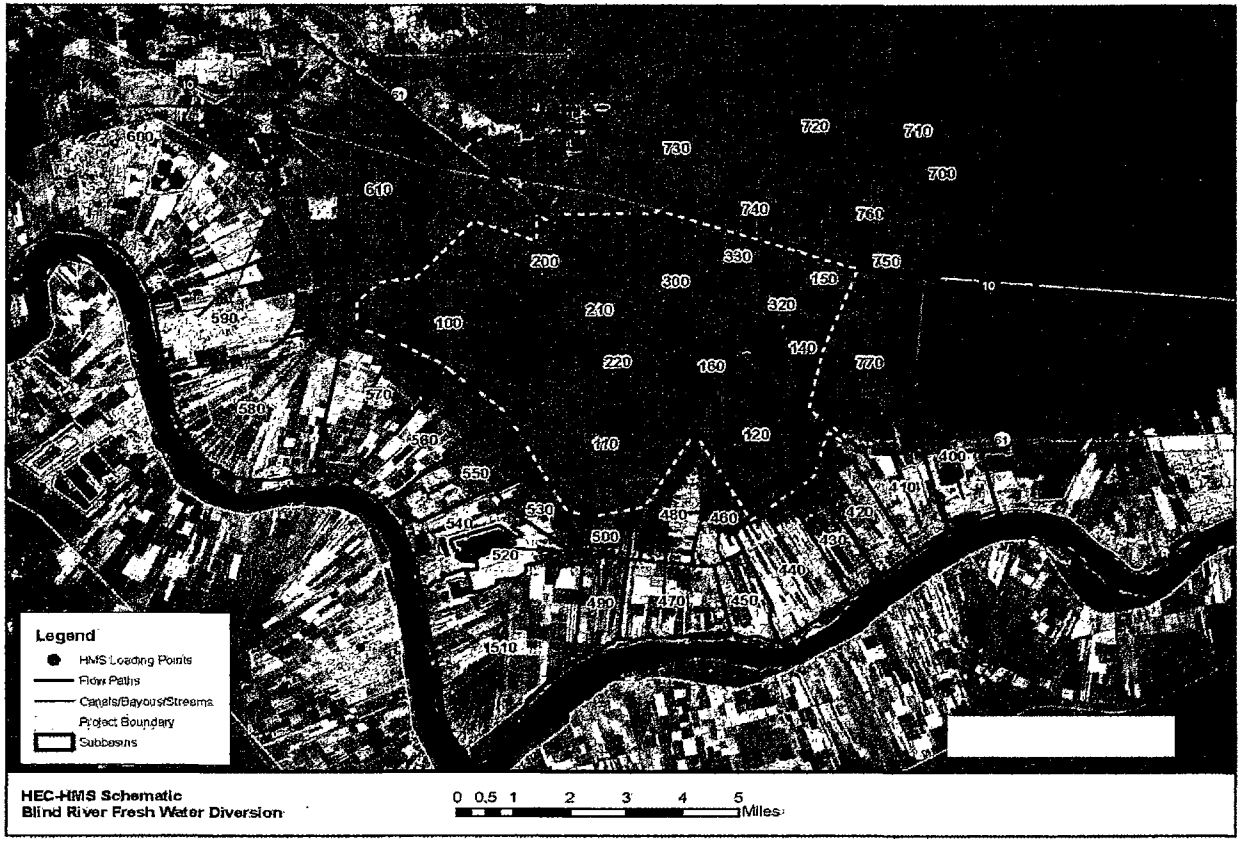


Figure L2.2.1-1 HEC-HMS Model Schematic

HEC-HMS was used to perform design storm simulations, and to perform continuous simulations throughout the representative year 2003 to analyze flows to the study area in dry as well as wet periods. Model parameters and supporting data sources are discussed in more detail in Section L2.3.4. Fundamental methodologies to develop the HEC-HMS model are summarized below in **Table L2.2.1-1**.

Table L2.2.1-1 HEC-HMS Attribute Methodology

Hydrologic Attribute	Applied Method
Runoff Method	Composite Soil Conservation Service (SCS) Runoff Curve Numbers
Land Use	Anderson land use/land cover classification system with simplification into seven representative categories
Soils	Soil types were grouped into hydrologic soil groups per the Natural Resource Conservation Service (NRCS)
Runoff Characteristics	Curve Number values range from 79 to 96, which represent both impervious land cover and pervious cover with applicable soil characteristics
Time of Concentration	Time of Concentration and the corresponding Lag Time were calculated based on flow lengths and average slopes in each subbasin
Unit Hydrograph	SCS Unit Hydrograph
Flood Routing	Routing was not performed in HEC-HMS. Flood routing was accounted for in the HEC-RAS hydraulic model.

L2.2.2 HEC-RAS

The USACE HEC-RAS software version 4.0 was used to simulate hydraulic performance in the study area. HEC-RAS is a one-dimensional hydraulic model and was applied in unsteady flow mode, which is well suited to represent the open channel dynamics of the canal network and storage characteristics of the swamp (**Table L2.2.2-1**). Existing topographic and bathymetric data were used in combination with available engineering plans to define channel cross-sections, roadway culverts, and surface storage areas. Stage-storage relationships were defined for surface storage areas to account for storage volume and flow attenuation in the study area. Standard engineering references, field photos, and aerial photography were utilized to input Manning's roughness and loss coefficient values in the HEC-RAS model. The existing condition of the study area includes culverts under US 61 and I-10 as per field observations and available engineering survey. HEC-RAS was also used to represent the influence of potential project improvements, such as various berm gaps and control structures.

The unsteady flow HEC-RAS input file was developed from the HEC-HMS model output. The flow hydrographs information from HEC-HMS stored in HEC Data Storage System (DSS) file was loaded at the appropriate locations along the Blind River and interior drainage canals and bayous. **Figure L2.2.2-1** shows a schematic of the intricate network of streams in the study area, and respective model features in HEC-RAS.

Table L2.2.2-1 HEC-RAS Attribute Methodology

Hydraulic Attribute	Feature Overview
Channel Cross-Sections	HEC-RAS supports irregular cross-sections and represents channel roughness using Manning's n coefficients
Culverts and Bridges	Federal Highway Administration (FHWA) methodology for computing losses through bridges and culverts
Loops and Flow Splits	Unsteady flow capability of HEC-RAS supports flow splits and network loops, both of which are present in the study area
Surface Storage	Storage-Area-Elevation (SAE) curves define storage volume in the portions of the system where water is stored but does not exhibit channel flow
Evaporation	Evaporation from the large surface storage areas in the swamp was represented as a flow time series computed and applied to each storage area based on available pan evaporation data
Canal to Surface Storage Flow Exchange	Lateral weirs defined based on available topographic data were used to allow for flow exchange between drainage canals and adjacent swamp areas
Surface Storage to Surface Storage Exchange	HEC-RAS storage area connections were included to facilitate flow exchange between adjacent surface storage areas
Downstream Boundary Condition	Water elevations observed at Lake Maurepas were used to define the downstream boundary condition of the model

L2.2.3 EFDC

Hydrodynamic and water quality analysis were completed for the project using the Environmental Fluid Dynamics Code (EFDC), which is a US EPA-sponsored public domain model. The EFDC is a general-purpose modeling package for simulating three-dimensional (3-D) flow, transport, and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and near-shore to shelf-scale coastal regions. In addition to hydrodynamic and salinity and temperature transport simulation capabilities, EFDC is also capable of simulating cohesive and non-cohesive sediment transport, near-field and far-field discharge dilution from multiple sources, the transport and fate of toxic contaminants in the water and sediment phases, and the dissolved oxygen, algae and nutrient process (i.e., eutrophication). Special enhancements to the hydrodynamics of the code, including vegetation resistance, drying and wetting, hydraulic structure representation, wave-current boundary layer interaction, and wave-induced currents, allow refined modeling of wetland and marsh systems, controlled-flow systems, and near-shore wave-induced currents and sediment transport. More information regarding the EFDC model can be found at the US EPA website.

The primary use of the EFDC model for the project was to quantify the water depth and elevation, hydraulic residence time (HRT), sedimentation and erosion, and water quality for various hydrologic response units (HRUs) with a relatively high resolution.

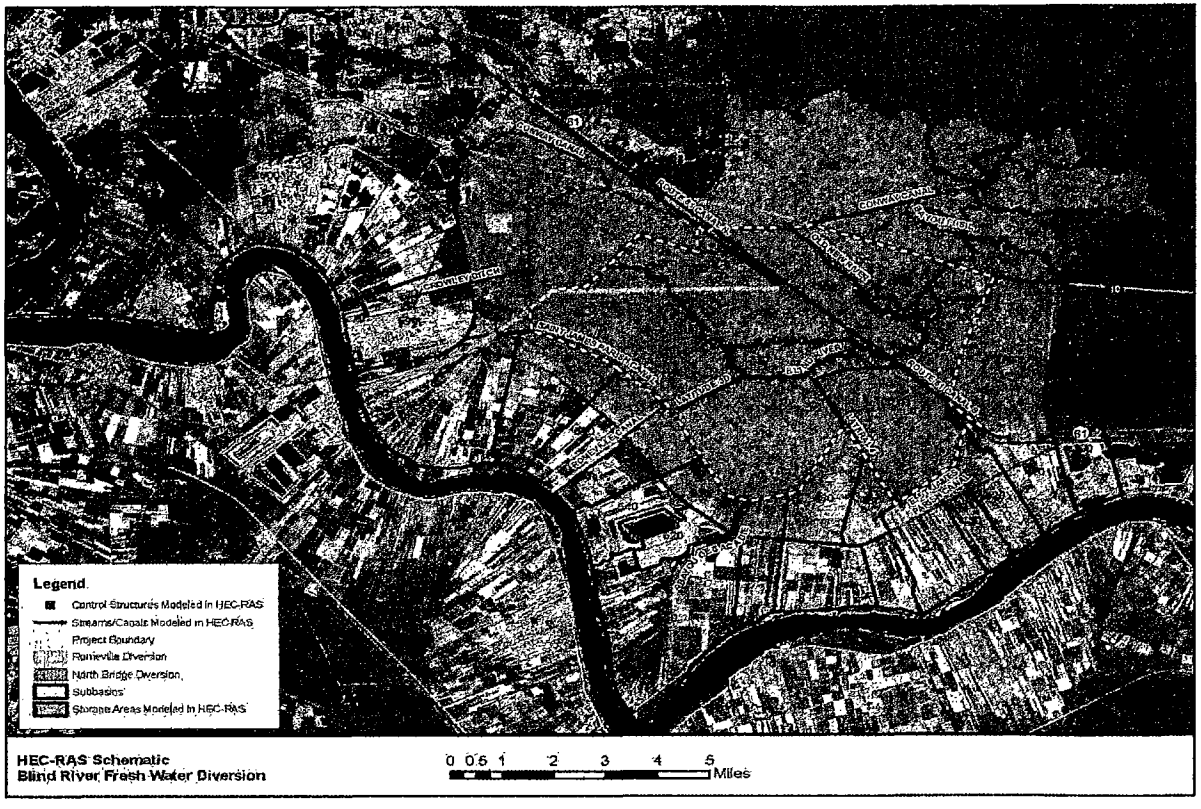


Figure L2.2.2-1 HEC-RAS Model Schematic

1213

It is essential to design a model grid that has a proper spatial resolution to represent key hydrodynamic, sediment, and water quality processes for the feasibility study. At the same time, the model grid should be computationally efficient so that one-year simulation can be accomplished within a reasonable CPU time (i.e., <24 hour CPU time). This would allow various project alternatives to be analyzed in a timely manner. This issue impacted the selection of the grid resolution due to computational issues and modeling productivity.

The project area is located about 43 miles northwest of New Orleans, between west of I-10 and St. James, Louisiana. Historically, without the Mississippi River levees, the flood water propagated toward the east into the Lakes Maurepas and Pontchartrain via the Blind River and the low-lying flat topography in the area during the periods of high Mississippi river flow conditions.

To drain the Maurepas Swamp, various man-made channels/canals were constructed in the area during the past several decades. **Figure L2.2.3-1** shows the location of the project area and major canals, such as St. James Parish and Conway Canals along the project boundary.

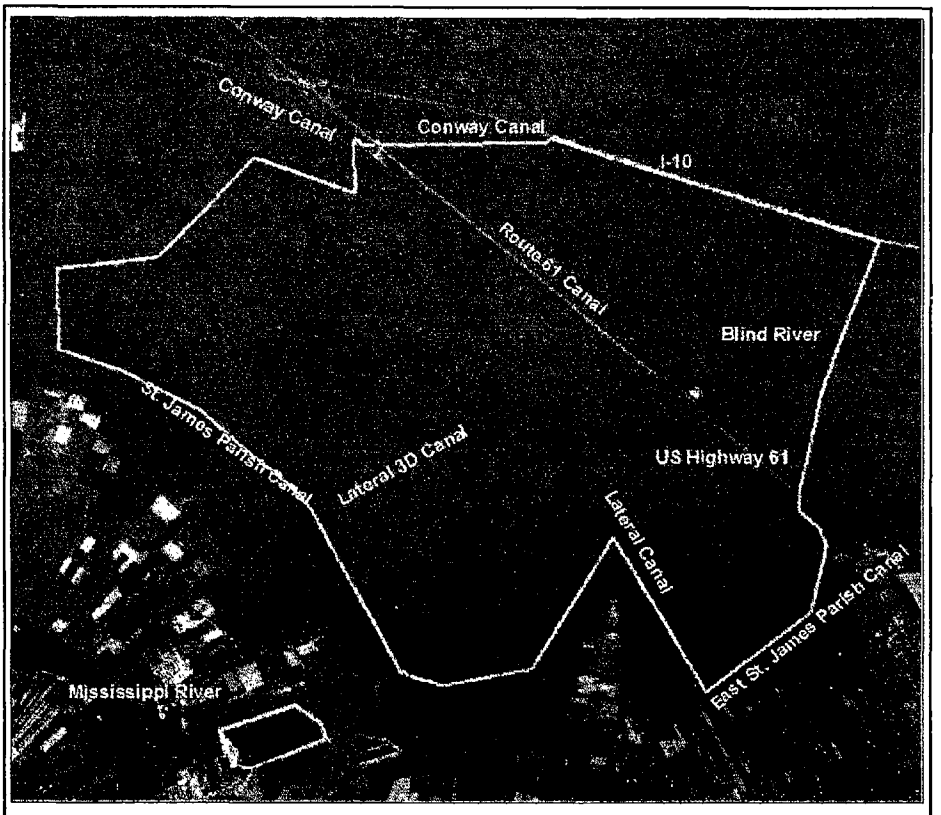
One of the physical characteristics of the project area is the low-lying flat topography. **Figure L2.2.3-2** shows the topographical variations based on the previous LiDAR survey data in the area. In general, the land area is higher in the south and west and lower in north with a typical variation range of 1 ft.

Wetland flow is typically dominated by both the topography and vegetation resistance. To accurately represent the variations of the topography and vegetation resistance as much as possible without sacrificing model computational efficiency, a cell size of 39,701 square meters or 427,323 square feet was selected such that a total of 2,345 model cells are included in the 35 square miles project area.

To easily reconfigure the model to various alternative project conditions, a Cartesian coordinate system was used to develop the model grid. A constant square cell size, that is, 199.25 m x 199.25 m or 653.70 ft x 653.70 ft was used throughout the system. The model grid system that covers the study area including the Blind River is shown on **Figure L2.2.3-3**.

Because the existing canals and Blind River are deeper and narrower than the wetland cells, a subgrid channel approach, with channel grid cells embedded in the wetland cells, was initially considered. However, several early model test runs showed that with the subgrid channel, the model became very unstable and the computational time step had to be significantly reduced to less than one second.

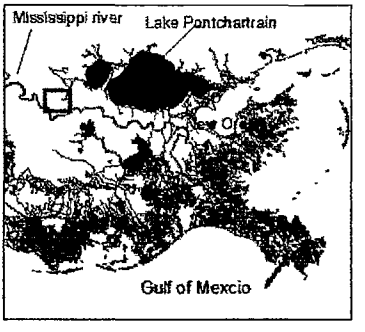
The subgrid channel approach was not used since: 1) this is a feasibility study project; 2) several dozen model simulations with different model configurations for different purposes were needed through the project cycle; and (3) the project schedule meant model running efficiency was extremely critical.



Legend

Project Boundary

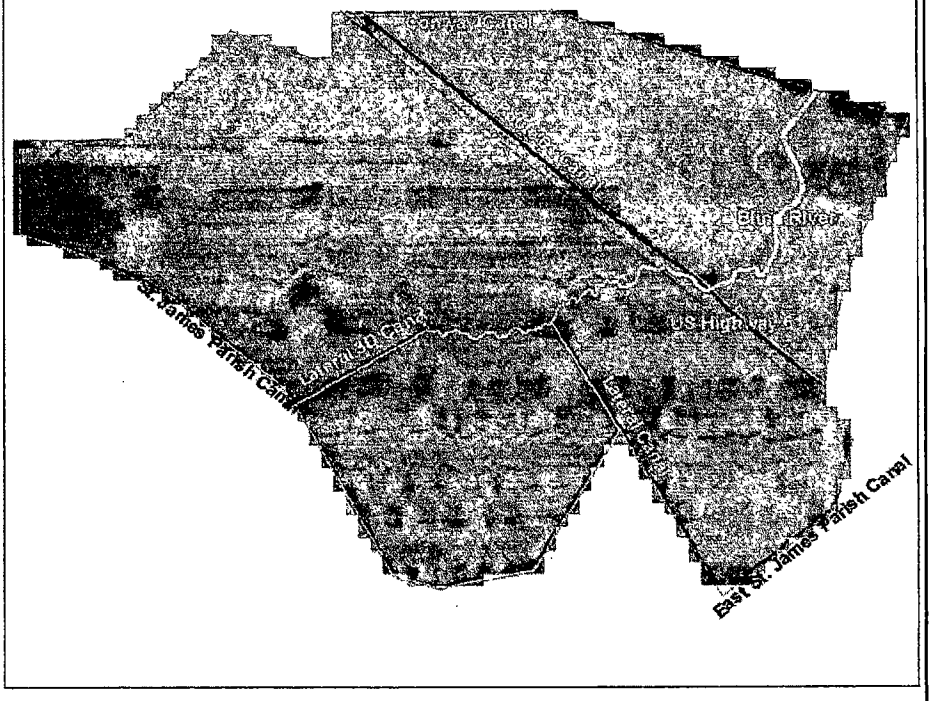
0 0.3 0.6 1.2 Miles



Blind River Freshwater Diversion Feability Study

Project Area and Boundary

Figure L2.2.3-1



Legend

Project Boundary

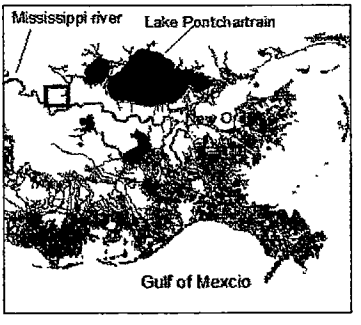
DEM (ft, NAVD88)

Value

High : 24.9788

Low : -20.8009

0 0.25 0.5 1 Miles



Blind River Freshwater Diversion Feability Study

Topography of the Project Area

Figure L2.2.3-2

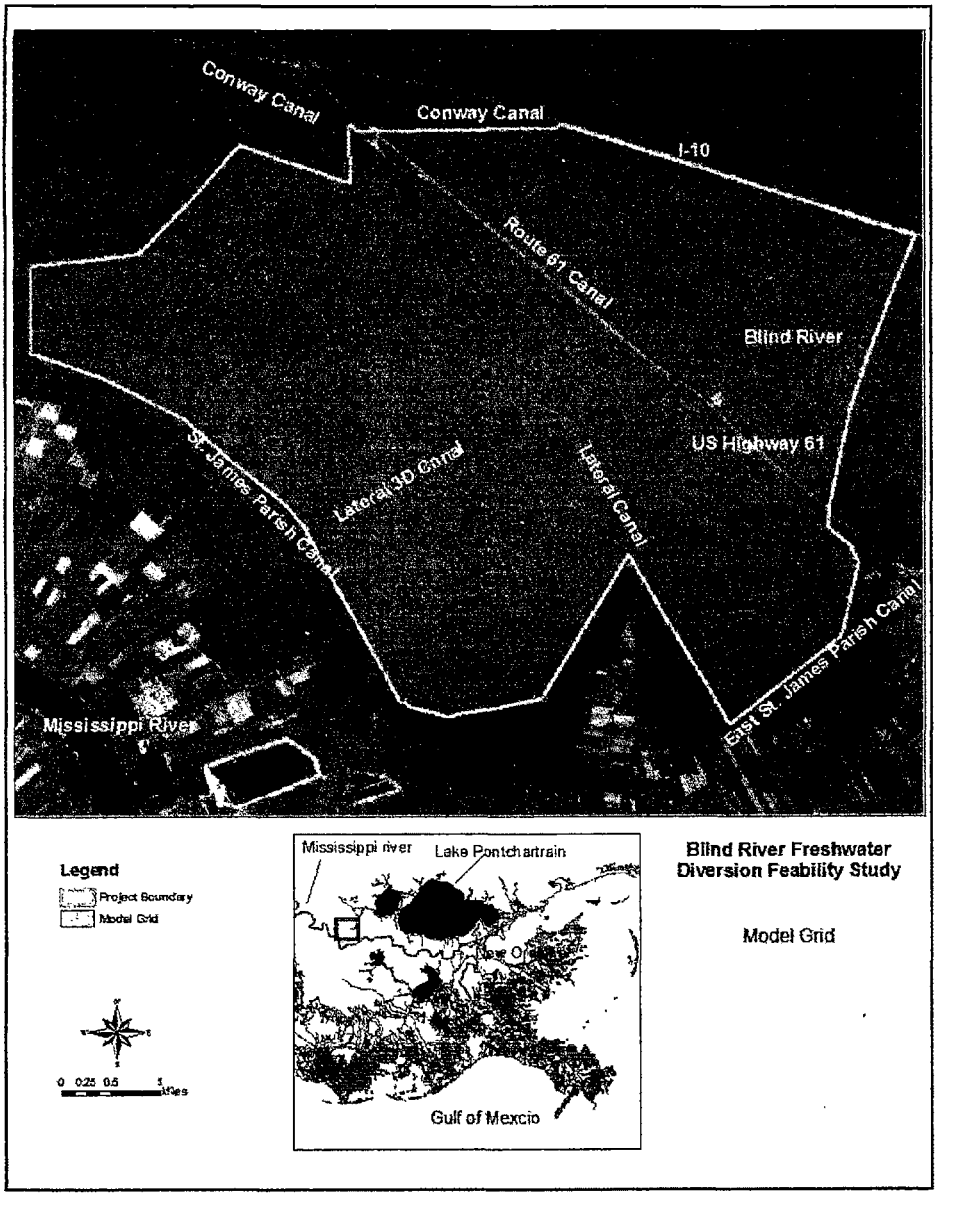


Figure L2.2.3-3 EFDC Model Grid

Instead, an equivalent channel approach was used to represent the existing canals and Blind River in the model.

The transformation of the existing canals and the Blind River into the equivalent channel is illustrated on **Figure L2.2.3-4**.

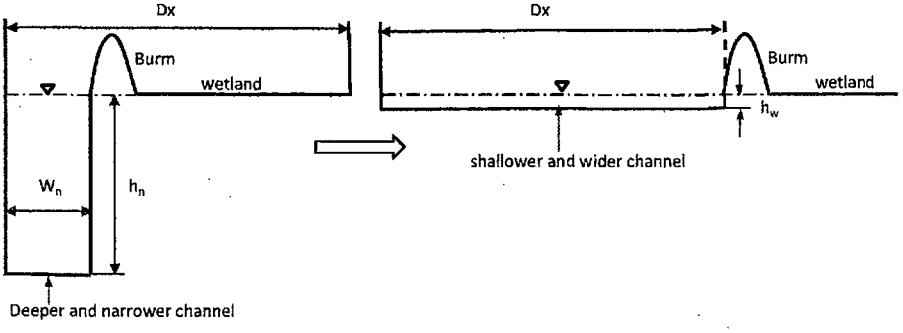


Figure L2.2.3-4 Schematic of the Existing Canals/Blind River and Equivalent Channel

For the equivalent channel, the flow conveyance capacity should match the capacity of the narrower but deeper channel when the channel water level is at the wetland elevation, that is,

$Q_n=Q_w$ (1)

where Q_n = the flow in the narrower channel (cfs);

Q_w = the flow in the wider channel (cfs); and

Subscript n stands for the narrower channel and w stands for the wider channel.

To calculate channel flow, the Manning Equation was used:

$$Q=VA= K/n * (A/P)^{2/3} * S^{1/2} * A \quad (2)$$

where k = 1.49;

A = flow cross-sectional area (ft^2);

P = wetted perimeter (ft);

S = bottom slope (ft/ft); and

n = Manning roughness coefficient.

Combining Equations (1) and (2) gives:

$$K/n_n*(A_n/P_n)^{2/3} *S_n^{1/2} *A_n = K/n_w * (A_w/P_w)^{2/3} * S_w^{1/2} * A_w \quad (3)$$

Let the equivalent flow cross-sectional area be the same as the existing channel, that is

$$W_n * h_n = Dx * h_w \quad (4)$$

where W_n = canal or Blind River width (ft);

h_n = depth relative to the adjacent wetland cell (ft);

Dx = model cell width, that is 653.70 ft; and

h_w = equivalent channel depth (ft).

Rearranging Equation (4) yields

$$h_w = W_n * h_n / Dx \quad (5)$$

Combining Equation (3) and (4) results in

$$n_w = n_n * (W_n + 2h_n)^{2/3} / (Dx + 2h_w)^{2/3} \quad (6)$$

Equations (5) and (6) were used to calculate the channel bottom elevation relative to the adjacent wetland cell and roughness, respectively, for the new wider and shallower channel.

Thus, the equivalent channel approach yields the same flow conveyance capacity and velocity in the equivalent channel wetland cells as in the existing canals/Blind River. However, one drawback of this approach is that simulated sediment deposition in the equivalent channel wetland cells will exceed expected sedimentation in the existing canals and Blind River because the equivalent settling depth is less than the actual channel or river depth.

Hydraulic flow barriers were used to represent the berms along the existing canals. Flow control structures represented with the head difference flow rating tables, which were derived from the HRC-RAS model simulation results, were used for various sizes of the existing berm gaps and proposed berm gaps in the following model simulations.

L2.2.4 Engineering Calculations

L2.2.4.1 Purpose

A set of standard engineering equations for runoff estimation and water balance in a networked system was developed for three purposes:

- Because of a lack of hydrologic data throughout the swamp and Blind River system, the HEC-HMS and HEC-RAS models could not be truly calibrated to historical data. They were programmed with the best available information and parameterized with professional judgment and knowledge of the hydrologic flashiness of contributing watersheds and tendencies toward stagnation within the swamp areas. In lieu of direct calibration of the HEC models, the engineering equations were used as a supplemental way of cross

checking of the HEC models by reproducing similar trends for runoff and water level dynamics using independent techniques and reasonable parameterization.

- Because the dynamic HEC-RAS model represents a complex, highly-linked network of canals and storage areas, each 1-year model run takes a very long time to execute. The HEC-RAS analysis focused on the year 2003, which represents average hydrologic conditions and for which daily lake level data for Lake Maurepas are available (an important boundary condition due to backwater effects throughout the swamp). Therefore, to enhance the breadth of conditions over which the alternatives were analyzed, the engineering calculations were used to evaluate daily water balance throughout the swamp for the period 1989 – 2004. This period represents the time for which all necessary input data were available, including precipitation and water levels in Lake Maurepas. The calculations were used to extend the period of record once the results for 2003 were shown to agree well with the dynamic trends for swamp filling and drawdown as represented in the HEC-RAS model.
- Fundamentally, the use of simple standard equations that replicate the general trends and patterns of more complex numerical models can help improve understanding of complex networks by focusing on key response patterns using familiar terms and expressions.

Most of the key hydrologic metrics, such as flow through the swamp and prevention of saline backflow from Lake Maurepas, were derived for the alternatives analysis directly from the HEC-RAS model. The engineering calculations were used to supplement that key hydrologic information with more general metrics such as:

- Average water elevation over the fuller time period;
- The potential for the swamp to experience periodic dry conditions that may be conducive to cypress germination and sapling survival; and
- Average annual sediment load into the swamp from the Mississippi River.

Lastly, the engineering calculations were used to develop time series of diversion flows for 2003 that were subsequently used by the HEC-RAS model. These were based on the simple equations and constraints presented below. By conditioning the diversions on the relativity between water levels in the swamp and water levels in the lake, the HEC-RAS analysis was able to avoid continuous diversions, and simulate a diversion schedule more likely to provide water only when it is most needed.

2.2.4.2 System Representation

To help identify the inflows and outflows comprising the water balance throughout the study area, the basic network diagram shown on **Figure L2.2.4-1** was developed as a guide. Some of the benefit areas were consolidated to simplify the water balance estimates in areas where internal topography was uncertain. The diagram essentially illustrates the flow pathways into and out of each swamp area via their connectivity to adjoining canals. The circled letters at the boundaries represent the introduction of natural watershed runoff into the system. At the outlet of the system, Lake Maurepas acts as a stage boundary condition that limits the passage of water out of the swamp under conditions described in the following sections.

2.2.4.3 Hydrologic Calculations

To provide an independent estimate of the hydrologic rainfall-runoff relationships in the HEC-HMS model, a simple set of equations for daily runoff and hydrograph recession was developed for each point of natural system inflow illustrated in the figure above. The equations represented each contributing subwatershed as a storage unit, and outflow from the watersheds as inflow to the study area (the watershed storage is simply a means to compute runoff into the swamp, in which storage areas are represented separately). Daily NOAA precipitation from station 2534 (Donaldsonville 4SW) was input to watershed storage, and a constant fraction of each daily rainfall amount was removed as the overall loss (representing watershed evaporation and seepage to groundwater). Hydrograph recession was accomplished by allowing water to accumulate in the watershed, and removing each day a constant fraction of the total accumulated storage. In this way, the effects of precipitation could be spread over multiple days, the slope of the recession curve could be tuned, and the long-term runoff volumes could be maintained.

Mathematically, the equations were expressed as follows, where t represents a daily index:

$$Loss_t = X(Precip_t) \qquad \{0 \le X \le 1:\ X \text{ is a constant fraction of precipitation}\}$$

$$Storage_t = Storage_{t-1} + Precip_t - Loss_t - Streamflow_t$$

$$Streamflow_t = C(Storage_{t-1}) \qquad \{0 \le C \le 1:\ C \text{ is a constant fraction of accumulated storage}\}$$

Watershed storage was also limited to an upper limit, which, if exceeded on any day, resulted in extra runoff equivalent to the precipitation (less the loss) for that particular day. However, this was fairly arbitrary, and did not appear to have a substantial impact on the calculations.

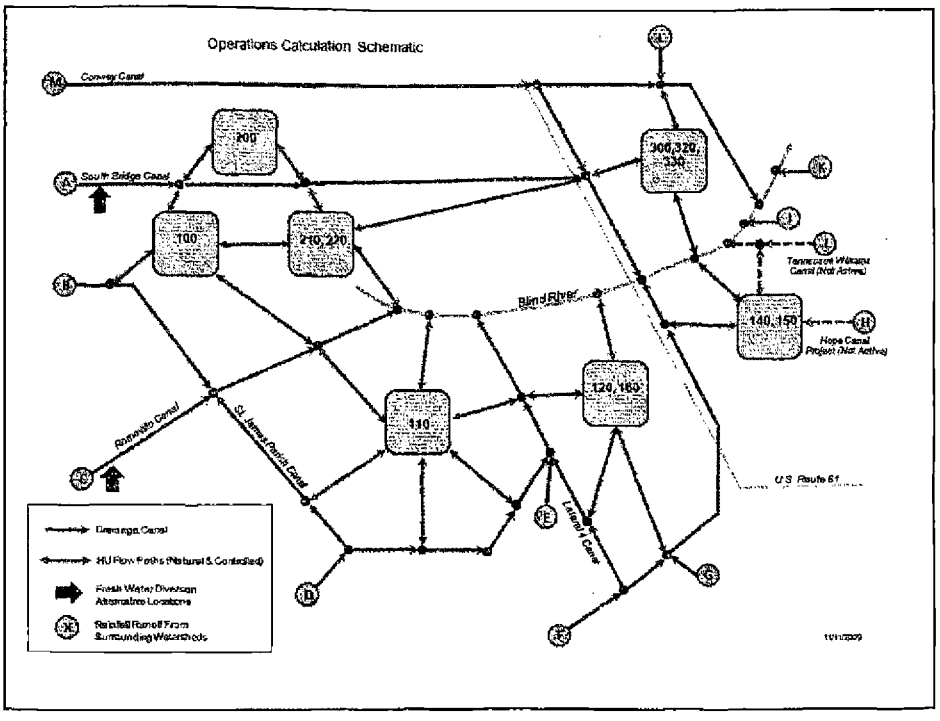


Figure L2.2.4-1 Functional Diagram for Water Balance Calculations

*Dashed lines illustrate flows that are boundary inflow from other project models

Figure L2.2.4-2 illustrates the basic structure of the equations:

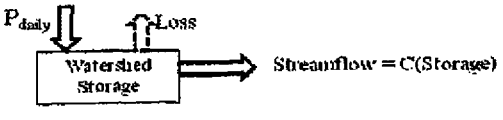


Figure L2.2.4-2 Basic Rainfall-Runoff Representation

Hence, three parameters were used for each watershed to simulate rainfall-runoff relationships and generate independent estimates which were compared with HEC-HMS. The parameters were tuned to match HEC-HMS results and then evaluated for the efficacy and hydrologic validity of final values, based on knowledge of the hydrologic flashiness of the canals and overall low permeability of the contributing subwatersheds. The value of X was tuned to match long-term runoff volumes from HEC-HMS, and the value of C was tuned to match the slope of the hydrograph recession.

2.2.4.4 Operational Calculations

As noted above, the runoff was computed as an input to the study area (upstream contributing watersheds to the canals flowing into and through the study area). A separate set of equations was developed to compute water balance for each benefit area (consolidated as shown above) on a daily timestep. These equations were matched to the hydrographs produced by HEC-RAS to test the overall validity of the swamp representation, and to subsequently extend the hydraulic analysis over the longer period of record.

The water balance for each of the seven consolidated benefit areas was calculated with the standard storage equation (where t represents a daily time index):

$$Storage_t = Storage_{t-1} + \sum Inflow_t - \sum Outflow_t$$

$$Where: \sum Inflows = Direct\ Precip + Inflow\ from\ Canals$$

$$\sum Outflows = Evaporation + Outflow\ to\ Canals$$

Resulting storage was converted into water stage (averaged across each individual benefit area) and water surface area using available topographic data. Direct daily precipitation was computed from the same gage as the data used for the runoff calculations leading into the study area (NOAA station 2534). Daily evaporation data were collected from NOAA station 5620 (LSU Ben-Hur Farm). The data were multiplied by a pan coefficient of 0.77 per guidance in *Evaporation Maps for the United States, Technical Paper No. 37, US Weather Bureau, 1959.* Inflows and outflows from the swamp areas from/to the canals, as well as diversions from the Mississippi River into the canal system, were computed with the following Boolean logic relationships:

- Mississippi River Diversions
- Diversions occur when the average water stage in the swamp (averaged over the seven benefit areas) is less than the water level in Lake Maurepas. The rationale is to try to prevent backflow by removing or reducing the negative (reverse) head potential caused when the lake rises above the swamp. The comparison is done on a daily basis, and the findings suggest that diversions normally remain in effect for several weeks or months, followed by extended

periods of no diversions (the logic does not seem to cause a great deal of "on/off" operations). A buffer of 0.1 feet is added to the target swamp stage to avoid counting days in which the swamp is right at or just below the lake as problematic.

- Diversions cease if the swamp stage is greater than the lake stage (no further need to prevent backflow), and also when the lake stage drops below 0.5 feet, as these conditions create the potential for swamp dryout and seed germination.
- Diversion flow rates are governed by rating curves that are dependent on water levels in the Mississippi River. Below certain river stages, capacity in the gravity-fed system will diminish below design capacity along an exponential curve computed with hydraulic models. The maximum flow rate will be capped at the design capacity of the alternative, even though higher flows could be achieved hydraulically.
- Internal Water Exchanges
- Water flows into swamp areas from canals if canal carrying capacity is exceeded.
- Water flows into canals from swamp areas if:
- Local swamp water elevation is higher than Lake Maurepas elevation
- Water in swamp is higher than the elevation of the berm crests and/or gaps.
- Water flows between connected swamp areas directly based on head differential and the elevation of crests/gaps of the separating berms.
- Outflow to Blind River
- The network diagram above shows the connectivity between the canals, the benefit areas, and the Blind River. These equations allow water to flow into the Blind River only when the swamp stage is at or above the lake stage. When the lake is higher than the swamp, no outflow occurs.
- Backflow from Lake Maurepas
- These calculations do not explicitly account for potential backflow from Lake Maurepas into the study area (backflow is accounted for with dynamic backwater simulation in HEC-RAS). Rather, periods of time in which calculated swamp stage is less than the lake stage can be considered to create the potential for such backflow, and the logic for the diversions was developed to prevent backflow occurrences with reasonable and practical regularity.

2.2.4.5 Checking

As stated, very little measured historical data are available to check the accuracy or predictive strength of the equations. In this case, the equations were developed and then tuned to match results from the HEC-HMS and HEC-RAS models to show that the results could be reproduced with independent techniques using standard parameters with reasonable values. Fundamentally, the equations are intended to increase overall credibility of the HEC models while also improving overall understanding of the fundamental dynamics of this system in simple hydrologic terms.

Three types of cross-checking were conducted between the standard equations and the HEC models:

- Runoff time series generated with the standard equations were compared with HEC-HMS results for each contributing subwatershed.
- Runoff time series in the Blind River as computed with these equations was compared to transposed river gage data from a nearby watershed – this effectively tested the overall efficacy of the calculations with respect to both runoff and the passage of water through the swamp.
- Time series of water stage within the swamp generated with the standard water balance equations were compared with results from HEC-RAS to test storm response (peak stage and drainage time) as well as longer-term patterns of filling and draining.

The results of these cross-checks between the HEC models, standard equations, and available data are presented in Section 2.3.6, along with the results of alternatives analysis.

L2.3 Watershed Hydrology and Hydraulics

Appendix Section L2.2 presented an overview of multiple analysis methods that were used to analyze and evaluate hydrology and hydraulics within the study area. The multi-tiered approach to completing hydrologic and hydraulic analysis was formulated to support the project objectives of understanding and quantifying the movement of freshwater, sediment, and nutrients into the southeast portion of the Maurepas Swamp. For the benefit of the reader, conceptual objectives of the project that guided the hydrologic and hydraulic analysis are listed below:

- Enhance water quality in the Blind River by increasing the flow of freshwater to the Blind River;
- Promote water distribution in the swamp to increase the area of freshwater inundation from existing conditions to increase swamp productivity and wetland assimilation;

- Increase nutrient input to the swamp to increase swamp productivity from existing conditions, and increase wetland assimilation;
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing swamp productivity, as described above and by increasing sediment input; and
- Establish hydroperiod fluctuation in the swamp to improve bald cypress and tupelo productivity and their seedling, germination, and survival by decreasing flood duration in the swamp and increasing the length of dry periods in the swamp.

This section discusses each component of hydrologic and hydraulic analysis completed to evaluate existing conditions, including supporting data, model set-up, model testing and validation, and specific simulations and evaluations. This section also discusses preliminary investigations that were used to understand hydrologic and hydraulic constraints and opportunities, which guided the refinement of project alternatives that are presented in greater detail in Section L2.10.

L2.3.1 Climatology and Physical Data

The climate of the study area is subtropical marine with long humid summers and short moderate winters, and regional atmospheric circulation is strongly influenced by many surrounding sounds, bays, lakes and the Gulf of Mexico. From a hydrologic perspective, the study area is also subject to periods of both drought and flood. During the spring and summer, the study area experiences warm, moist tropical air masses that are conducive to thunderstorm development. In addition, the study area is susceptible to tropical waves, tropical depressions, tropical storms and hurricanes. Historical data from 1899 to 2007 indicate that 30 hurricanes and 41 tropical storms have made landfall along the Louisiana coastline (NOAA, 2009).

The wide range of climate conditions expected within the study area provides the potential for hydrologic conditions ranging from extreme flooding to extended drought. The full range of conditions is essential to the fundamental ecosystem restoration project objectives. For the purpose of the hydrologic and hydraulic analysis, the trends of continuous periods such as frequency and duration of flood and dry conditions were considered. Flood conditions were also considered to understand existing conditions and evaluate potential project impacts. The following sections discuss specific climate and physical data that were utilized to complete the hydrologic and hydraulic analysis.

L2.3.1.1 Precipitation and Evaporation Data

Observed Precipitation

Specific sources of measured hydrologic data, such as precipitation data and stream flow measurements, are generally lacking within the study area. No rainfall gages are present in the study area, and based on review of available precipitation data near the study area presented on **Figure L2.3.1-1** the nearby

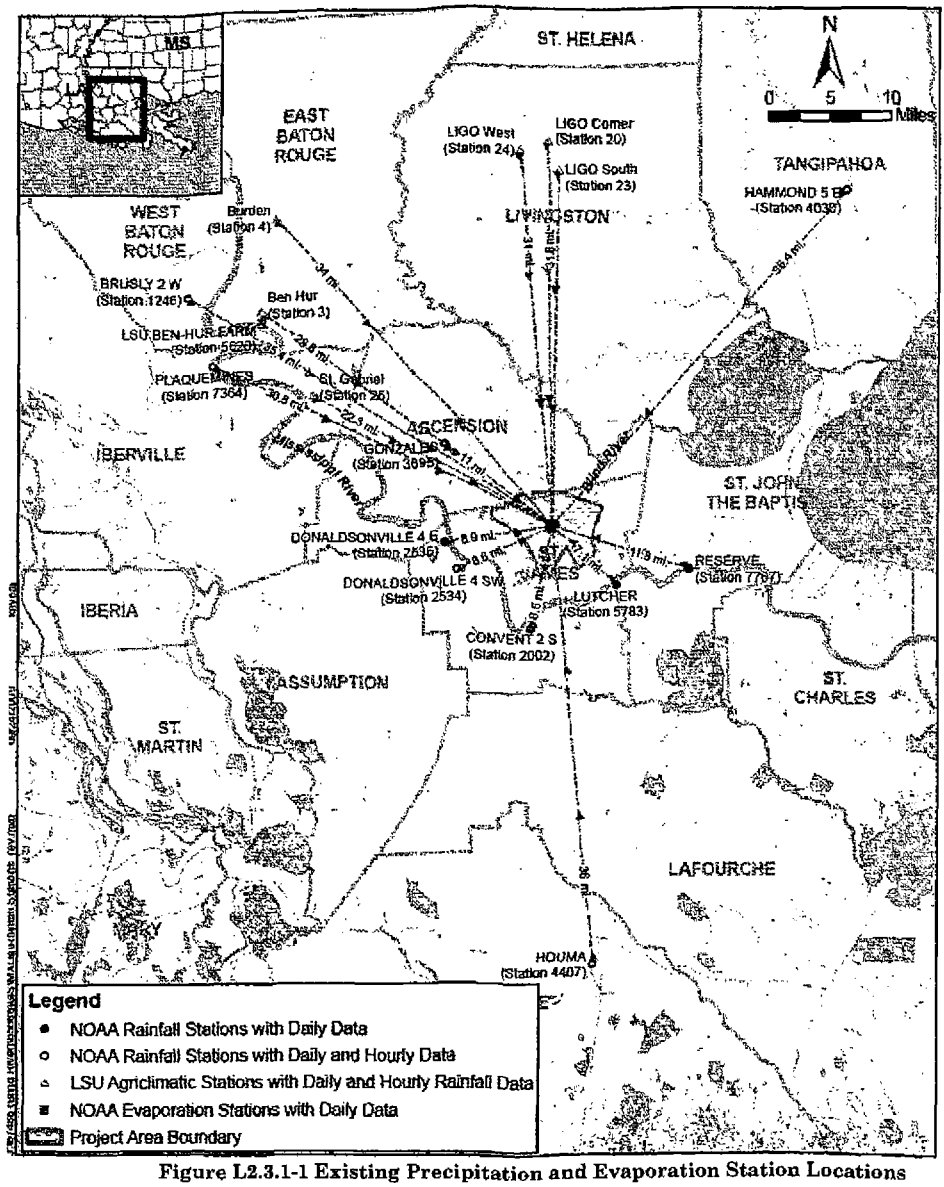


Figure L2.3.1-1 Existing Precipitation and Evaporation Station Locations

Donaldsonville 4 SW Station (NOAA Station 2534) was found to have the most complete continuous hourly rainfall record. A summary of precipitation data records that were reviewed is presented in **Table L2.3.1-1**. Rainfall data from the Donaldsonville 4SW Station were used to support both short duration and long duration hydrologic and hydraulic analyses.

Table L2.3.1-1 Available Precipitation Data

Station Name	Station Number	Period of Record		Distance from Study Area Centroid (Miles)	Data Source
		Daily Data	Hourly Data		
Donaldsonville 4 E	2536	11/1996-12/2008	NA	8.9	NOAA
Donaldsonville 4 SW	2534	1/1930-7/2009	6/1988-12/2007	8.6	NOAA
Convent 2 S	2002	11/1996-12/2008	NA	8.5	NOAA
Houma	4407	1/1930-12/2006	11/1947-1/2007	36	NOAA
Lutcher	5783	2/1993-12/2008	NA	7.1	NOAA
Reserve	7767	1/1948-12/2008	NA	11.8	NOAA
Hammond 5 E	4030	1/1981-11/2007	12/1983-12/2007	36.4	NOAA
Gonzales	3695	3/1978-12/2008	10/1969-1/1982	11	NOAA
Brusly 2 W	1246	6/1987-11/2007	11/1989-12/2007	35.4	NOAA
Plaquemines	7364	1/1948-4/1962	10/1947-11/1964	30.8	NOAA
LIGO Corner	20	1/2006-12/2006	1/2006-12/2006	31.6	LSU Ag
LIGO South	23	1/2006-12/2006	1/2006-12/2006	29.3	LSU Ag
LIGO West	24	8/2001-7/2009	8/2001-7/2009	31	LSU Ag
Burden	4	8/2001-7/2009	8/2001-7/2009	34	LSU Ag
Ben Hur	3	8/2001-7/2009	8/2001-7/2009	29.8	LSU Ag
St. Gabriel	25	8/2001-7/2009	8/2001-7/2009	22.3	LSU Ag

NA indicates data not available.

Design Storm Precipitation

Surface water modeling was performed in the HEC-HMS and HEC-RAS models using rainfall estimates for the 2-, 5-, 10-, 25-, 50-, and 100-yr, 24-hour design storms defined for the study area using values provided in the National Weather Service Technical Paper 40. The Type III SCS rainfall distribution was applied in the HEC-HMS model in combination with rainfall depths corresponding to the depths of precipitation determined for each frequency, which are presented in **Table L2.3.1-2.**

Table L2.3.1-2 Design Rainfall Depths

Recurrence Interval (Years)	Rainfall Depth (Inches)
2-Year	5.5
5-Year	7.5
10-Year	8.8
25-Year	10.2
50-Year	11.3
100-Year	12.8

Evaporation

Daily evaporation data were collected from NOAA station 5620 (LSU Ben-Hur Farm). For application in the analysis, the measured daily data were multiplied by a pan coefficient of 0.77 per guidance in *Evaporation Maps for the United States, Technical Paper No. 37, US Weather Bureau, 1959.* Monthly evaporation values for 2003 and historical monthly averages (1989-2004) are presented in **Table L2.3.1-3.**

Table L2.3.1-3 Monthly Evaporation Values

Month	Evaporation (inches)	
	2003 Monthly Values	Historical Monthly Average Values
January	2.98	2.84
February	2.58	3.18
March	3.49	4.58
April	5.98	6.13
May	7.72	7.75
June	6.52	7.43
July	6.69	7.18
August	7.10	6.95
September	6.07	5.90
October	4.70	4.78
November	3.77	3.31
December	3.94	2.75
TOTAL	61.54	62.78

L2.3.1.2 Topographic Data

A combination of available mapping data and new data collected during the project was used to support the hydrologic and hydraulic analysis. Topographic and field surveys conducted during the project are discussed in Appendix Section L3. Other available data sources were also used to support hydrologic and hydraulic modeling in the project area and in the tributary watershed area. Topographic data are pertinent to the hydrologic analysis in order to define hydrologic boundaries used to calculate runoff that occurs in response to rainfall. For the hydraulic model, topographic and bathymetric data were critical for determining overland flow slopes, channel cross-sectional geometry, critical elevations, and stage-area-storage relationships. In addition to the data discussed in Appendix Section L3, topographic data were available in the watershed from two other major sources:

- Digital Elevation Model (DEM) from the United States Geologic Survey (USGS); and
- Light Detection and Ranging (LiDAR) Data from the Louisiana State University (LSU) Atlas.

Two-foot interval LiDAR data collected by LSU for Ascension and St. James Parishes as part of their state-wide effort were used to develop a Digital Terrain Model (DTM) in the form of a Triangular Irregular Network (TIN) in ESRI Arc View GIS 9.2. The TIN together with USGS quadrangle maps and Google Earth aerial images were used to visualize the terrain and to identify and digitize the stream centerlines, swamps, and connected conveyance areas. Knowledge gained from field visits and surveys was used to interpret features visible in the available aerial photography, and differentiate between drainage canals that will convey flow through the study area and utility corridors that will not provide significant flow conveyance.

The Blind River Diversion Project used the 1988 North American Vertical Datum (NAVD). The bridge, culvert, and cross-section survey data were provided by the surveyors and LiDAR data in both NAVD and 1929 National Geodetic Vertical Datum (NGVD); however, the hydraulic models for the project used only the NAVD datum. Historical data such as road profiles, stage elevations, and structural controls were converted from NGVD to NAVD where necessary using a constant offset of -1.3 ft. The offset between the two datums varies little over the project area (less than 0.1 ft).

L2.3.2 Blind River and Swamp System

The study area for this project is located within the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. The study area for this project is within the Upper Lake Pontchartrain Sub-basin, and consists of areas located within the Louisiana parishes of St. John the Baptist, St. James, and Ascension.

Since the construction of the Mississippi River flood control levees, the Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the Mississippi River, which included freshwater, sediment, and nutrient input. With minimal soil building and moderately high subsidence rates, there has been a net lowering of ground surface elevation, so that now the swamps are persistently inundated.

The limited ability to drain and persistent flooding are characteristics of existing hydrology in the study area, which conflict with the historical seasonal drying of the Swamp. The soils within the Swamp area are inundated or saturated by surface water or ground water on a nearly permanent basis throughout the year except during periods of extreme drought. Additional features within the study area that influence hydrology are associated with past construction of logging trails, drainage channels, pipe lines and other utilities, and roads through the Swamp. These facilities disrupt the natural flow and drainage patterns. Short circuiting of the natural drainage patterns has created ponding in some areas.

L2.3.3 Lake Maurepas

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St. John the Baptist Parish, and then discharges into Lake Maurepas. The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor.

Because of past hydrologic alterations, water levels in Maurepas Swamp are primarily influenced by the stage level of Lake Maurepas, with strong winds also exerting significant effect (Lee Wilson & Associates 2001, Mashriqui et al. 2002, Lane et al. 2003, Day et al. 2004). Tidal pulses are introduced into the Lake Maurepas system through Pass Manchac. Fluctuations in water level are generally expected to be similar throughout Maurepas Swamp, acknowledging slight variability associated with landscape position and elevation. Within any given year, stage is characterized by a bimodal hydrograph. Water level rises in the spring, then falls to its lowest level during the summer, rises to its highest level in the fall, and again falls to low levels in the winter (Thomson et al. 2002, Keddy et al. 2007). The intensity of peaks and troughs is typically associated with meteorological events, such as droughts and hurricanes.

Based on the strong correlation between lake and swamp water levels, the observed doubling of flood durations from 1955 to present at Pass Manchac (Thomson et al. 2002) coupled with lower swamp than lake elevations (Shaffer et al., unpubl. data) suggests that the duration of inundation within the project area has drastically increased over the last 50 years. Increased wetland impoundment also has been driven by the construction of canals, berms, and other artificial structures that alter the existing hydrology by proportionally increasing channelized flow volumes while reducing overland flow volumes.

Relative to historical flooding events, freshwater inputs presently have a substantially reduced influence on the hydrology of Maurepas Swamp. Inflow of freshwater into the project area occurs through drainage of runoff regionally, through riverine systems, and more locally through man-made channels. A series of dredged canals to the southwest and southeast of the swamp transport local drainage into the project area from the residential, industrial, and agricultural lands associated with the Mississippi River levee. Affected by these channels, the western and southwestern portions of the project area constitute the headwaters of the Blind River. General flow direction is southeast, then east and northeast toward its confluence with the Amite River Diversion Canal (ARDC), after which the combined water discharges into Lake Maurepas. The ARDC, a flood-control structure authorized by Congress in 1955 and completed in 1967, is 10 miles in length, 300 feet in width, and 25 feet in depth and connects mile marker 25.3 of the Amite River to mile marker 4.8 of the Blind River. At present, approximately half of the Amite River's flow discharges into Lake Maurepas via the diversion, and the other half along the natural flowpath. Modification of the ARDC to restore the adjacent bald cypress-tupelo swamp impaired by its construction is a near-term critical feature of the LCA Plan.

The Blind River and the Amite River, in particular, receive input from the drainage of urban areas to the west, most notably Baton Rouge. Due to increased urbanization, runoff contribution to these streams has increased in recent decades (LCA 2004). The smaller Tickfaw River also flows into Lake Maurepas from the north. These rivers—flashy streams prone to brief, high-intensity flood events throughout the year—contribute the majority of freshwater and sediment that enters Lake Maurepas, with an average flow rate of 1,000 to 4,000 cfs (Day et al. 2004). The flashy nature of inflow into Lake Maurepas is largely dependent on meteorological conditions; for instance, the Amite River may discharge at 10,000 cfs during storm events, but averages only 1,000 cfs in drought conditions (Day et al. 2004).

L2.3.4 HEC-HMS

Simulation of hydrologic response of the study area to precipitation and surface water flow was performed in HEC-HMS. HEC-HMS is a hydrologic model capable of performing continuous or event simulations of surface runoff and groundwater baseflow. The hydrologic system operates by applying precipitation across Hydrologic Units (HUs). Precipitation is converted to surface runoff or infiltrates into the subsurface, and the runoff of infiltrated water is conveyed to receiving water loading points. Runoff and baseflow hydrographs at these loading points provide input for hydraulic routing in downstream reaches. The hydrologic flow routing of HEC HMS uses a sub-basin-reach representation of the hydrologic modeling system to route flows. The hydrologic model parameters used for the model simulations are described below.

Establishment of hydrologic parameter values utilized available GIS tools to automate the generation of data needed for the model. The base hydrologic GIS data is a representation of the watershed terrain, also known as a digital elevation model (DEM). Hydrographic (swamps, canals/ bayous, and streams) and transportation information obtained in ESRI Arc View GIS shapefiles format from St. James and Ascension Parishes, aerial photography from LSU, land cover information from USGS Land Cover Data Set and soils survey information from NRCS SSURGO in Arc View GIS shapefiles format were used to develop the hydrologic parameters for use in the HEC-HMS model of the watershed. Spatial and 3D analyst extensions available in ESRI Arc View GIS 9.3 were used to develop hydrologic unit boundaries and the parameters needed for each hydrologic unit, which includes composite runoff curve number, flow path locations, lengths and slopes, and channel flow lengths and slopes.

The preliminary hydrologic unit boundaries developed using Arc View GIS tools were refined to locate appropriate flow junctions using knowledge gained from field visits and engineering judgment. In all, 42 hydrologic units were delineated to comprise approximately 165 square miles of study area modeled in HEC-HMS.

L2.3.4.1 HEC-HMS Model Set-up

The study area is divided into HUs. In the model, the HUs were delineated by topographic highs, roads, levees, streams, and canals within the project area. Due to the relatively flat nature of the topography, HU divides are often overtopped during high intensity events. The hydrologic parameters assigned to each HU include area, width, slope, impervious area, roughness, initial abstraction, infiltration, and groundwater parameters.

Hydrologic Characteristics of Study Area Soils

Soil classification for the study area was obtained from the SSURGO database. **Figure L2.3.4-1** presents the predominant soil classification in the study area. As presented on the figure, the predominant soil group in the study area is Group D, with a very high runoff potential. The predominant groups in the study area are Hydrologic Soil group (HSG) C and D. Group C soil has low infiltration rates when thoroughly wetted, moderately fine to fine texture, and a higher runoff potential.

Hydrologic Characteristics of Study Area Land Cover

The land cover for the study area was obtained using the most recent available aerial photographs and is supported by field reconnaissance and observations. The hydrologic land cover for the study area is classified based on the Anderson land use/land cover classification system. The land cover category was further simplified into seven primary types with one category being all wetlands grouped together and the other six as listed below. The remaining land cover types such as transportation and urban-built up land were grouped into category "other" since the percentage of land in this category, in the study area, is relatively small. **Figure L2.3.4-2** presents the land cover distribution for the study area.

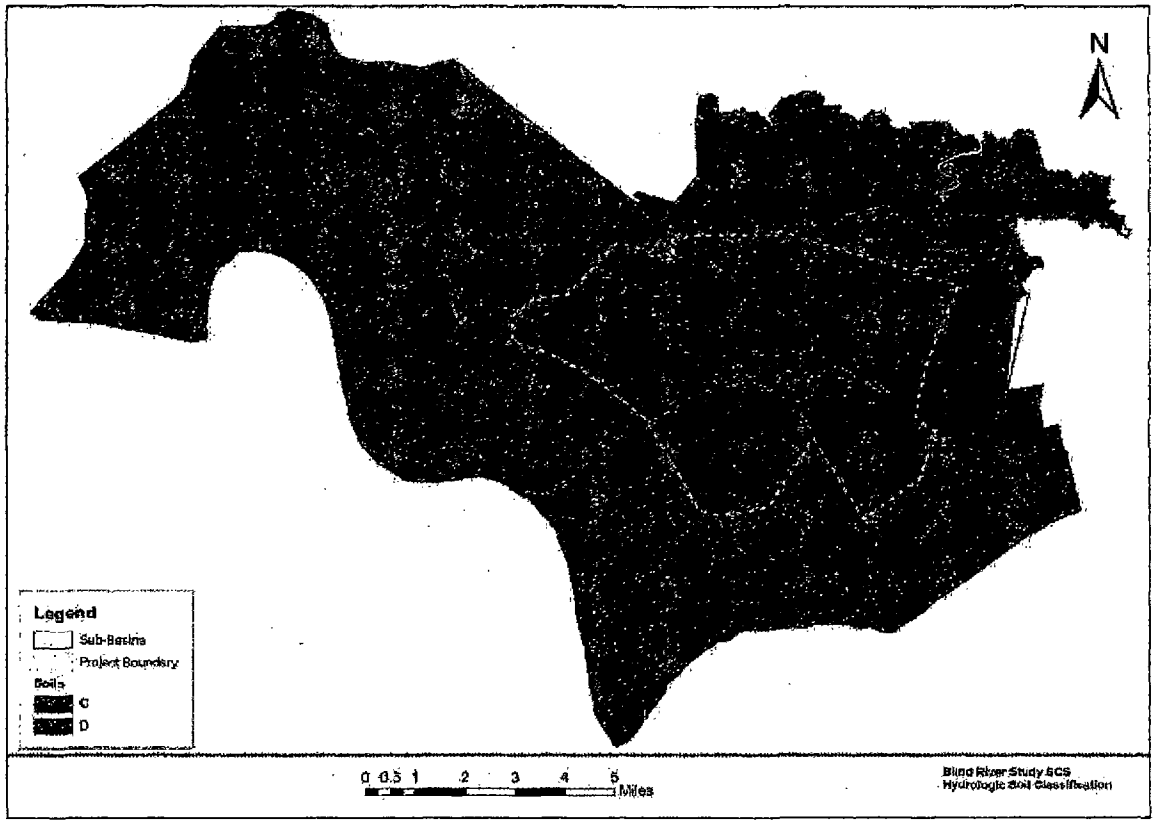


Figure L2.3.4-1 Soil Classification

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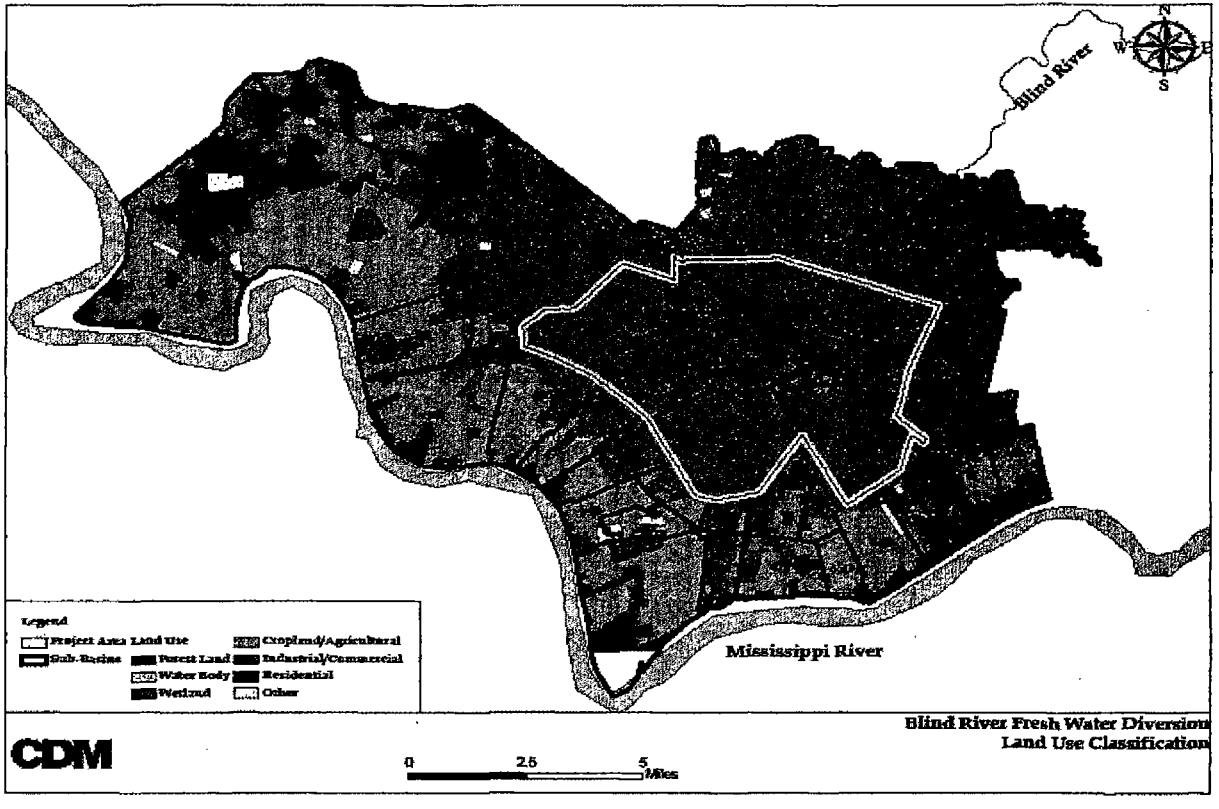


Figure L2.3.4-2 Land Use Classification

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Based on the area percentages, the dominant land cover in the study area is wetland. The hydraulic and hydrologic model parameters were estimated based on these land cover categories in combination with soil classification. **Table L2.3.4-1** presents the percentage of land use type in the study area.

Table L2.3.4-1 Hydrologic Land Cover Percentages

Land Cover Type	Percentage of Watershed Area (%)
Forest Land	7.7
Water body	0.3
Wetland	53.4
Cropland/Agriculture	30.6
Commercial/Industrial	4.3
Residential	3.0
Others	0.7

Runoff Curve Numbers

The study area is divided into hydrologic units with each hydrologic unit assigned a unique hydrologic unit ID. Study area characteristics and hydrologic parameters were estimated for each hydrologic unit using SCS_methodology. Runoff curve numbers and time of concentration were extracted for each hydrologic unit and used as HEC-HMS model parameters.

The SCS runoff curve number method is calculated using the methodology described in NRCS TR-55 manual titled "Urban Hydrology for Small Watersheds". The runoff curve number is an empirical coefficient that relates runoff potential to land cover and hydrological soil classification. The NRCS hydrological soil groups include four groups designated as A, B, C and D (TR-55). The runoff curve number was computed for each hydrologic unit using the soil classification and land use classification together with the curve number tables in TR-55 manual. **Table L2.3.4-2** presents the list of hydrologic unit IDs with the composite curve number calculated for each hydrologic unit.

Time of Concentration

Time of concentration is defined as the time required for all the drainage area to contribute to the flow. The longest flow path in each hydrologic unit is estimated using the slope of the hydrologic unit, which was calculated from USGS topographical maps and contours. The time of concentration along the selected flow path was estimated using a segmental approach based on the type of flow such as shallow concentrated flow or channel flow. Hydrologic parameters were estimated using aerials and field observations. For comparing the results of segmental approach, SCS lag equations was used to compute the time of concentration. Lag time is computed as 60 percent of time of concentration. Lag time for each hydrologic unit is presented in Table L2.3.4-2.

Table L2.3.4-2 HEC-HMS Model Parameters

Sub-basin Number	Drainage Area (Square Miles)	Composite Curve Number	Lag Time (Hours)	Percent Impervious Area (%)
100	6.8	79.0	20.8	0
110	6.24	79.4	10.1	0
120	4.93	79.1	20.1	0
140	1.84	79.0	3.2	0
150	0.7	79.1	8.8	0
160	0.52	79.0	2.0	0
200	2.27	79.0	9.5	0
210	3.42	79.1	18.1	0
220	1.42	79.1	2.4	0
300	3.58	79.2	9.8	0
320	0.62	80.8	8.9	0
330	2.38	81.0	9.8	0
400	2.58	85.0	10.4	10
410	2.33	83.6	9.2	15
420	1.91	83.0	10.5	20
430	1.41	83.8	10.4	20
440	3.04	83.4	10.7	10
450	1.21	82.5	9.1	10
460	1.17	77.9	9.7	10
470	2.61	83.2	9.4	10
480	2.36	79.0	9.7	10
490	1.46	83.2	10.2	0
500	0.79	79.0	8.2	0
510	7.38	84.0	17.2	0
520	1.57	96.0	8.3	0
530	1.21	85.0	8.3	0
540	1.86	85.0	9.4	0
550	2.68	79.0	11.3	0
560	2.84	82.3	12.4	0
570	4.08	83.8	11.4	0
580	6.47	83.4	11.9	0
590	4.16	86.5	10.4	0
600	37.63	76.0	21.6	0
610	13.79	79.0	21.2	0
700	3.31	79.0	12.3	0
710	1.16	79.0	5.4	0
720	1.51	79.0	5.4	0
730	8.81	75.0	20.7	0
740	2.2	79.0	6.8	0
750	1.2	79.0	7.3	0
760	1.65	79.0	7.5	0
770	5.72	79.3	14.0	0

L2.3.4.2 HEC-HMS Model Testing and Validation

Except for one stream gage in Ascension Parish that measures less than 25% of the watershed, there are no known stream gages available within the study area to calibrate the HEC-HMS model. Lacking available measured data, the storm runoff flows calculated in HEC-HMS were checked for reasonableness by comparing them to USGS regression equation estimate (USGS NSS version 4.0) and effective FEMA Flood Insurance Study (FIS) report of Ascension Parish. Neither the USGS stream flow estimates nor the FEMA FIS flows are directly applicable to the entire Blind River watershed due to the significant surface storage present in the swamp. However, the comparison presented in **Table L2.3.4-3** is appropriate, as it compares the HEC-HMS flows to the USGS flow estimates for drainage areas upstream of the swamp, such as the Conway Canal and other areas that are served by local drainage canals.

Table L2.3.4-3 HEC-HMS Validation Summary

HEC-HMS Model Location	Tributary Area (Square Miles)	Peak Storm Runoff Flow (cfs per Square Mile)			
		HEC-HMS (2-Year)	USGS NSS (2-Year)	HEC-HMS (100-Year)	USGS NSS (100-Year)
400	2.58	385	394	1090	994
410	2.33	382	444	1078	1162
420	1.91	286	300	801	723
430	1.41	215	233	599	545
440	3.04	433	444	1238	1020
450	1.21	193	254	556	577
460	1.17	163	191	490	354
470	2.61	408	471	1176	1154
480	2.36	335	402	996	866
490	1.46	206	248	610	529
500	0.79	120	229	373	512
510	7.38	689	587	2019	1396
530	1.21	208	315	602	727
540	1.86	290	348	842	863
550	2.68	319	379	987	768
560	2.84	336	343	1002	711
570	4.08	534	518	1569	1362
580	6.47	809	731	2390	1951
590	4.16	619	596	1768	1632
600	37.63	974	1101	3107	2259

Multiple HEC-HMS model simulations, or plans, were created to generate runoff hydrographs for six design storm events ranging from 2-year to 100-year recurrence intervals using the runoff and routing parameters for hydrologic units and channels modeled. A separate plan was also created to simulate storm runoff flows over an entire year to evaluate hydroperiod within the swamp. A summary of the HEC-HMS plans is provided in **Table L2.3.4-4**. The flows generated by HEC-HMS are written to a HEC-DSS database and subsequently loaded to the companion hydraulic model developed in HEC-RAS. Results of the hydrologic and hydraulic models for existing conditions are presented in Appendix Section L2.3.5.3.

Table L2.3.4-4 HEC-HMS Plan Summary

HEC-HMS Plan Name	Source Rainfall
2-yr run	2-year design storm. 24-hr rainfall depth, SCS Type-III
5-yr run	5-year design storm. 24-hr rainfall depth, SCS Type-III
10-yr run	10-year design storm. 24-hr rainfall depth, SCS Type-III
25-yr run	25-year design storm. 24-hr rainfall depth, SCS Type-III
100-yr Simulation	100-year design storm. 24-hr rainfall depth, SCS Type-III
Continuous Simulation	Continuous simulation. 2003-yr, 1-hr interval rainfall from Donaldsonville, LA gage

L2.3.5 HEC-RAS

HEC-RAS was used in combination with HEC-HMS to simulate the movement of water through the study area with particular focus on the drainage canals that drain through the project area and flow exchange between the drainage system and surface storage in the swamp. HEC-RAS is well suited for this task, especially with the capability to simulate unsteady flow conditions.

L2.3.5.1 HEC-RAS Model Set-up

To simulate the flow routing in the existing and proposed conditions through the study area, an unsteady state, one-dimensional hydraulic model was developed in version 4.0 of HEC-RAS. All topographic and planimetric data used in the model development are projected to State Plane 1983 Louisiana South (feet) coordinates and utilize elevations per the North American Vertical Datum of 1988 (NAVD 88). The geometric data input file in HEC-RAS model was prepared using HEC-GeoRAS version 4.1.1 and ESRI Arc View GIS 9.2. HEC-GeoRAS is an ArcView extension developed by HEC in cooperation with ESRI, specifically to process geospatial data for use with HEC-RAS. The unsteady flow HEC-RAS input file was developed from the HEC-HMS model output. The flow hydrographs information from HEC-HMS stored in HEC Data Storage System (DSS) file was loaded at the appropriate locations along the Blind River and interior drainage canals and bayous.

Cross-sectional geometry that describes the conveyance and storage capacity of open channels were entered into the model at regular intervals of approximately 500-600 feet. Information obtained from the project channel bathymetric surveys and design drawings of Conway Canal together with LiDAR data was used to create composite cross-sections for all canals and streams modeled in HEC-RAS. Flow regulating structures such as bridges/culverts, natural weirs (allows flow transfers between canals and swamps), and levees in the existing conditions, and weirs and control gates in proposed conditions were also modeled in HEC-RAS. Field survey data and design drawings were used for bridge and culvert representation. Standard engineering references, field photos, and aerial photography were utilized to input Manning's roughness and loss coefficient values in the HEC-RAS model. The existing condition of the study area includes culverts under US 61 and I-10 as per field observations and available engineering survey. Refinements were provided with various berm cuts and control structures.

Downstream Boundary Condition

To accurately assess the influence of Lake Maurepas, time varying head boundary conditions were applied at the downstream study boundary to control flows in and out of the intricate network of canals and swamps in the HEC-RAS model. The Lake Maurepas water surface elevation was approximated using observed stage time series data from the Pass Manchac gage that is maintained by USACE. Continuous simulations were performed on the existing and proposed conditions model for one full year (Dec 31st, 2002-Dec 31st, 2003) that was selected to represent the average meteorological conditions over the study area.

Stage-Area Relationships

Stage-storage area relationships were estimated for each HU using the topography DEM and ArcGIS 9.2 with 3D Analyst. Stage-storage area relationships are necessary in relatively flat models where flood waters may overflow the channel banks and fill low-lying areas. An accounting of the volume of these areas is needed for both accurate water surface elevation predictions as well as peak flow estimates.

Evaporation Time Series

The HEC-RAS model is refined to reflect the bathymetric data and to account for the evaporation losses over the 2003 simulation run. Hence, the evaporation losses were incorporated into the HEC-RAS model as a time series data for all storage areas. The HEC-RAS model does not provide a mechanism to include evaporation loss. The volume of water lost due to evaporation is then extracted from the storage areas in the model. Pre-processing of the data was required to estimate the time series with negative flows.

Control Structures

Various control structures such as bridges, lateral structures, and storage areas are entered into the HEC-RAS model. There are 30 storage areas, 35 storage area connections and 67 weir/lateral structures in the HEC-RAS model. The bridge data typically included one upstream section, one downstream section (includes bridge pier locations and low chord information). For the bridges, the most confining

section was chosen to represent the structure in the model. Typically, this included reducing the cross-sectional area by removing the bridge pier area and by cutting off the cross-section at the low chord. The bridge data was obtained from State of Louisiana, Department of Highway drawings. The datum was verified with that in the drawings and necessary adjustments were made to match the data obtained from field observations and DEM elevation data.

Dimensions and geometry for many of the ditches, bridges, and culverts in the model were not field surveyed during completion of this project. However, hydraulic model data were developed using available engineering and as-built drawings to determine approximate length, size, and inverts of these elements. Some data were also estimated from aerial photos. These elements are not within the primary conveyance of the system, but are necessary to provide an approximation of the mass flows between HUs.

System Inflows

Boundary conditions are defined in the hydraulic model as flow hydrographs, uniform lateral flows, lateral inflow hydrographs, and stage hydrographs. The stage hydrograph is set only at the Blind River outfall reach. All the other hydrographs at various reach locations are read from the DSS file that contains output from the HEC-HMS model continuous simulation run.

L2.3.5.2 HEC-RAS Model Testing

Existing Drainage Canals

The total watershed that drains to the Blind River contains numerous existing drainage canals. Areas of Ascension Parish located in the northern extent of the watershed generally drain to the Conway Canal, which conveys flows along the northern boundary of the project area and discharges to the Blind River downstream of I-10. Areas of St. James Parish drain to drainage canals that generally flow from high ground along the Mississippi River toward the Blind River. The existing drainage canals convey flows to the St. James Parish Canal that surrounds the swamp and in many places is coincident with the project area boundary. The Lateral 3D and Lateral 4 drainage canals convey flow from the St. James Parish Canal to the Blind River upstream of US 61. The extent of the watershed and the network of drainage canals downstream of US 61 is more limited, and primarily consists of natural channels and drainage canals that convey flows to the Blind River. Test simulations completed using both design rainfall of various magnitudes and observed rainfall from 2003 indicate that the majority of rainfall runoff volume to the Blind River flows through the drainage canals and bypasses the swamp.

Influence of Lake Maurepas

Lake Maurepas influences both flow and water elevations in the Blind River and the project area. Test simulations with HEC-RAS indicate that peak water surface elevations in the Blind River and the swamp result from Lake Maurepas water elevations, as opposed to stormwater runoff from the Blind River watershed. This

effect is apparent on **Figure L2.3.5-1**, which compares the resulting stage hydrograph of two hydraulic simulations in HEC-RAS with two different boundary conditions. The result presented on Figure L2.3.5-1 is for Sub-basin 110, and is typical of the change in response observed in all the swamp hydrologic units. The first simulation shown by the light blue line on Figure L2.3.5-1 was calculated using a constant tailwater elevation at Lake Maurepas of 0.5 feet NAVD. The second simulation produced the stage hydrograph represented by the dark blue line on Figure L2.3.5-1 used the observed water surface elevation at Lake Maurepas. As shown, the dark blue line is much higher and more variable than the light blue line.

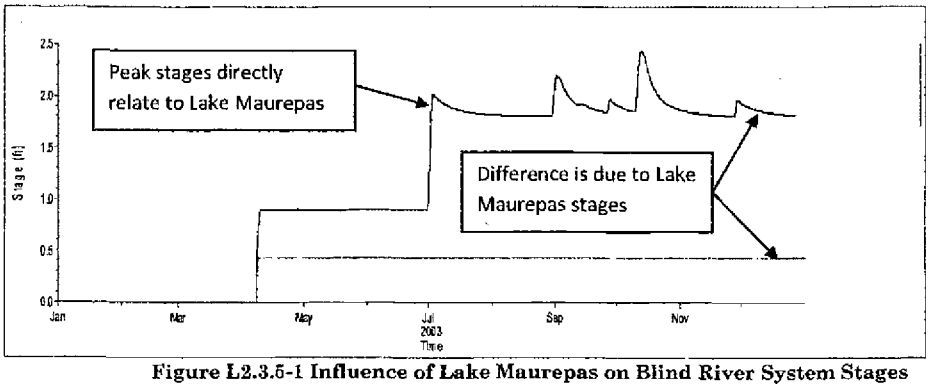


Figure L2.3.5-1 Influence of Lake Maurepas on Blind River System Stages

Figure L2.3.5-2 presents flow simulated in the Blind River at I-10 in HEC-RAS with 2003 rainfall and observed water surface elevations at Lake Maurepas. As shown, flow in the Blind River at I-10, the downstream limit of the project area, is both positive and negative over the course of the year. This occurrence of flow in two directions further demonstrates the influence Lake Maurepas has on the Blind River and the swamp, as well as the importance of including this downstream boundary condition in the hydraulic analysis.

Review of the observed water surface elevations at Lake Maurepas during 2003 indicates that four peak water surface elevations occurred that were significantly higher than other peak elevations measured in 2003. Additional research of hydrologic conditions during 2003 revealed that three of the four highest peak water surface elevations at Lake Maurepas during 2003 were caused by Tropical Storms Bill, Isidore, and Lily that tracked through the region. The fourth peak water surface elevation occurred in response to a large regional precipitation event that caused flooding in portion of the Amite River watershed, a much larger tributary to Lake Maurepas than the Blind River. Additional information about the frequency of Lake Maurepas water surface elevations and associate effects on the study area is provided in Section L2.9.

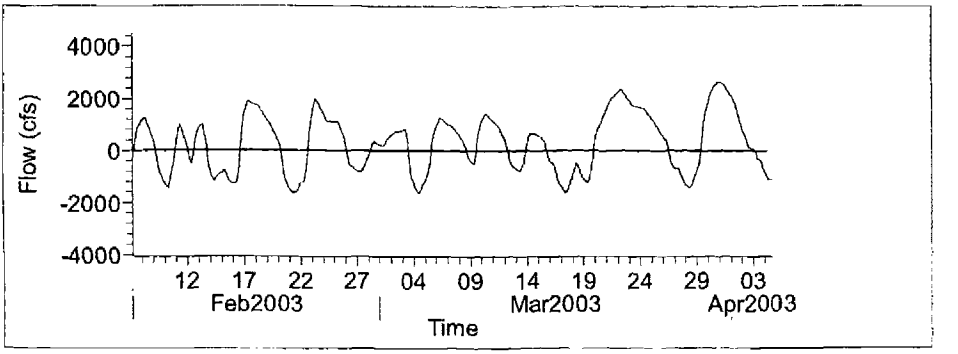


Figure L2.3.5-2 Blind River Flow at I-10

Typical Flow Patterns

HEC-RAS test simulations were also conducted to understand typical flow patterns in the existing drainage canals and the swamp. **Figure L2.3.5-3** shows typical flow patterns and flow magnitudes calculated by HEC-RAS in response to 2003 hydrologic conditions. Observations from the model results suggest that a number of factors influence flow patterns that occur in response to frequent rainfall events that occur in the Blind River watershed:

- Drainage canal cross-section dimensions;
- Locations and elevations of existing berms;
- Elevations of ground elevations adjacent to the existing drainage canals;
- Tributary area to each lateral drainage canal; and
- Blind River channel and overbank cross-sections.

L2.3.5.3 HEC-RAS Model Results

Two types of simulations were completed with HEC-HMS and HEC-RAS; a simulation of the watershed with design storm rainfall and a simulation using observed rainfall and Lake Maurepas water elevations during the year 2003, an average hydrologic year. Model results produced with design rainfall depths are intended to define peak water surface conditions in the existing study area for comparison with project alternatives to identify the potential adverse project impacts to flooding. Model results produced with the simulation of the year 2003 are intended to establish existing hydroperiod characteristics for comparison with the project alternatives.

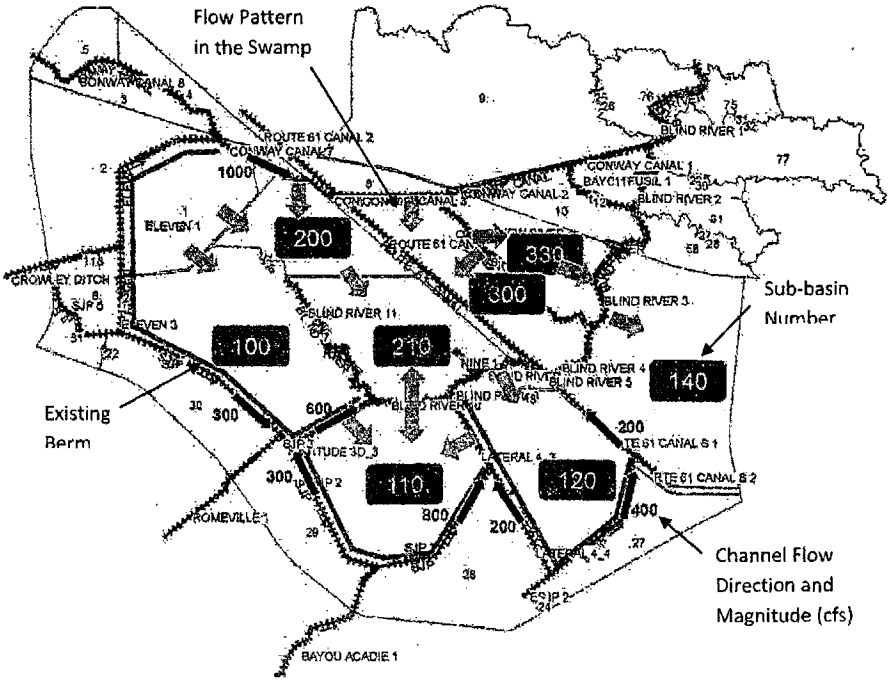


Figure L2.3.5-3 Typical Flow Patterns

The results for each type of simulation are summarized as follows:

- Peak Water Surface Elevations in feet-NAVD were produced by the design storm simulations at locations throughout the existing drainage canal network, and are reported for the 2-, 5-, 10-, 25-, 50- and 100-year rainfall events (**Table L2.3.5-1**).
- Average Water Surface Elevations in feet-NAVD were produced by the simulation of the year 2003 for specific hydrologic units in the swamp (**Table L2.3.5-2**).
- Net Freshwater Throughputs in acre-feet were produced by the simulation of the year 2003 for specific hydrologic units in the swamp (**Table L2.3.5-3**). The net freshwater throughput is calculated as the total inflow to a hydrologic unit minus the inflow volume attributed to backflow from Lake Maurepas.
- Backflow in acre-feet were produced by the simulation of the year 2003 for specific hydrologic units in the swamp (**Table L2.3.5-4**).

Average water surface elevations and volumes for throughput and backflow were calculated for existing sea level conditions and with projected increases in mean sea level that will result in increases to Lake Maurepas water levels. Similar results are

calculated for the array of alternatives (Section L2.10) for consistency with USACE policy for considering the effects of sea level rise in civil works programs. The sea level rise scenarios presented correspond to projected sea level rise for 20-year, 30-year and 50-year increments that are utilized by the Wetland Value Assessment (WVA) to quantify project benefits.

Table L2.3.5-1 HEC-RAS Peak Water Surface Elevations

Location	HEC-RAS Cross-Section Number	Water Surface Elevation (feet - NAVD)					
		2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Conway Canal	39851.31	3.35	4.13	4.68	5.26	5.63	5.92
Conway Canal	19048.58	1.17	1.33	1.42	1.51	1.57	1.65
Crowley Ditch	474.9322	3.31	3.79	4.07	4.40	4.60	4.90
St. James Parish Canal	45041.35	3.34	3.82	4.07	4.40	4.59	4.90
St. James Parish Canal	28520.59	2.80	3.32	3.67	4.05	4.34	4.69
St. James Parish Canal	14574.43	3.07	3.55	3.90	4.27	4.55	4.88
East St. James Parish Canal	13175.13	2.58	3.07	3.38	3.71	3.96	4.29
Blind River	42581.05	1.37	1.56	1.69	1.80	1.88	2.00
Blind River	27088.77	0.95	1.07	1.14	1.21	1.26	1.32

Note: Design storm simulations completed with downstream boundary condition water surface of 0.5 feet.

Table L2.3.5-2 HEC-RAS Average Water Surface Elevations

Sea Level Condition	Water Surface Elevation (feet, NAVD) by Sub-basin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	1.79	1.34	1.66	1.74	1.64	1.36	1.37
20-Year	1.98	1.74	1.77	1.98	2.06	1.72	1.75
30-Year	2.21	2.09	2.12	2.19	2.32	2.06	2.09
50-Year	2.85	2.83	2.84	2.85	3.00	2.81	2.81

- Note: Average water surface elevation based on simulation of hydrologic conditions observed in 2003.

Table L2.3.5-3 HEC-RAS Net Freshwater Throughput Volumes

Sea Level Condition	Net Freshwater Throughput (Acre-feet) by Sub-basin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	20,700	47,400	55,900	9,400	3,900	172,100	98,300
20-Year	62,300	63,500	121,300	34,800	13,300	226,200	69.900
30-Year	87,300	75,800	196,300	52,000	17,900	346,300	121,000
50-Year	127,900	91,200	359,800	97,600	25,500	554,800	248,800

Note: Average water surface elevation based on simulation of hydrologic conditions observed in 2003.

Table L2.3.5-4 HEC-RAS Backflow Volumes

Sea Level Condition	Backflow Volume (acre-feet) by Sub-basin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	7,900	11,500	7,000	5,400	5,200	42,400	24,000
20-Year	42,300	45,500	64,200	25,100	15,700	139,000	83.700
30-Year	64,700	50,200	94,600	44,800	21,800	175,700	111,000
50-Year	88,000	53,900	151,200	72,200	28,200	233,500	147,500

Note: Average water surface elevation based on simulation of hydrologic conditions observed in 2003.

In addition to the numerical HEC-RAS results presented above, a summary of general observations and conclusions based on review of the HEC-RAS model results for existing conditions are provided below:

- Local drainage contributes storm runoff to the Blind River and surrounding swamp from multiple rainfall events each year. Most storm runoff is conveyed by existing drainage channels directly to the Blind River.
- Under existing conditions, the swamp has minimal circulation of water, and the only water movement occurs during an average of 5-7 rainfall events per year that are large enough to exceed drainage canal capacity and contribute flow to the swamp. Although not simulated by HEC-RAS, a reasonable inference is that contribution and circulation of nutrients and sediment will also be minimal and limited under existing conditions.

- Water levels in Lake Maurepas significantly influence the ability for the Blind River system to drain, and significant backflow from Lake Maurepas to the Blind River system occurs multiple times per year.
- Peak flows and stages for the Blind River range from 500 to 6,000 cfs and -0.5 to 2.5 feet (NAVD), respectively for the 2003 simulation year.
- Three of four peak stages in Lake Maurepas during 2003 were the result of tropical storms in the region (Bill, Isidore, Lily), and the fourth peak stage in Lake Maurepas resulted from a large regional system that caused significant flooding in the Amite River watershed.
- Local runoff to the Blind River can occur during periods when Lake Maurepas levels are high, but typically does not coincide with peak lake levels.
- Lake Maurepas stage is not closely related to runoff flows contributed to the Blind River. Lake Maurepas stage appears to be most closely related to runoff response from the larger Amite River watershed.
- Peak Lake Maurepas levels rise and recede on the order of two weeks while runoff in the Blind River watershed occurs in 2-3 days.
- The US 61 bridge has a maximum capacity of approximately 7,000 cfs while the I-10 bridge has a much larger capacity. Half of the US 61 bridge opening is below elevation 0.5 feet (NAVD). With a flow of 3,500 cfs the US 61 bridge will have 2 feet of freeboard from the low chord elevation of 4.5 feet with a downstream water elevation of 0.5 feet at Lake Maurepas.
- Future conditions that include both mean sea level rise and continued subsidence will increase the magnitude of land area in the swamp that is inundated during average hydrologic conditions, primarily because the average and peak water elevations in Lake Maurepas will increase relative to the ground elevation in the swamp. While this will deliver more water to the swamp, conditions will continue to be stagnant and the risks of potential impacts associated with inundation resulting from storm surge, such as salinity, will increase.

L2.3.6 Engineering Calculations

The following section builds on the methodology discussion presented in Section L2.2.4, and explains how the engineering calculations were tested with comparisons to HEC-HMS results, HEC-RAS results, and another nearby stream gage. Once tested, the engineering calculations were used to extend the period of record for hydraulic analysis from 1989-2004. At the conclusion of this section, engineering calculations results are provided for existing conditions over the 1989-2004 period of record.

L2.3.6.1 Engineering Calculations Set-up

The study area is represented conceptually for the purpose of the engineering calculations on Figure L2.2.4-1. As shown, the existing swamp is comprised of seven hydrologic units in the engineering calculations, and includes many flow paths between each of the swamp areas, drainage canals and the Blind River. Figure 2.2.4-1 also includes the conceptual locations of alternatives for the Mississippi River diversion, shown in red arrows. Additional discussion of diversion alternatives screening is provided in Section L2.4, and discussion of the final alternatives is included in Section L2.10.

Existing conditions represent all the possible flow paths, and only allows water exchanges into or out of the seven swamp hydrologic units if the water level is higher than the estimated berm crest elevation between adjacent swamp areas or swamp areas and adjacent canals. Results for existing conditions will be compared with results for additional scenarios that include gaps in the berms to improve freshwater delivery to the swamp, from the Mississippi River, and drainage out of the swamp. For clarification, the engineering calculations analysis is not a rigorous hydraulic analysis, but rather a conceptual representation of the potential connectivity and water exchange potential that could occur under a range of hydrologic conditions over the period of record from 1989 to 2004. The explicit representation of hydraulics is included in the HEC-RAS and EFDC analyses.

L2.3.6.2 Engineering Calculations Testing

As stated, very little measured historical data are available to check the accuracy or predictive strength of the equations. In this case, the equations were developed and then tuned to match results from the HEC-HMS and HEC-RAS models to show that the results could be reproduced with independent techniques using standard parameters with reasonable values. Fundamentally, the equations are intended to increase overall credibility of the HEC models, extend the period of record that can be analyzed, and improve overall understanding of the dynamics of this system in simple hydrologic terms.

Three types of cross-checking were conducted between the standard equations and the HEC models. Results of each are presented below:

- Runoff time series generated with the standard equations were compared with HEC-HMS results for each contributing subwatershed.
- Time series of water stage within the swamp generated with the standard water balance equations were compared with results from HEC-RAS to test storm response (peak stage and drainage time) as well as longer-term patterns of filling and draining.
- Runoff time series in the Blind River as computed with these equations was compared to transposed river gage data from a nearby watershed – this effectively tested the overall efficacy of the calculations with respect to both runoff and the passage of water through the swamp.

Watershed Runoff Time Series

Per the methodology described in Section L2.2, the daily runoff from each of the contributing subwatersheds to the study area (not including the study area itself) was estimated using standard hydrologic equations that account for bulk loss of total precipitation, retention of water in the soil, and gradual discharge of soil moisture into the canals flowing into and through the study area. **Figure L2.3.6-1** shows the contributing watersheds (areas 400 – 770) in addition to the study area (areas 100-330).

Figures L2.3.6-2 to **L2.3.6.2-13** illustrate the runoff performance as estimated with the standard equations, and compared with the HEC-HMS predictions for the year 2003 (which represents typical hydrologic conditions).

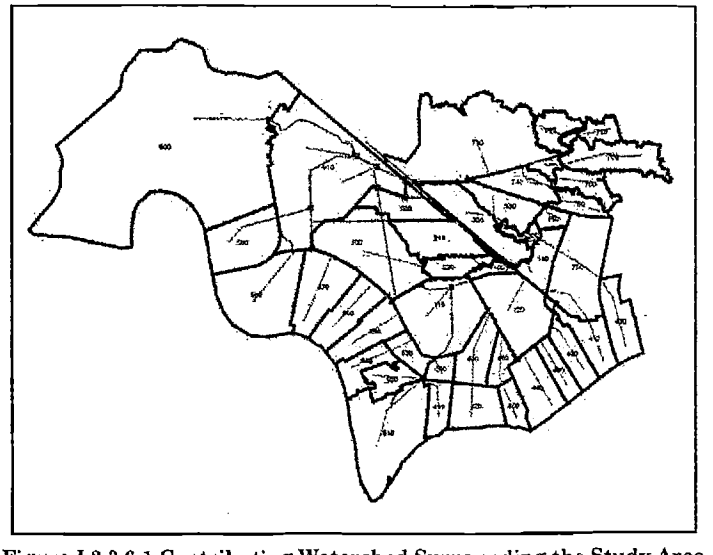


Figure L2.3.6-1 Contributing Watershed Surrounding the Study Area

The resulting parameters (listed in the figures for each watershed) were determined using the following criteria:

- Total annual runoff predicted by HEC-HMS would be preserved with the simplified calculations;
- The timing and magnitude of peak flows would be matched reasonably well (judging qualitatively); and
- The slope of the hydrograph recession curves would also be matched reasonably well.

When these criteria are applied, most of the contributing watersheds are hydrologically "flashy" – that is, runoff occurs very quickly after rainfall events, and very little precipitation is lost to evaporation or groundwater seepage (the contributing watershed areas do not include the study area itself). These findings were compatible with the basic hydrologic features of the contributing watersheds, which are geographically small and characterized by poorly drained soils (predominantly Type D soils per SCS).

Fundamentally, then, in the absence of data with which to confirm HEC-HMS hydrologic predictions, the basic rainfall-runoff dynamics of the system as predicted by HEC-HMS could be reproduced using standard hydrologic relationships with parameters that reasonably conform to the hydrographic characteristics of the contributing subwatersheds.

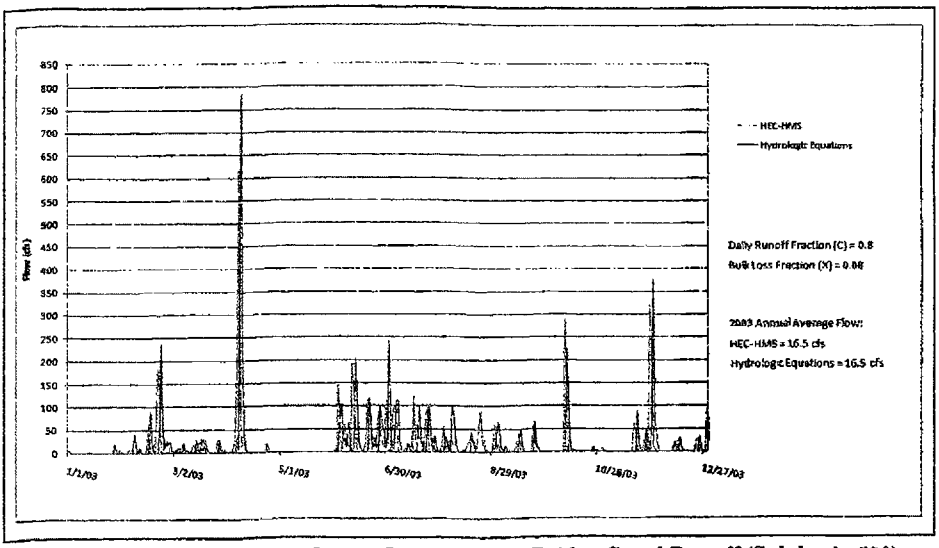


Figure L2.3.6-2 South Bridge Canal Runoff (Sub-basin 590)

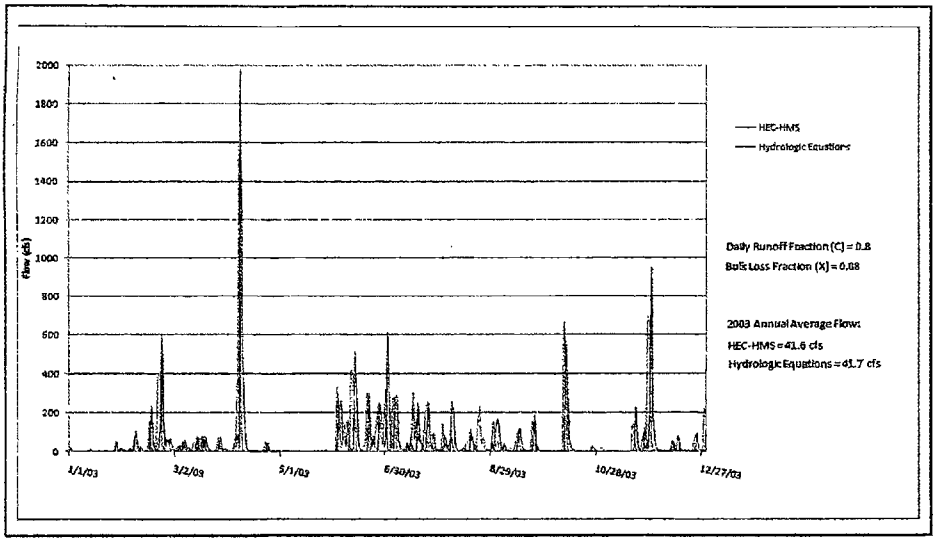


Figure L2.3.6-3 St. James Parish Canal Runoff (Sub-basins 570, 580)

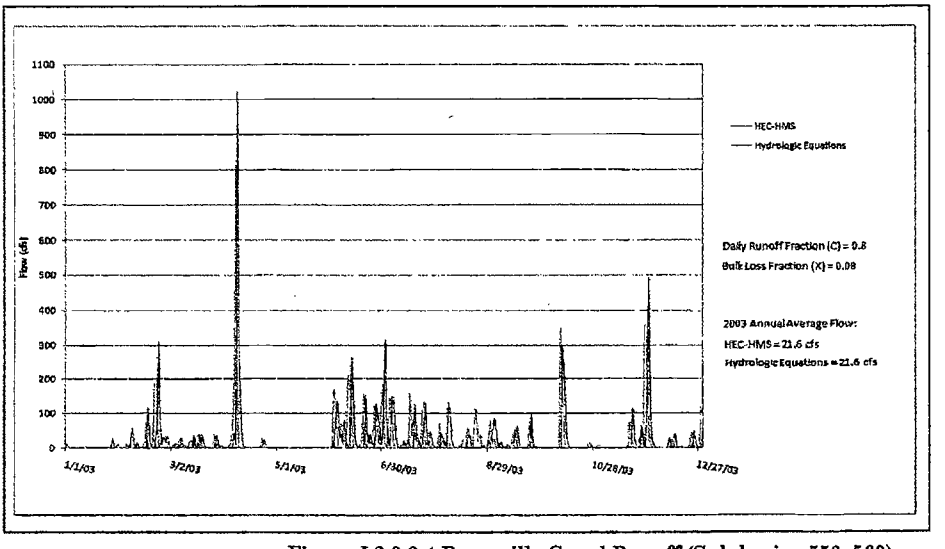


Figure L2.3.6-4 Romeville Canal Runoff (Sub-basins 550, 560)

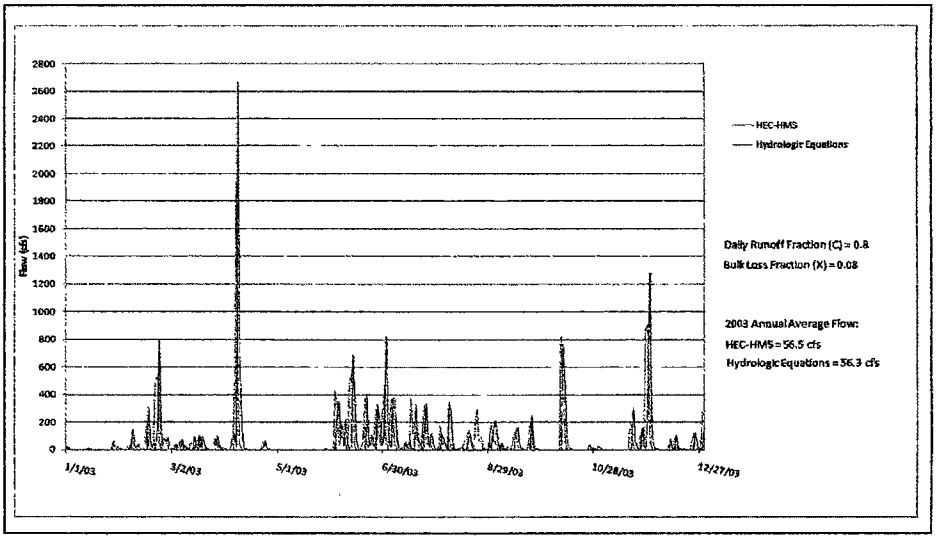


Figure L2.3.6-5 External Drainage Canal 1 Runoff (Sub-basins 490, 500, 510, 520, 530, 540)

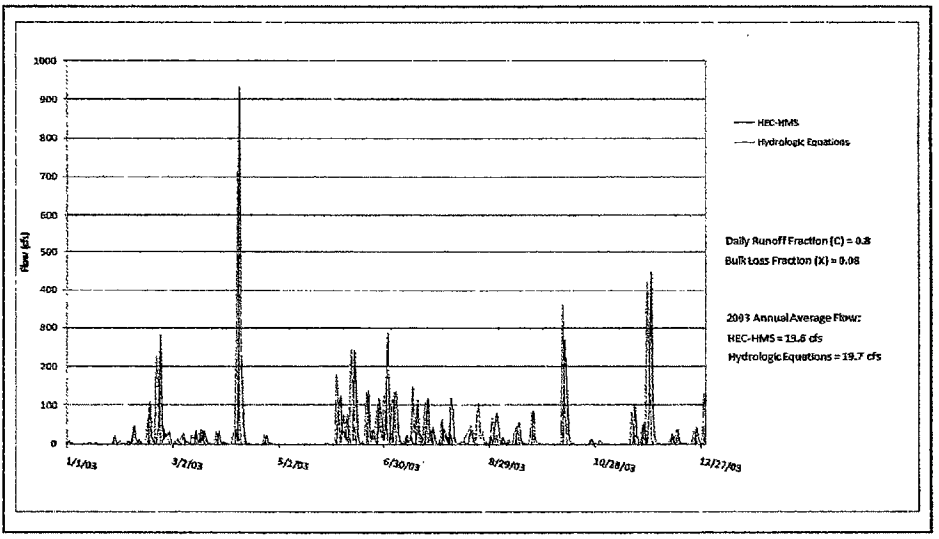


Figure L2.3.6-6 External Drainage Canal 2 Runoff (Sub-basins 470, 480)

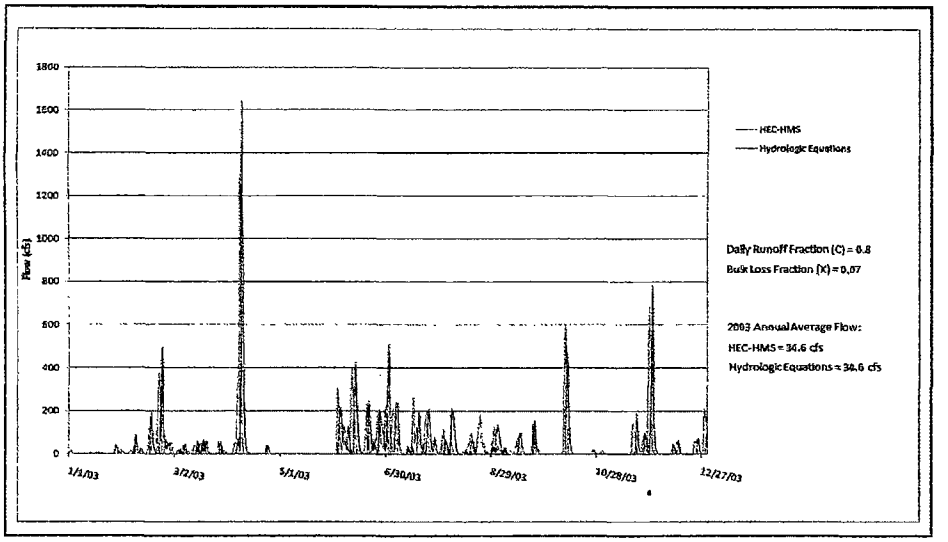


Figure L2.3.6-7 External Drainage Canal 3 Runoff (Sub-basins 420, 430, 440, 450, 460)

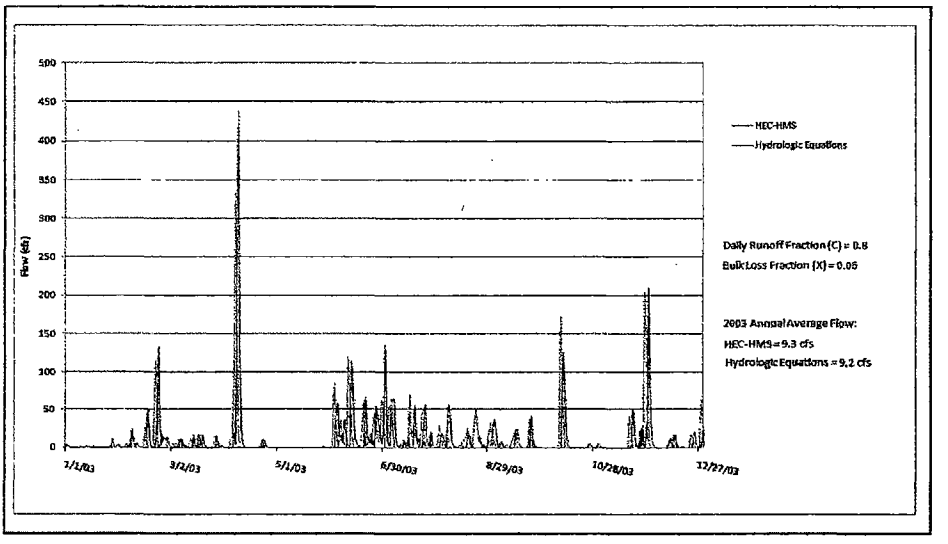


Figure L2.3.6-8 Southeast US 61 Canal Runoff (Sub-basin 410)

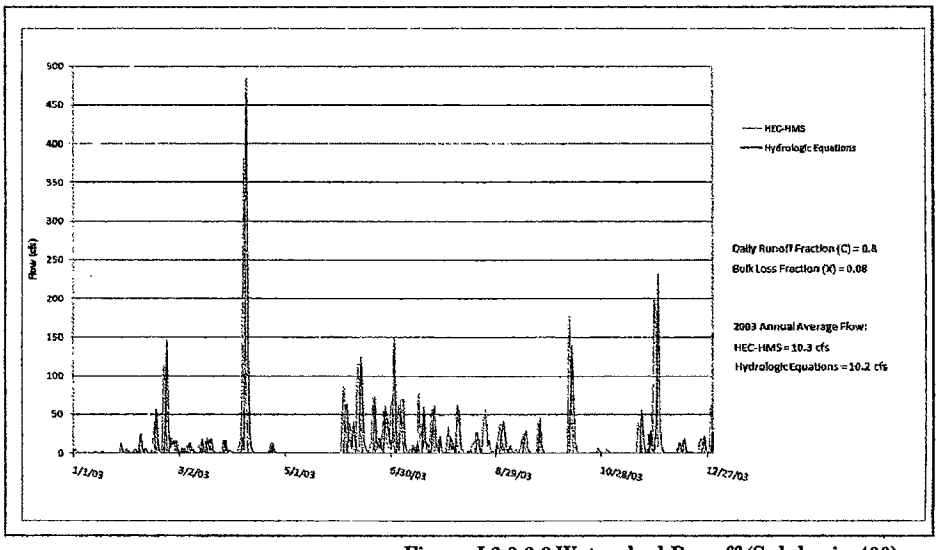


Figure L2.3.6-9 Watershed Runoff (Sub-basin 400)

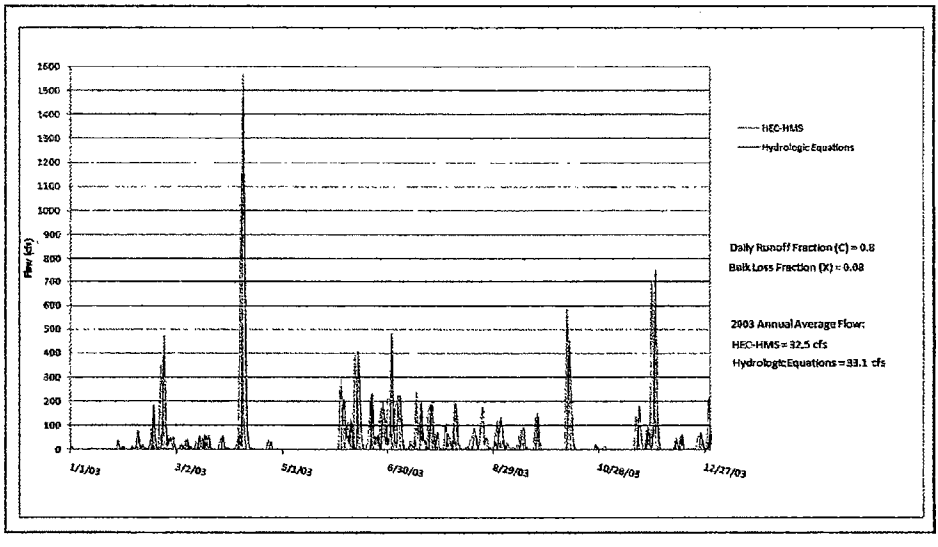


Figure L2.3.6-10 Watershed Runoff (Sub-basins 700, 740, 750, 760)

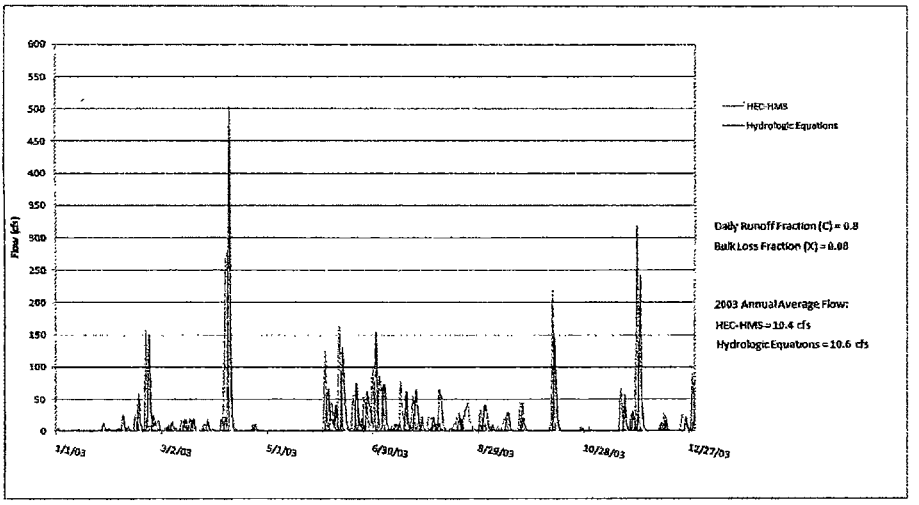


Figure L2.3.6-11 Watershed Runoff (Sub-basins 710, 720)

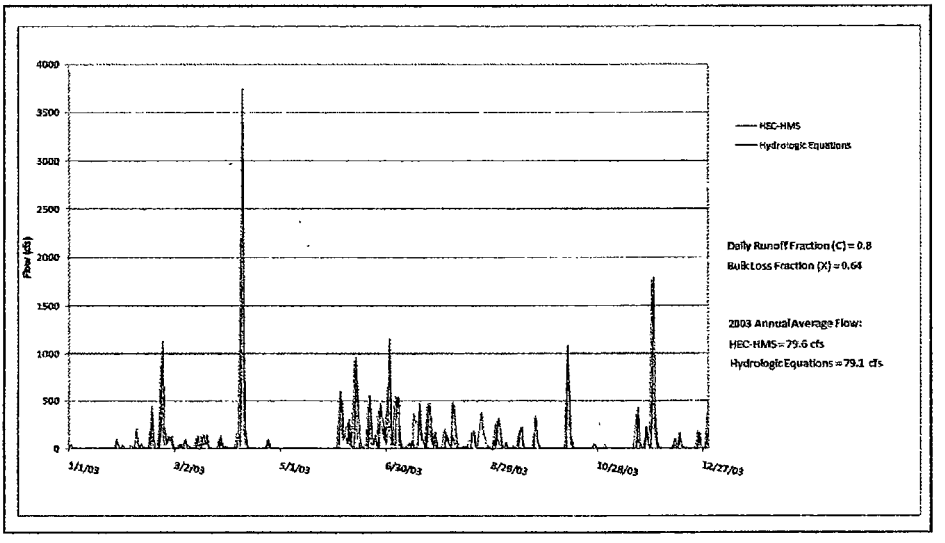


Figure L2.3.6-12 Watershed Runoff (Sub-basins 600, 610)

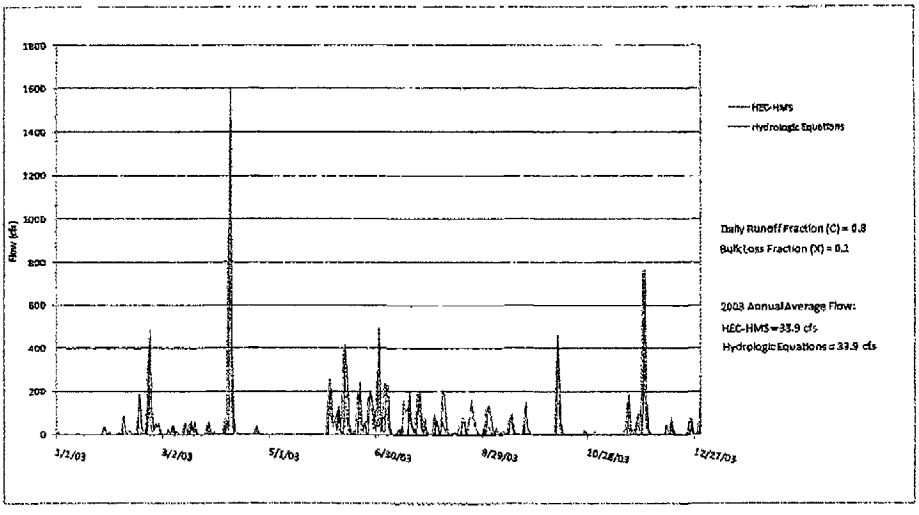


Figure L2.3.6-13 Conway Canal 2 Runoff (Sub-basin 730)

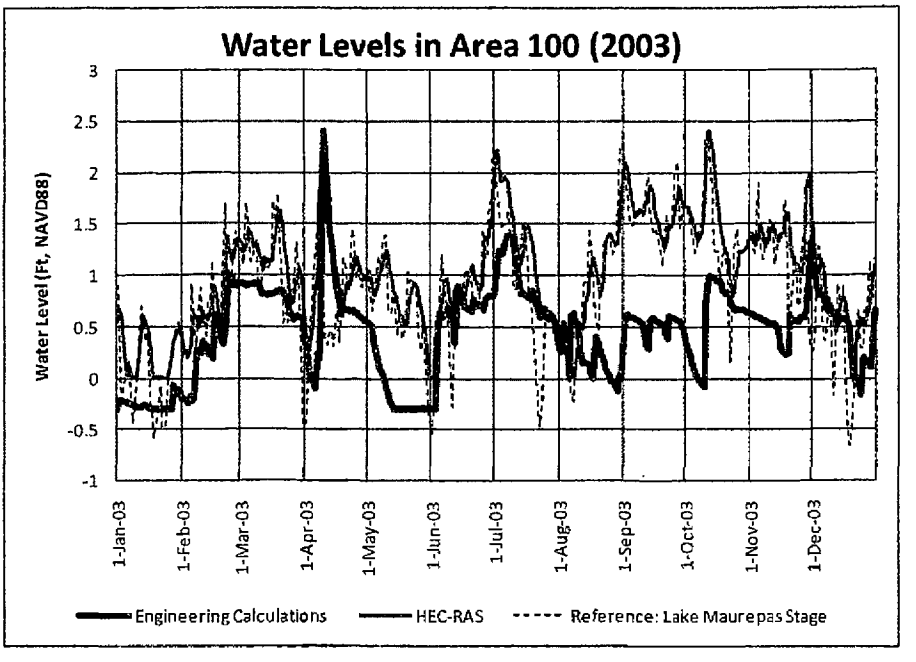
Hydrologic Response Patterns within the Swamp

The engineering equations also compute generalized routing trends as the runoff (and diversions) pass through the swamp, in accordance with the logic described in Section L2.2.4. The recession coefficient applied to the entire swamp area (governing the rate of discharge from overflowing swamp areas to a canal, the Blind River, or adjacent swamp areas) was adjusted to match the overall rate at which the HEC-RAS model predicted drawdown of the swamp area.

Figure L2.3.6-14 illustrates the simulated response in swamp area 100 (as a typical example). Several important aspects of the swamp dynamics as represented in the engineering equations:

- The rate at which the swamp drains (draws down) following large storms matches the rate predicted by HEC-RAS reasonably well. Different recession coefficients were applied to represent differences in drawdown tendency for the swamp with and without cuts in the berms (these cuts also allowed drawdown to lower elevations). Without berm cuts, the recession coefficient that best matched HEC-RAS drawdown patterns was 0.4 throughout the swamp. That is, on any day, if there was surplus water in a swamp area above the berm elevation, 40% of that surplus would flow to downstream or adjacent water bodies. Over time, the pattern is exponential drawdown. Likewise, to represent berm gaps, the recession coefficients ranged between 0.2 and 0.3 for the various swamp areas – slightly slower overall drawdown, but the faster drawdown associated with no

berm gaps only occurs at very high water surfaces (above berm crests), and is not expected to occur over the much broader range of elevations in which connectivity is afforded with gaps in the berms. (These values were tuned to match the recession rates observed in the HEC-RAS model, mostly to accommodate the extension of the period of record, and not necessarily to prove the validity of either approach – unlike standard rainfall-runoff dynamics, the swamp dynamics are less intuitive and not as easily correlated to physical landscape features).



- *Results are for existing conditions with berm cuts (no diversions)*
- *Results show similar fill times and drawdown times, both short-term (days) and longer-term (week/months).*
- *Differences in absolute water elevations are attributed to the inclusion of free-surface evaporation in the engineering calculations, and the inclusion of backwater influence in the HEC-RAS results. When the blue trace of the engineering calculations (fresh water only) is below the dashed trace of Lake Maurepas, the results are suggestive of backflow potential from the lake into the swamp (not enough fresh water input on its own to provide enough countering head). These differences become much smaller when diversion flow is added into the swamp.*
- *Only swamp area 100 is shown in the graph above. Results are representative of other swamp areas.*

Figure L2.3.6-14 Comparison of Swamp Fill and Drain Dynamics in Sub-basin 100

- Differences between the HEC-RAS trace for 2003 and the engineering equation results can be explained with two important distinctions:
- The HEC-RAS model includes backwater calculations from Lake Maurepas, and hence, the water level in the swamp never drops below that of the Lake. The engineering equations do not account for backflow, just runoff and direct precipitation (and diversions when alternatives are analyzed later). Hence, when the trace representing the engineering calculations drops below the lake level, this is representative of times when the lake would have the potential to flow back into the swamp.
- The engineering equations account more specifically for surface evaporation from the open water surfaces in the swamp than is possible in HEC-RAS.

When diversions were included in the water balance, the differences between the engineering calculations and the HEC-RAS results were substantially reduced. Therefore, it was determined that the general dynamics of filling time, draining time, and peak water levels were captured effectively with the engineering calculations, and that the calculations could be used to extend the period of record analysis from 1989-2004.

Flow in the Blind River Downstream of Study Area

Because there is no long-term continuous flow record for the Blind River, the computed outflow from the study area to the river (as computed with the engineering calculations) was compared to a synthesized flow record using data from a nearby watershed. The accumulated effects accounted for in the calculated data include both the hydrologic and hydraulic dynamics described above: watershed runoff and the retention/passage of that water through the canals and swamp areas under investigation (without any external diversions).

The goal of this comparison was not to achieve exact replication of the synthesized flow data, since the transposition itself is subject to uncertainty. Specifically, uncertainty with respect to hydrologic similarity, effects of impounded water within the swamp, precipitation patterns, etc. render an exact comparison impractical.

Rather, the comparison was made to determine if the total hydrologic output from the Blind River study area, as represented by the engineering equations, was reasonable. A number of USGS stream flow gages were considered as potential reference gages with which to compare computed Blind River flow. Ultimately, the gage that was selected for comparison was on the Natalbany River at Baptist (USGS Station ID #07376500, identified as Station #9 on **Figure L2.3.6-15**).

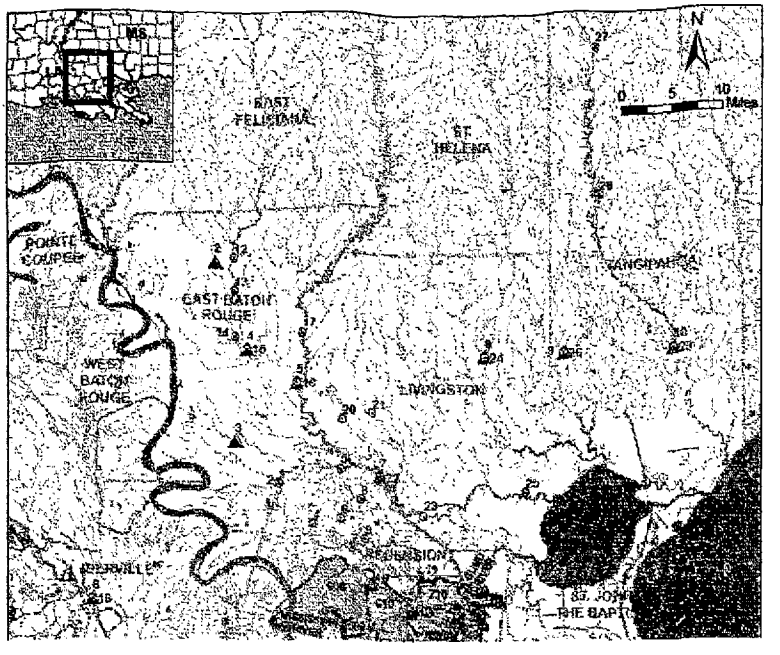


Figure L2.3.6-15 Map of Comparative USGS Stream Flow Gages

This station was selected for the following reasons:

- It is comparable in drainage area to the Blind River study area (79.5 square miles compared with 166 square miles for the Blind River). Many other drainage basins were either much smaller or much larger, and would therefore offer poor correlative value.
- It is comprised of similar land use types, though the fractions vary significantly. Both include substantial areas of woody wetlands (roughly a quarter of the drainage area of the Natalbany River, and more than half the drainage area of the Blind River).
- The available period of record includes the time period used for this analysis (1989-2004), which was determined based on the overlapping periods of necessary data from climate stations and Lake Maurepas.

Key differences between the reference basin and the Blind River Basin include:

- The soils in the Blind River Basin are more poorly drained, as indicated in Table L2.3.6-1. This suggests that unit runoff will be higher in the Blind River than in the Natalbany River.
- The precipitation near the Natalbany Basin (Measured at Hammond, LA – NOAA Station 4030) differs from that of the Blind River Basin (measured at Donaldsonville, LA – NOAA Station 2534), particularly later in the year during 2003. The comparison of 2003 monthly precipitation is shown in Figure L2.3.6-16. This suggests that more runoff would be observed in the Blind River during later months.

Table L2.3.6-1 Soil Type Comparison

Hydrologic Soil Type	Percentage of Watershed Area	
	Blind River Watershed*	Natalbany Watershed**
A	--	--
B	--	11%
C	23%	58%
D	77%	30%

**Based on data used in HEC-HMS*

***Based on analysis of NRCS soil data*

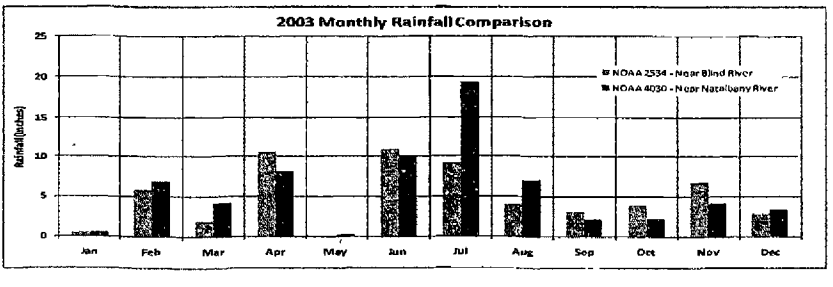
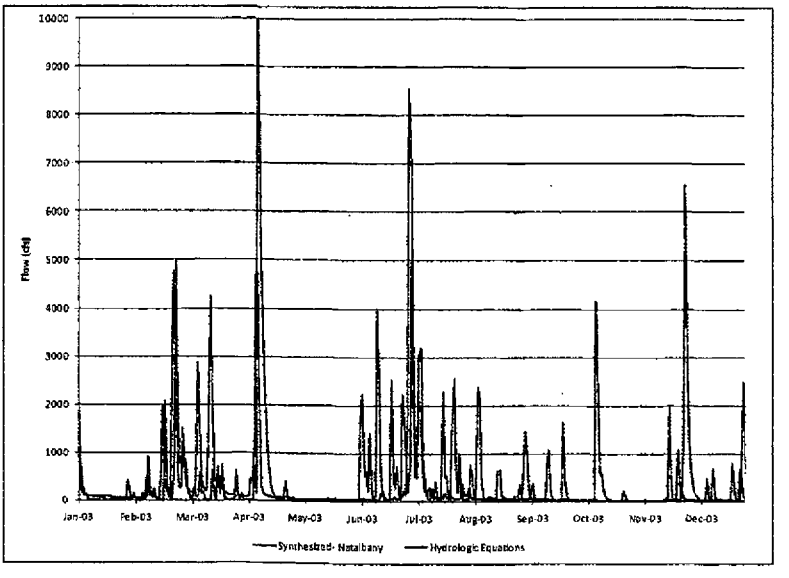


Figure L2.3.6-16 Comparison of Precipitation near Blind River and Natalbany River

The comparison of the engineering calculations (accounting for the combined effects of contributory runoff and simplified hydraulic routing through the swamp areas) with the measured Natalbany data is shown on **Figure L2.3.6-17**. The Natalbany flow data were scaled up by the drainage area ratio of 2.1:1 in order to approximate Blind River flows. As expected, the figure illustrates that the Blind River generally exhibits higher unit discharge, due in part to the poorer drainage ability of the soils.

Also, the figure shows more unit runoff in the Blind River in later months, due to the much higher precipitation in the Blind River vicinity during those months (and a corresponding higher unit runoff in the Natalbany River in July, when that basin received much more precipitation). Over the course of the year, the annual unit discharge for the Natalbany River was just 55% of the unit discharge for the Blind River, but this can be explained in part by the significant differences in soils and precipitation. There is, too, uncertainty inherent in the engineering calculations, which represent complex hydrologic and hydraulic phenomena with simplified relationships. Overall, the engineering equations yielded an average Blind River flow for 2003 (downstream of the study area) of 439 cfs, which accounts for approximately 36 inches of rainfall over the entire 166 square miles of upstream contributory area (or 60% of the total estimated rainfall of 59 inches). Fundamentally, the responses match expectations – higher unit discharge in the Blind River, much more discharge in the later months due to higher regional precipitation, overall high percentage of precipitation converted into runoff due to poorly drained soils, and an overall tendency to respond to large rainfall events with similar patterns of peak flow and hydrograph recession.



"Hydrologic Equations" represents flow downstream of the study area, accounting for natural runoff and simplified hydraulic routing through the swamp, without diversions or berm cuts. "Synthesized Natalbany" represents measured flow in the Natalbany River scaled to the watershed size of the Blind River watershed.

Figure L2.3.6-17 Comparison of Scaled Flow at Natalbany with Calculated Blind River Flow

L2.3.6.3 Engineering Calculations Results (Existing Conditions 1989-2004)

The engineering calculations provide reasonable approximations of hydrologic runoff into the study area and the hydraulic routing through the study area. Using reasonable hydrologic parameters, they help corroborate the HEC-HMS and HEC-RAS results in the absence of actual historical data, and can also be credibly used to extend the hydraulic analysis over the period from 1989-2004, and overcome the limitations of simulation periods that can be completed with HEC-RAS. Consideration of an extended period over multiple years is important, as analysis results demonstrate that boundary conditions are important in this system. The water level in the swamp is highly dependent on the water level in Lake Maurepas, which frequently back-flows into the swamp each year.

Two specific categories of results are provided from the engineering calculations to describe existing conditions within the swamp:

- Annual Average Water Depth; and
- Annual Average Dry-out Frequency.

The annual average water depths were calculated from the 16-year simulation of conditions based on rainfall conditions and Lake Maurepas water levels observed from 1989 to 2004. The engineering calculations produce a daily water level for each hydrologic unit, and the average water depth for each year of the period of record was calculated to determine the annual average. Similarly, results were calculated to characterize the frequency of dry-out conditions in the swamp. Dry-out conditions are defined as times when the water depth drops below 0.5 feet. This metric is indicative of conditions that provide the potential for seedling germination, which is a desirable element for ecosystem enhancement.

In addition, engineering calculations results were developed with projected increases in mean sea level that will result in increases to Lake Maurepas water levels. Similar results are calculated for the array of alternatives (see Section L2.10) for consistency with USACE policy for considering the effects of sea level rise in civil works programs. The sea level rise scenarios presented below correspond to projected sea level rise for 20-year, 30-year and 50-year increments that are utilized by the Wetland Value Assessment (WVA) to quantify project benefits. Average annual water depths are presented in **Table L2.3.6-2** and annual average dry-out frequency is presented in **Table L2.3.6-3**.

Table L2.3.6-2 Average Annual Water Depths (Existing Conditions)

Sea Level Condition	Annual Average Water Depth (feet) by Sub-basin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	1.91	1.86	1.85	2.09	1.34	1.53	1.61
20-Year	1.93	1.90	1.87	2.11	1.37	1.57	1.65
30-Year	1.97	1.97	1.90	2.14	1.42	1.61	1.71
50-Year	2.19	2.24	2.10	2.33	1.64	1.83	2.02

Table L2.3.6-3 Average Annual Dry-out Frequency (Existing Conditions)

Sea Level Condition	Annual Average Dry-out Frequency (%) by Sub-basin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	1%	1%	2%	1%	3%	2%	0%
20-Year	1%	1%	2%	1%	3%	2%	0%
30-Year	1%	1%	2%	1%	3%	2%	0%
50-Year	1%	1%	1%	1%	3%	2%	0%

Note: Dry-out conditions defined as water depth less than 0.5 feet

L2.4 Swamp Hydroperiod Analysis and Alternatives Screening

The term hydroperiod is often used to describe the duration of time that a wetland is inundated by standing water. Applied in context to this project, the term hydroperiod is also used in reference to the cycle of wetting and drying of the swamp areas within the study area. This broader concept of hydroperiod as a cyclical and repeated occurrence is critical to defining conditions from a hydrologic perspective that will promote ecosystem restoration benefits. This section presents hydrologic and hydraulic analyses completed with specific focus on hydroperiod, including hydroperiod conditions that presently occur within the study area, desirable hydroperiod conditions, and potential modifications to the hydroperiod from the project.

L2.4.1 Hydroperiod Characteristics

Since the construction of the Mississippi River flood control levees, Maurepas Swamp and Blind River have been virtually cut off from periodic overflows from the Mississippi River that brought freshwater, sediment, and nutrients to the swamp. With minimal soil building and moderately high subsidence rates, there has been a net lowering of ground surface elevation, so that now the swamps are persistently inundated. A limited ability to drain and persistent flooding characterize the

existing hydrology in the swamp, which conflict with historic drying cycles in the swamp. Features within the study area such as drainage canals, roads, and other utilities disrupt natural flow and drainage patterns. Short circuiting of the natural drainage patterns has created ponding and stagnant waters in some areas. The contribution and circulation of nutrients and sediments is minimal and limited under existing conditions.

In contrast to existing conditions, historic hydroperiod characteristics prior to extensive human modification was dominated by overbank flow of the Mississippi River during spring floods and tidal inflow through Pass Manchac, into Lake Maurepas, and southwest to the study area. Overbank flows from the Mississippi river brought nutrients, sediment, and fresh water that promoted productivity and sustained the health of the swamp ecosystem. As floodwaters receded, surface flows traveled eastward as sheetflow into existing channels and subsequently Lake Maurepas.

L2.4.2 Management Measures to Enhance Hydroperiod Characteristics

During the formulation of potential project alternatives, a number of management measures were conceptualized with the intent of promoting hydroperiod characteristics that would be beneficial to the existing ecosystem in the study area. Early in the planning process, it was recognized that from a hydrologic perspective, beneficial changes to the existing hydroperiod would encompass a balance of multiple elements:

- Increased delivery of freshwater that includes sediment and nutrients to promote productivity;
- Increased circulation of freshwater to increase dissolved oxygen levels;
- Reduced inundation depths within the swamp;
- Reduced durations of inundation within the swamp; and
- Attainment of extended dry periods to promote cypress and tupelo germination and sapling survival.

The project formulation process continued with the identification of potential management measures intended to achieve the desirable hydroperiod characteristics. The following specific management measures were identified and evaluated with respect to their influence on the hydroperiod:

- Water management enhancements in the swamp and redirection of local hydrology. The features of this measure are designed to manage the water that enters the system as rainfall or as drainage from outside of the study area to improve the distribution of water and hydroperiod across the swamp. This will increase the length of dry periods in the swamp and reduce the areal distribution and timing of standing/stagnant water to the extent possible, in order to increase productivity and assimilation while promoting cypress/tupelo germination and sapling growth.

- Gaps in Existing Embankments. There are more than 40 miles of existing embankments (levees and spoil banks throughout the swamp that would be potentially gapped (cut) at regular intervals (e.g., every 500 to 1,000 ft) to allow a more distributed flow pattern in the swamp and better drainage from the swamp.
- New or Improved Culverts at Highway 61. This management measure could also include new and/or improved culverts-bridges under Highway 61 to improve flow and reconnect the hydrology of the Swamp across man-made features.
- Control Structures in Existing Drainage Canals. This management measure consists of gates constructed at strategic locations in the existing drainage canals for lateral distribution of local rainfall-runoff into the swamp (and not bypass the swamp). The distribution weirs would be variable and could be raised during dry, normal, and/or small storm conditions (as determined in the operations plan) to facilitate the dual distribution-drainage system by using the existing drainage and pipeline channels to distribute water, sediments, and nutrients.
- Romeville Freshwater Diversion. This management measure consists of a diversion structure at the Mississippi River and transfer canal from the Mississippi River to the swamp. From a hydrologic and hydraulic perspective, the key aspects of this management measure are that diversion flows enter the St. James Parish Canal at the location of the existing Romeville Canal. The magnitude of the diversion flow and the potential influence area are characteristics analyzed with hydrologic and hydraulic analysis.
- North Freshwater Diversion. This management measure is similar to the Romeville division above, and consists of a diversion structure at the Mississippi River and transfer canal from the Mississippi River to the swamp. From a hydrologic and hydraulic perspective, this management measure provides an opportunity to influence different areas that are likely to be influenced by the Romeville diversion. The magnitude of the diversion flow and the potential influence area are characteristics analyzed with hydrologic and hydraulic analysis.

L2.4.3 Water Management Enhancements

Figure L2.4.3-1 illustrates the potential impacts of improved connectivity between swamp elements associated with gaps in the existing berms. Using swamp area 100 as an example, the figure shows that without cuts or gaps in the existing berms, water levels tend to remain high; generally at or near the berm crest elevation, even when Lake Maurepas is drawn down. This condition suggests that dryout of the swamp in many areas (necessary for seed germination and sapling survival) will be very difficult to achieve, as the internal berms will tend to retain water flowing into the swamp.

The figure also shows that when the berms are gapped to improve connectivity and flow potential throughout the swamp, the water level within the swamp has much more flexibility to follow the lake levels both up and down. This connectivity will allow water to pass out of the swamp more easily during periods when the lake is low, thereby allowing the necessary dry-out conditions for tree regrowth. However, the connectivity can also cause more backwater from the lake to enter the swamp when there is not enough inflowing freshwater from natural runoff. This can be visualized in the difference in the right-hand graph between the blue line for engineering calculations (which is due to fresh water runoff only, and no backflow) and the water level in Lake Maurepas. For these reasons, it was deemed necessary to include gaps in the internal berms as an integral element of every alternative under evaluation.

It was also determined that gaps on their own, without the benefit of diverted water from outside the study area, would be insufficient as a stand-alone alternative, since just as they would facilitate beneficial drainage when Lake Maurepas is low, so too would they allow backflow into the swamp when Lake Maurepas is high. Backflow from Lake Maurepas will potentially increase the movement of water in the swamp, but will provide a source of sediment and nutrients to the project area. More importantly, there is a potential that backflow from Lake Maurepas can at times introduce water with increased salinity levels, which would adversely impact the project area. Reducing the potential for backflow is a compelling reason for including a diversion flow to "push against" the backflow from the lake, and the berm gaps are needed to promote drainage of the swamp when conditions allow it.

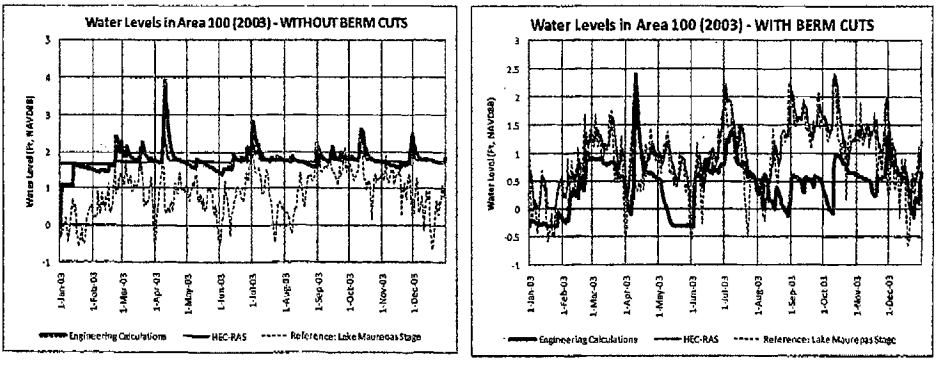


Figure L2.4.3-1 Representative Hydroperiod Modifications from Berm Gaps

L2.4.4 Screening Analysis for Diversion Location and Capacity

A screening analysis was conducted using both HEC-RAS and engineering calculations to evaluate a range of potential freshwater diversion scenarios. A number of variables related to the magnitude, location, and frequency of freshwater diversion flow were initially identified. Fundamentally, the appropriate magnitude of a freshwater diversion to the project area is a balance between maximizing the delivery of sediment, nutrients, and water without exacerbating inundation and stagnation that typify existing conditions. Additional considerations are constraints on the ability to discharge from the project area as a result of Lake Maurepas water levels and the desire to reduce backflow from Lake Maurepas to the project area.

Initial analysis of potential diversion magnitude was completed using HEC-RAS. The existing conditions HEC-RAS model was modified to include a constant diversion inflow that enters the St. James Parish Canal from the Romeville Canal. Simulations completed with various diversion flow rates and resulting flows and water surface elevations in other drainage canals, the swamp, and the Blind River were reviewed. Of particular note was the relationship observed between diversion flow rate and response in the Blind River near the downstream boundary of the project area at I-10. As indicated on **Figure L2.4.4-1**, a diversion flow rate of 500 cfs appears to produce minimal change in the Blind River flow conditions downstream, while a flow rate of 4,000 cfs appears to prevent most occurrences of reverse flow in the Blind River.

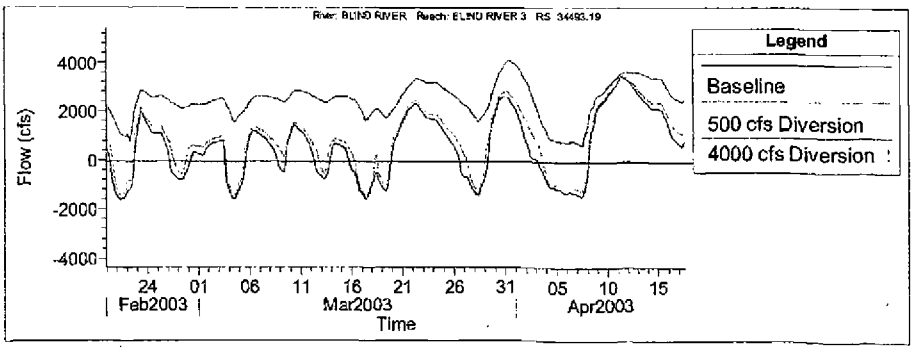


Figure L2.4.4-1 HEC-RAS Simulations with Multiple Diversion Flow Rates

The engineering calculations were then applied over the daily period of record for 1989-2004 in order to screen the broad range of potential diversion capacities, and to test the alternative effects of different diversion locations.

Three diversion locations were screened:

- Romeville;
- South Bridge (originally referred to as "North Bridge"); and

- Combination of Romeville and South Bridge.

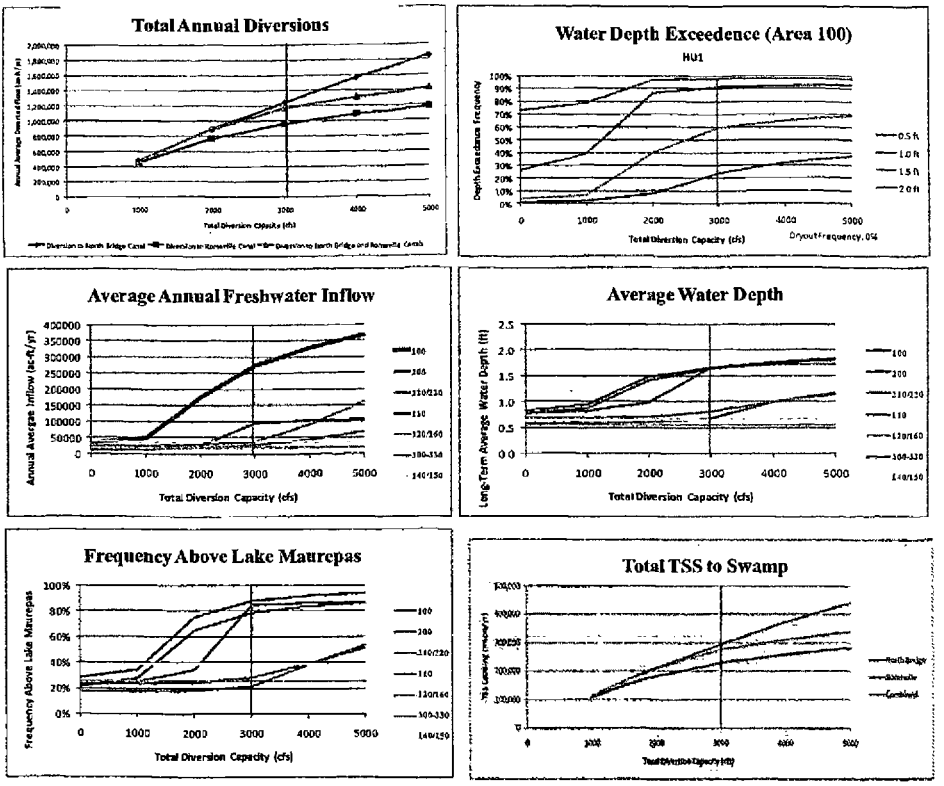
Diversion capacity was then incrementally increased in successive analyses, applying the logic outlined in Section L2.2. Water was diverted only when the average water level in the swamp was below the Lake level. Diversions were discontinued when the average water level in the swamp exceeded the Lake level, or when the lake dropped below 0.5 feet NAVD (to accommodate potential dry-out conditions).

In addition to tracking the total volume of diverted water, five other hydrologic metrics were tracked over the 16-year analysis period for comparative purposes:

- Average annual freshwater inflow (includes runoff and diversions);
- Frequency at which the swamp water level exceeds Lake Maurepas water level (to help prevent backflow);
- Frequency at or above certain water depths in the swamp;
- Long-term average depth of water in the swam; and
- Annual average Total Suspended Solids (TSS) into the swamp (using data from the USGS NWISWeb database, Station 07374000: Mississippi River at Baton Rouge).

Figure L2.4.4-2 illustrates the results of the sensitivity analysis, as the diversion capacity was increased from 1,000 cfs to 5,000 cfs. The graphs illustrate two important findings. First, no substantial change in the response of the system to the introduction of diversions occurs until a capacity of at least 1,000 cfs is provided. At this "point of departure," many of the hydrologic metrics outlined above begin to respond dramatically to increased diversion capacity. Second, once diversion capacity exceeds 2,000 – 3,000 cfs, the hydrologic metrics are generally much less sensitive to increased diversion capacity. That is, above 2,000 – 3,000 cfs, there would be diminishing returns on further increases in capacity with respect to hydrologic sensitivity. This is due in part to the fact that additional capacity may not always be needed to help keep the swamp above the lake elevation. These findings were confirmed (and refined) with the HEC-RAS hydraulic model, which suggested that a minimum capacity of 1,500 cfs would be required to substantively reduce backflow potential, and that 3,000 – 4,000 cfs would be required to practically guard against it completely (based on 2003 conditions).

For these reasons, a minimum diversion capacity of 1,500 cfs was established for the alternatives, and a maximum capacity of 3,000 cfs was established.



Results represent the introduction of water at both Romeville and South Bridge locations simultaneously, with the capacity divided equally between the two. Trends are similar with respect to individual locations for water introduction to the swamp.

Figure L2.4.4-2 Sensitivity of Hydrologic Metrics to Diversion Capacity

The results of the sensitivity analysis were confirmed for each of the alternative locations, and the same trends were observed. That is, whether the diversion site was Romeville, South Bridge, or a division of the total capacity between the two, the range of sensitivity in the hydrologic parameters was very similar. Additionally, all three alternatives for the diversion location yielded substantive hydrologic effects. **For these reasons, none of the three alternatives for diversion location/division were screened out.**

Therefore, the following six alternatives in **Table L2.4.4-1** were identified as a result of this screening process, each of which included as a key element the gaps in berms discussed above to improve connectivity of flow paths throughout the study area:

Table L2.4.4-1 Preliminary Alternatives Identified Through Screening

Alternative Number	Diversion at Romeville (cfs)	South Bridge Diversion (cfs)	In-Swamp Management Measures
1	1,500	-	Yes
2	3,000	-	Yes
3	-	1,500	Yes
4	-	3,000	Yes
5	750	750	Yes
6	1,500	1,500	Yes

Note: In-swamp management measures include berm gaps, control structures and new culverts under US 61.

Further analysis of the potential diversion structure discussed below, indicated that water levels in the Mississippi River could diminish the diversion capacity during certain months (generally August – November) to varying degrees. This, in turn, would effectively reduce the total average capacity of each alternative. For the 1,500 cfs alternatives, this was a concern, since hydraulic modeling and the engineering equations suggested that it was at or near the lower end of prospective capacities capable of providing substantive hydrologic effects. Reduction in the 3,000 cfs capacity was less of a concern, since many of the sensitivity curves actually began to exhibit diminishing hydrologic effects at capacity levels below 3,000 cfs. **For this reason, the alternatives at 1,500 cfs capacity were removed from further consideration.**

The three remaining alternatives were analyzed in detail. Alternative 4 was subdivided into 2 alternatives:

- Alternative 4A: 3,000 cfs diversion at South Bridge, delivered entirely to the South Bridge Canal (passing through swamp areas 100, 200, 210, and 220).
- Alternative 4B: 3,000 cfs diversion at South Bridge: 1,500 cfs delivered to the South Bridge Canal, 1,500 cfs delivered to the St. James Parish Canal for introduction into the swamp in similar fashion to the Romeville Diversion.

Therefore, the final array of alternatives for detailed analysis of costs, environmental impacts, hydrology and hydraulics, and ecosystem restoration potential is identified in **Table L2.4.4-2.**

Table L2.4.4-2 Final Array of Alternatives

Alternative Number	Diversion at Romeville (cfs)	South Bridge Diversion (cfs)	In-Swamp Management Measures
2	3,000	-	Yes
4	-	3,000	Yes
4B	-	3,000*	Yes
6	1,500	1,500	Yes

*Note: Flow split for Alternative 4B accomplished with a single north diversion transfer canal and control structures to split the flow between the swamp transmission canal and the St. James Parish Canal.

L2.4.5 Consideration of Sea Level Rise

The effects of potential sea level rise (discussed elsewhere in this report) are included in the discussion of detailed results of the four alternatives in the final array (Section L.2.10). Ultimately, the final four alternatives are not distinguished by differences in capacity; they all are characterized by diversions up to 3,000 cfs. As such, the impact of sea level rise will not further distinguish the alternatives based on the information available at this time. Detailed consideration of impacts on the Tentatively Selected Plan (TSP) will continue as the TSP advances through the design process, and as further information becomes available on the topography of the swamp and the potential ways that future accretion rates may partially offset sea level rise impacts.

L2.4.6 Effects of Mississippi River Water Level on Diversion Capacity

Boundary conditions are important factors in the dynamics of the Blind River / Maurepas Swamp system. Just as Lake Maurepas water levels can govern water levels in the swamp, and backflow into the swamp, so too can water levels in the Mississippi River affect the ability of an engineered system to move fresh water through the system.

Figure L2.4.6-1 illustrates the relativity of the two boundary conditions, upstream and downstream. While there is almost always positive driving head from the Mississippi River to Lake Maurepas, there are times when the differential is marginal, and also times when the head in the Mississippi River is low enough that full capacity of the diversion structures cannot be achieved. **Figure L2.4.6-2** shows the flow rating curves for conceptually designed diversion culverts at the Romeville diversion location. The design capacity can be achieved when the stage in the Mississippi River is at or above 10 feet NAVD. However, the capacity is diminished when the stage drops below 10 feet.

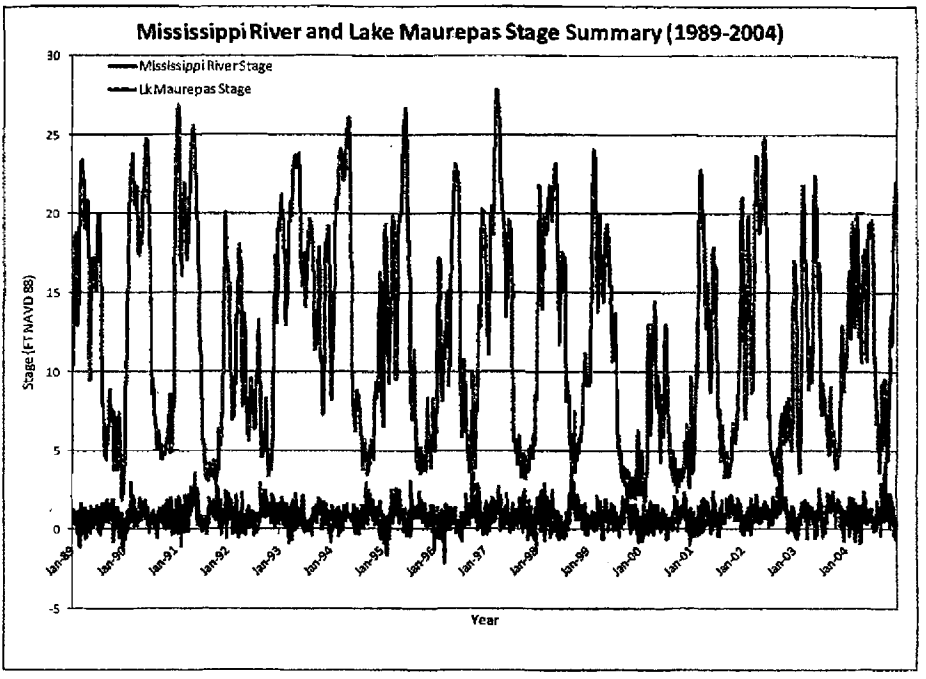


Figure L2.4.6-1 Upstream and Downstream Boundary Condition Water Levels

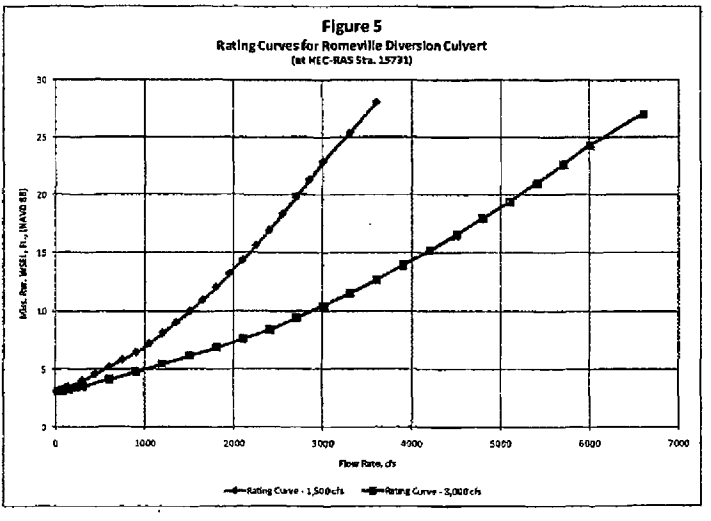
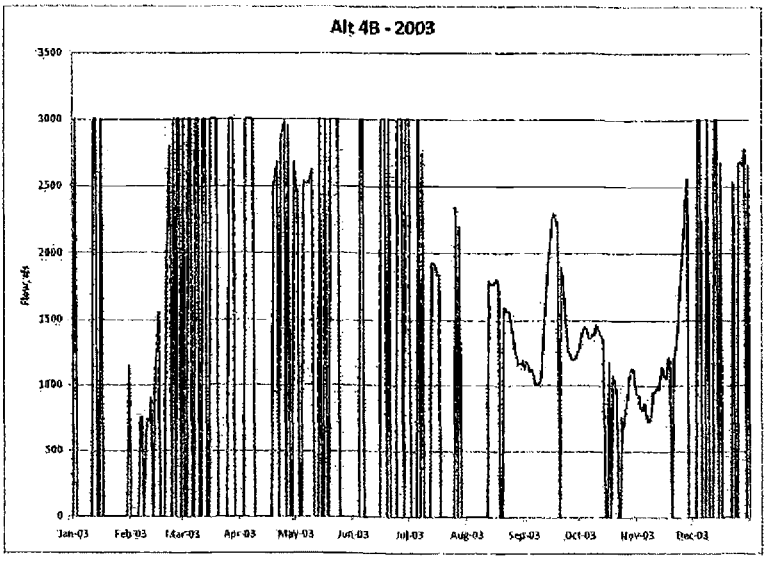


Figure L2.4.6-2 Rating Curve for Romeville Diversion Culvert

The engineering calculations were used to evaluate the potential effects of periodic reductions in diversion capacity. **Figure L2.4.6-3** illustrates the diversion time series for 2003 (the representative year of average hydrologic conditions). In most of the observed years, the reductions in capacity were observed less frequently – 2003 seems to have been a particularly low-flow year for the Mississippi River, even though relatively average for the Blind River system.

Clearly, there is an extended period of time toward the end of the year (generally August through November in most years) in which capacity is diminished. This is partially offset by more frequent and extended diversions. In general, the incorporation of the rating curves and their effects on diversion capacity reduced the overall throughput of freshwater for the alternatives from 15% - 25% when no adjustments to operating logic are applied. However, on average, approximately 5% to 8% of the total throughput can be recovered through alternative operations, such as continuous diversions in July and August, or even continuous diversions between July and November (as long as Lake Maurepas is above 0.5 feet).

With this refinement in the analysis, the basic trends in hydrologic effects did not change, even though the magnitude of effects was diminished somewhat by the upstream boundary conditions. The operational flexibility of the system, and its performance, will be further examined as the TSP is advanced to further planning and design.



Alternative 4B is shown – others follow very similar trends.

Figure L2.4.6-3 Diversion Time Series for 2003 with Capacity Constraints

L2.4.7 Conclusions

This section presented the process by which a very broad spectrum of alternatives was screened down to the most practical and promising four alternatives using simple techniques and an understanding of the dynamics of the Blind River / Maurepas Swamp system. More detailed analysis was conducted on the final array of alternatives, and results are presented in Section L.2.10. The following conclusions can be drawn from the screening analysis discussed above:

- The engineering calculations are reasonable approximations of hydrologic runoff into the study area and the hydraulic routing through the study area. Using reasonable hydrologic parameters, they help corroborate the HEC-HMS and HEC-RAS results in the absence of actual historical data, and can also be credibly used to extend the hydraulic analysis over the period from 1989-2004 (whereas HEC-RAS is practically limited to one-year simulations due to the hydraulic complexity of the system).
- There are three principal areas of uncertainty that must be considered when evaluating these results:
- The topographic information used to define the bathymetry of swamp area is coarse, and should be refined as the TSP is advanced into more detailed planning and design phases.
- The analysis is based on historic climate and hydrologic conditions – future conditions cannot be forecast, although the four alternatives in the final array are evaluated under the influence of projected sea level rise in Section L.2.10.
- The swamp areas in this analysis were represented as storage areas with uniform access to available water. In reality, they will be characterized by overland flow. Three-dimensional hydrodynamic modeling is currently underway to better define flow pathways and the potential for equitable distribution of water throughout the targeted swamp areas.
- Boundary conditions are very important in this system. The water level in the swamp is highly dependent on the water level in Lake Maurepas, which has historically back-flowed into the swamp regularly (the diversion will be aimed at limiting this to the extent practical). Likewise, at the upstream end of the system, the Mississippi River stage can significantly reduce the diversion capacity during certain months, which can, in turn, permit unwanted backflow from Lake Maurepas more frequently.
- Gaps in the existing berms are an essential element in each of the alternatives. They will provide flow pathways to allow drainage when Lake Maurepas is at low levels, which in turn can promote periodic dry conditions in the swamp that are needed for seed germination and sapling survival. However, the gaps on their own without the benefit of diverted water from outside the study area would be insufficient as a stand-alone alternative. Just as they would facilitate beneficial drainage when Lake Maurepas is low, so too would they allow detrimental backflow into the swamp when Lake Maurepas is high. Therefore,

the gaps are included as an element to each alternative to promote drainage, but are not considered as an alternative on their own.

- A minimum of 1,500 cfs diversion capacity is required to provide substantive hydrologic effects in the swamp, including the prevention of backflow from Lake Maurepas. However, this lower limit is fairly marginal in its potential hydrologic effectiveness.
- Diversion capacities above 3,000 cfs begin to exhibit diminished hydrologic effects (sometimes even lower than 3,000 cfs), as measured by five hydrologic metrics: freshwater inflow, frequency of backflow prevention, frequency of water depths, long-term average water depth, and introduction of Total Suspended Solids. Therefore, 3,000 cfs was identified as the upper limit of diversion capacity for the alternatives analysis.
- Both diversion locations offer the potential for hydrologic effects, though the distribution of these effects is different. Therefore, the hydrologic screening analysis did not rule out either diversion location alternative (Romeville or South Bridge, or both). Hence, the preliminary array of screened alternatives included six (in addition to the No-Action alternative): 1,500 and 3,000 cfs diversions at Romeville, South Bridge, and divided equally between both.
- The reduction in driving head when the Mississippi River is at low stages (below 10 feet NAVD) can reduce the capacity of the diversion system. This, in turn, can reduce the average total freshwater throughput in the system, though the reduction can be partially offset by preemptive diversions in certain months (this will be further developed as the TSP advances through further planning and design, and as hydrodynamic modeling is advanced to provide better understanding of the effectiveness of water distribution throughout the study area). However, since the alternatives with 1,500 cfs capacity were deemed marginal even without this periodic reduction in capacity, the potential for reduced flow effectively ruled out the 1,500 cfs alternatives. The final array is comprised of four alternatives, all of which include 3,000 cfs diversions.
- The final array of alternatives includes 4 configurations, all of which include berm gaps to improve internal drainage:
- Alternative 2: Romeville at 3,000 cfs;
- Alternative 4A: South Bridge at 3,000 cfs, routed primarily to the North of the Blind River;
- Alternative 4B: South Bridge at 3,000 cfs, divided between North and South of the Blind River by diverting 50% of the flow southward through the St. James Parish Canal; and
- Alternative 6: 1,500 cfs diversions at both Romeville and South Bridge.

L2.5 Hydrodynamic Analysis

Appendix Section L2.2 presented an overview of multiple analysis methods used within the study area and Appendix Section L2.3 discussed detailed watershed hydrology and hydraulics analysis with HEC-HMS and HEC-RAS. As discussed in Section L2.2.3, the EFDC model provides a more detailed spatial and temporal representation of hydrodynamic variation and characteristics within the project area.

This section discusses each component of the hydrodynamic analysis completed to evaluate existing conditions, including supporting data, model testing, and specific simulations. This section also presents supporting information relevant to understanding hydrodynamic constraints and opportunities, which were considered during evaluation of project alternatives, as presented in Section L2.10.

L2.5.1 Flow and Stage Boundary Conditions

A local watershed model, HEC-HMS, and flow routing and water surface calculation model, HEC-RAS, were developed to provide channel/canal flows and stages as the boundary conditions for the EFDC model. Detailed information regarding these two models can be found in Sections L2.2 through L2.4. The locations of boundary conditions provided by 18 HEC-HMS simulated channel/canal flows and 2 HEC-RAS simulated canal/river stages (**Figure L2.5.1-1**) were incorporated in the EFDC model to define flow and stage boundaries from upstream and downstream locations that influence the project area. For this feasibility study, the year 2003 was selected as a basis for representing average hydrologic conditions during model setup, testing, and alternative analysis. HEC-HMS model simulated 2003 local watershed inflows to the project area are shown on **Figure L2.5.1-2a** and **Figure L2.5.1-2b**.

HEC-RAS simulated flows for the Conway Canal and Blind River stages at I-10 (Figure L2.5-1) were used as stage boundaries in the EFDC model. In general, the Blind River stages at I-10 significantly influence water elevation in the swamp although the water elevations in the swamp do not instantaneously respond to the river stages due to high vegetation resistance in the wetland. **Figure L2.5.1-3** shows the 2003 stage data at these two locations simulated by the HEC-RAS model for existing conditions. It is noted that the range and pattern of the simulated stages at the two locations are very similar.

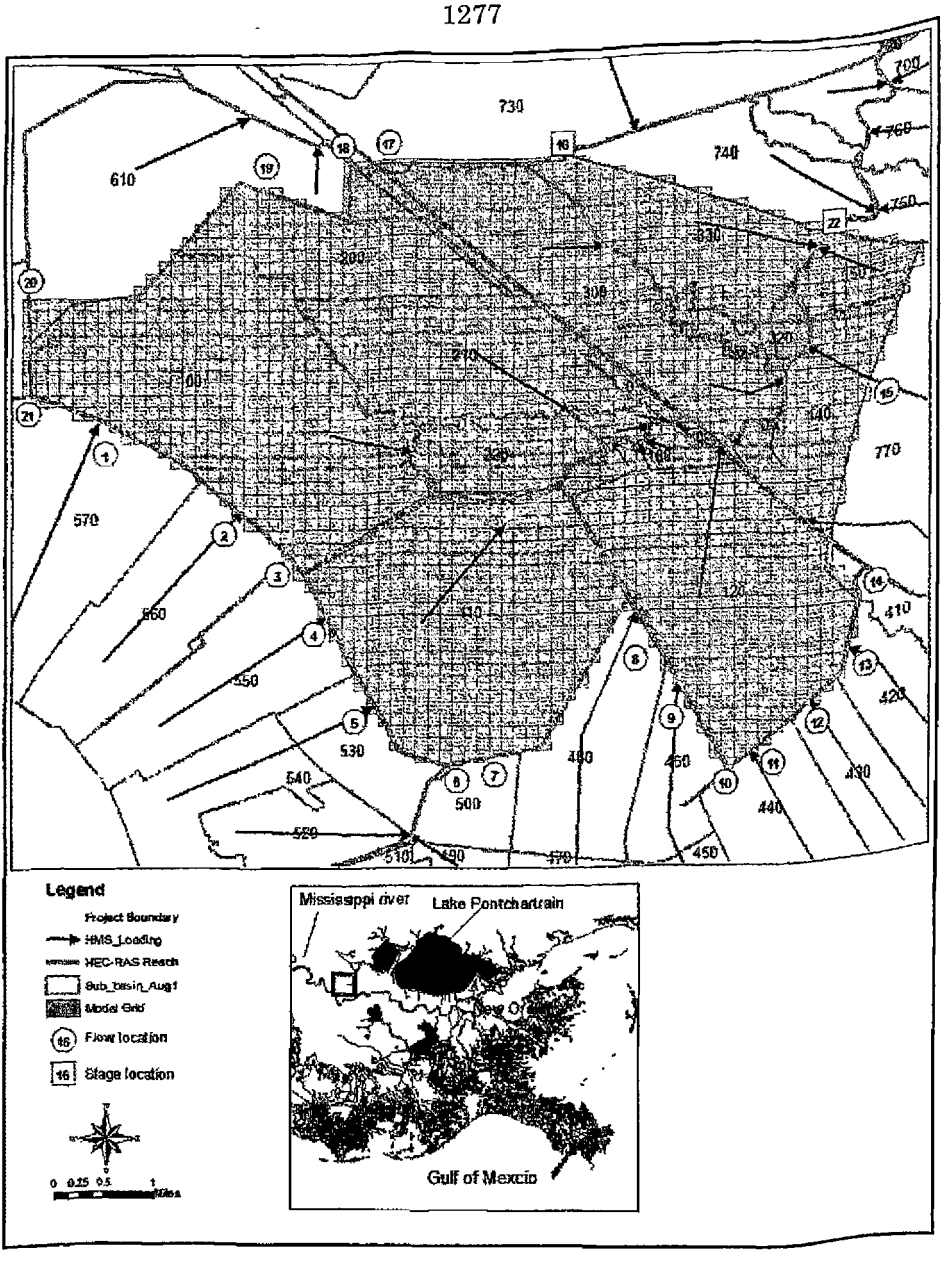


Figure L2.5.1-1 Locations of EFDC Flow and Stage Boundaries

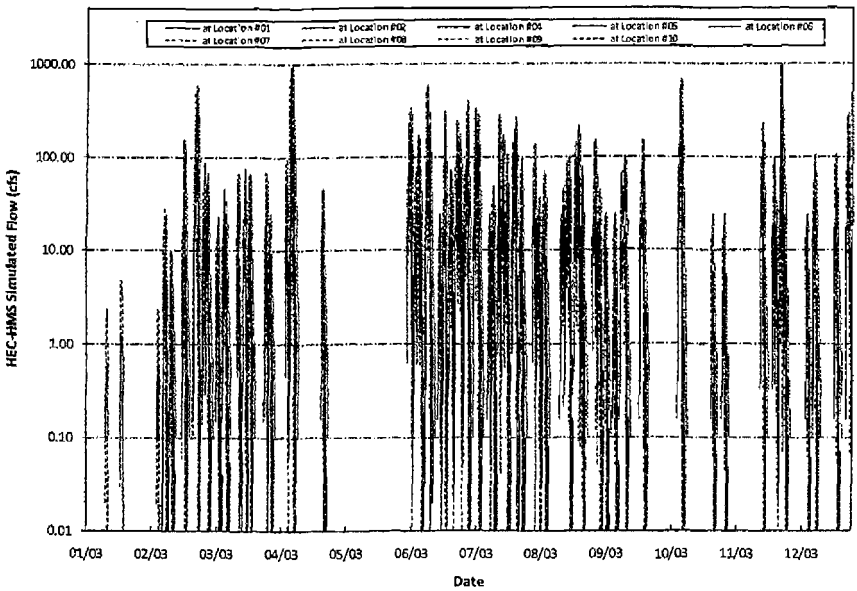


Figure L2.5.1-2a Boundary Inflows (Locations 1 to 10)

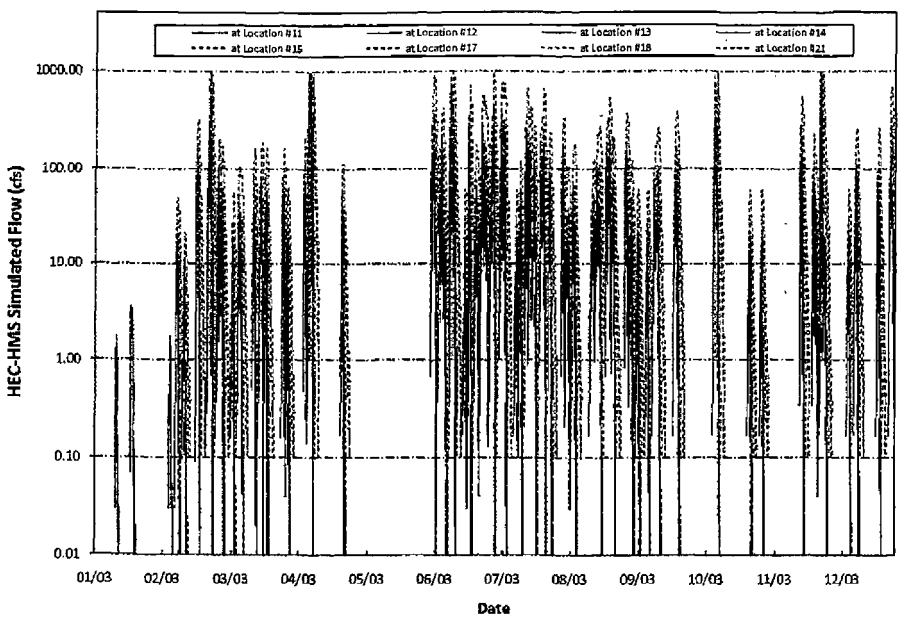


Figure L2.5.1-2b Boundary Inflows (Locations 11 to 21)

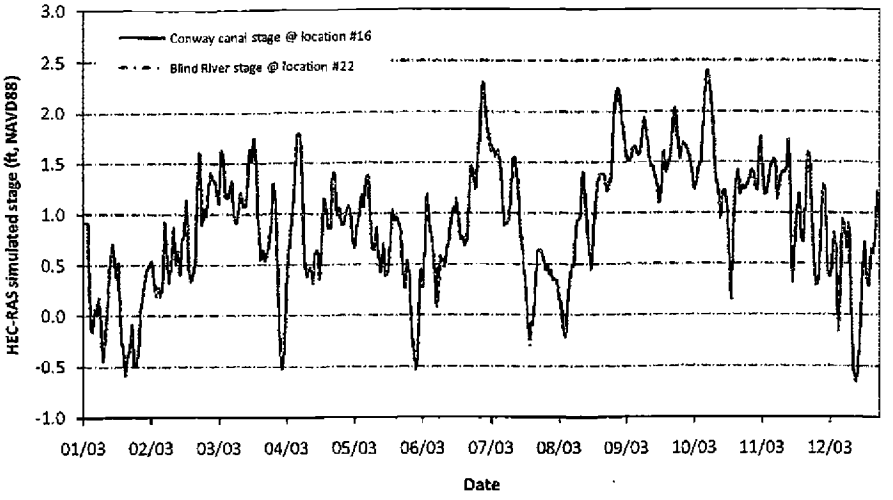


Figure L2.5.1-3 Downstream Boundary Stage

L2.5.2 Temperature Boundaries

To simulate water temperature in the wetland, water temperature data along with the flows and stages at the boundaries are needed. However, no measured watershed runoff temperature data in the area were available and very limited water temperature data at the two most nearest gauges - Baton Rouge gauge (Gauge ID 7374000) and Belle Chasse gauge (Gauge ID 7374525) on the Mississippi River were measured during 2003. For modeling purposes, continuously monitored daily mean temperature data from the Baton Rouge gauge in 2006 was selected because it provided the most complete period of record.

A plot of the temperature data is shown on **Figure L2.5.2-1**. The plot demonstrates a seasonal pattern, where warmest water temperatures occur late June through August, while cooler temperatures occur in late December through early March. In general, although water temperature associated with the watershed runoff will be slightly different from that of a large river, such as the Mississippi River, the river water temperature shown on Figure L2.5.2-1 was used for all watershed inflow boundaries and stage boundaries.

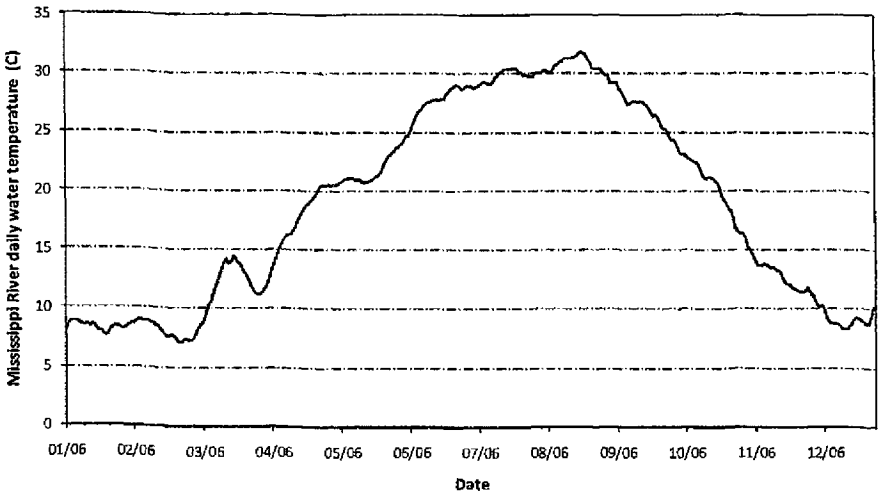


Figure L2.5.2-1 Mississippi River Daily Water Temperature (2003)

L2.5.3 Sediment Boundaries

Sediment is an essential component for evaluating hydrologic benefits and impacts from the project. As discussed in Section L2.4, historical supply of sediment was interrupted when the Mississippi River levees were constructed. For existing conditions, local watershed runoff will contribute minimal amounts of sediment. For the purpose of representing sediment contributions from forests/wetlands, a mean sediment concentration of 8.5 mg/L was used based on Harper and Baker (2007). Sediment associated with the watershed runoff will be delivered into the project area at various locations as shown on Figure L2.5.1-1. Due to lack of sediment concentration data, the sediment concentrations associated with the Blind River stage boundary were considered to be a constant value of 10 mg/L.

The introduction of sediment from a constructed freshwater diversion has the potential to reduce the subsidence of the project area and bring more nutrients to revitalize the ecosystem of the swamp. The main source of sediment from potential freshwater diversion flows will be the Mississippi River. Limited sediment concentration data collected at the Baton Rouge gauge on the Mississippi River were used to developed monthly average sediment concentration for year 2003 as shown on Figure L2.5.3-1. Field data in other studies (Snedden et al., 2006) showed that in a normal river flow condition, about 99% of the suspended sediment in the river water column is fine cohesive sediment with particle size varying from ~63 um (coarse silt) to ~1 um (very fine clay). For purpose of sediment transport deposition and erosion model simulation, the median sediment particle size was considered to be 2.5 um (USGS, 1988). Based on Stokes Law, for a particle size of 2.5 um, the settling velocity is 8.2 ft/day. This settling velocity was used in the model although the actual settling velocity can be higher due to sediment flocculation.

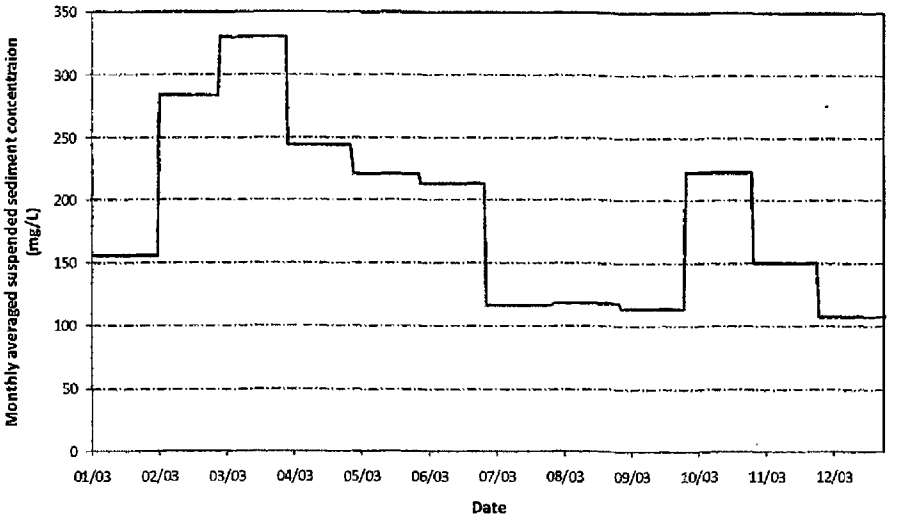


Figure L2.5.3-1 Monthly Average Mississippi River Suspended Sediment Concentration (2003)

L2.5.4 Water Quality Boundaries

For water quality associated with stormwater runoff, hourly loading was calculated using flows from the HEC-HMS model at each flow location shown on Figure L2.5.1-1 multiplied by the typical concentrations reported in the literature and a conversion factor. **Table L2.5.4-1** presents a summary of the parameters that were included in the water quality for runoff. As shown in the table, the majority of the runoff values were obtained from Harper and Baker (2007). The data from Harper and Baker (2007) only provided total concentrations for nitrogen and phosphorus. Therefore, the runoff concentrations of various nitrogen and phosphorus species were estimated using averages of observed data from the Mississippi River at both Baton Rouge and Belle Chasse stations. The refractory and labile components were also calculated using the same assumptions presented in the diversion discussion above. A summary of model input loads from runoff at each flow location shown on Figure L2.5.1-1 are presented in **Table L2.5.4-2.**

In the event of a freshwater diversion from the Mississippi River, additional nutrients will be delivered to the project area. The Baton Rouge (Gauge ID 7374000) and Belle Chasse (Gauge ID 7374525) monitoring stations were used to supply water quality input information for the diversion flow. For both gauges, average concentrations for the period of record at each gauge were calculated and are shown in **Table L2.5.4-3.** As can be seen from the table, average concentrations

of most parameters are quite similar between the two stations (less than 20%) with the only exceptions being BOD5, dissolved organic nitrogen, and dissolved organic carbon. Average BOD5 concentrations were found to be higher at Baton Rouge, while dissolved organic nitrogen and dissolved organic carbon were found to be higher at Belle Chasse.

The saturated dissolved oxygen concentration was first calculated using a standard empirical equation as follows (Weiss, 1970):

$$\ln(DO) = A_1+A_2*100/T+A_3*\ln(T/100)+A_4*T/100+S*[B_1+B_2*T/100+B_3*(T/100)^2] \quad (1)$$

where $A_1 = -173.4292$, $A_2 = 249.6339$, $A_3 = 143.3483$, $A_4 = -21.8492$,

$B_1 = -0.033096$, $B_2 = 0.014259$, $B_3 = -0.001700$,

T = temperature in Kelvin, and S = salinity (g/kg).

The daily mean temperature data from the Baton Rouge gauge in 2006 as shown on Figure L2.5.2-1 were used in the DO calculation with the above Eqn. (1). Then, the estimated diversion flow DO was obtained by multiplying the calculated saturated DO with the average DO percent saturation (89.6%), which was calculated from limited DO percent saturation data collected at the Baton Rouge and Belle Chasse gauges.

Table L2.5.4-1 Runoff Water Quality Concentrations

Constituent	Runoff value	Source
BOD5	1.40	Harper & Baker, 2007
Organic Carbon - Dissolved	9.07	Suarez et al., 2006[1]
Organic Carbon - Particulate	7.83	Suarez et al., 2006[1]
Dissolved Ammonia	0.02	Harper & Baker, 2007[2]
Organic Nitrogen - Dissolved	0.17	Harper & Baker, 2007[2]
Organic Nitrogen - Particulate	0.13	Harper & Baker, 2007[2]
Nitrate + Nitrate - Dissolved	0.78	Harper & Baker, 2007[2]
Total Phosphorus	0.06	Harper & Baker, 2007[2]
Organic Phosphorus - Dissolved	0.00	Harper & Baker, 2007[2]
Organic Phosphorus - Particulate	0.03	Harper & Baker, 2007[2]
Total Nitrogen	1.15	Harper & Baker, 2007

Notes: [1] Site SS-9 used to provide total organic carbon value; distributed based on average observed concentrations at Baton Rouge and Belle Chasse USGS stations; and [2] Total provided, distributed over

Table L2.5.4-2 Runoff Load Summary

Location	Total Phosphorus (lb/year)	Total Nitrogen (lb/year)	Nitrate + Nitrite (lb/year)
#14	41,895	875,978	591,115
#13	29,051	607,434	409,900
#10	27,176	568,226	383,442
#5	31,617	661,085	446,104
#1	79,741	1,667,305	1,125,108
#3	8,011	167,505	113,033
#9	48,796	1,020,285	688,494
#7	11,900	248,810	167,898
#2	12,443	260,178	175,570
#4	31,326	654,993	441,993
#6	14,606	305,403	206,088
#8	19,754	413,048	278,727
#11	24,074	503,367	339,675
#15	72,451	1,514,889	1,022,257
#20	85,624	1,790,317	1,208,117
#19	176,345	3,687,210	2,488,152
#16	42,995	898,995	606,647
Total	774,364	16,191,253	10,925,958

Table L2.5.4-3 Diversion Flow Water Quality Concentrations

Constituent	Belle Chasse Average (mg/l)	Baton Rouge Average (mg/l)	Average Value Used for Model Input (mg/l)
BOD5	3.60	1.97	2.79
Organic Carbon - Dissolved	3.89	3.68	3.79
Organic Carbon - Particulate	3.39	3.15	3.27
Dissolved Ammonia	0.04	0.02	0.03
Organic Nitrogen - Dissolved	0.35	0.35	0.35
Organic Nitrogen - Particulate	0.28	0.25	0.27
Nitrate + Nitrate - Dissolved	1.58	1.51	1.55
Total Phosphorus	0.27	0.23	0.25
Organic Phosphorus - Dissolved	0.01	0.01	0.01
Organic Phosphorus - Particulate	0.17	0.14	0.16
Total Nitrogen	2.35	2.23	2.29

Model input loads were calculated using the diversion flow multiplied by the various water quality concentrations and a conversion factor. Labile and particulate components were estimated using the assumption that the refractory component represented 80% of the organic species, while the labile component was comprised of the remaining 20%. A summary of the daily and yearly loads for total phosphorus, total nitrogen and nitrate+nitrite (NOx) from the diversion flow is shown in **Table L2.5.4-4** for a 3,000 cfs diversion flow. As shown in the table, the total nitrogen load for the diversion flow is 37,062 lb/day, while the total phosphorus load is 4,043 lb/day.

Table L2.5.4-4 Nutrient Loads for 3,000 cfs Diversion Flow

Constituent	Load (lb/day)	Load (lb/year)
Total Phosphorus	4,043	1,475,608
Total Nitrogen	37,062	13,527,628
Nitrate+Nitrite	25,010	9,128,527

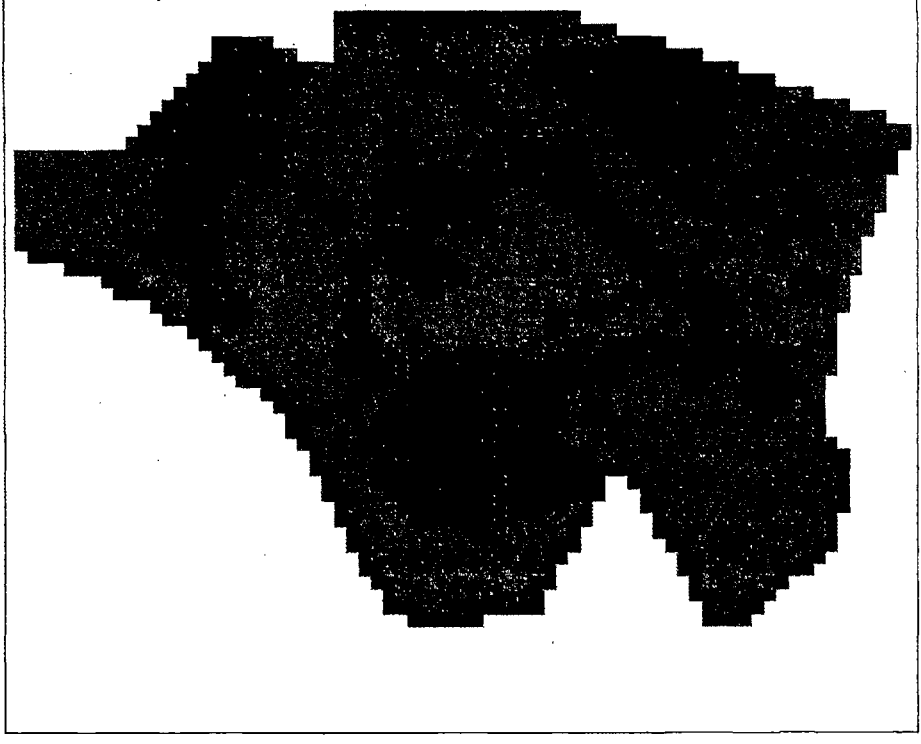
L2.5.5 Wetland Vegetation and Bottom Resistance

Flow resistance within the project area will relate directly to the type and density of existing vegetation and trees. Roughness coefficients were developed based on a wetland evaluation completed in support of the project. **Figure L2.5.5-1** illustrates how varying quality and characteristics of existing wetlands were applied to the model grid cells in order to represent 1) the Blind River; 2) Canals; 3) Areas with trees classified as 20-30 years to marsh; 4) Areas with trees classified 30-50 years to marsh; and 5) Areas with trees classified >50 years to marsh. For three different types of vegetation/tree zones, average tree diameters and tree densities were used in the EFDC model to better simulate vegetation resistance (**Table L2.5.5-1**).

Table L2.5.5-1 Average Tree Diameters and Densities by Condition Class

Condition Class	Average tree diameter (ft)	Average tree density (tree/acre)
20-30 years to marsh	0.92	119
30-50 years to marsh	1.21	184
>50 years to marsh	1.31	205

Bottom roughness values were used for different tree/vegetation zones in the project area. Based on field observation, for the areas with trees classified 20-30 years to marsh, the areas with trees classified 30-50 years to marsh, and the areas with trees classified > 50 years to marsh, the log law roughness height was assigned to a constant value of 15 cm, 10 cm, and 8 cm, respectively.

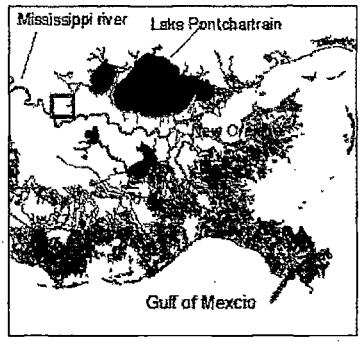


Legend

Vegetation Type and Distribution

- 20-30 years to marsh
- Canal cells
- Blind River cells
- 30-50 years to marsh
- >50 years to marsh

0 0.25 0.5 1 Miles



Blind River Freshwater Diversion Feability Study

Vegetation Type and Distribution

Figure L2.5.5-1

L2.5.6 Meteorological Forcing

Meteorological forcing boundary data include atmospheric pressure, dry atmospheric temperature, wet bulb atmospheric temperature, rainfall, evaporation rate, solar short wave radiation, fractional cloud cover, and wind speed and direction. Because no meteorological stations are located near the project area, the Donaldsonville station (Station 2534), which is located about nine miles west from the center of the project area, and the LSU Ben-Hur Farm station (Station 5620), which is located about 30 miles northwest from the center of the project area, were used for rainfall and evaporation data collection, respectively. All other meteorological forcing parameters were collected from the Baton Rouge station. To more accurately represent the tree canopy shading effect that blocks part of the solar radiation, the solar radiation data were multiplied by a factor of 0.67 and 0.33 for the wetland and the canals / Blind River, respectively, in the model simulations.

L2.5.7 EFDC Model Testing

Initial EFDC model setup was based on existing conditions. The year 2003 boundary data including meteorological forcing data, watershed inflows, canal and river stages, and water quality data were considered in the model setup. To test and verify the model setup, a dye test run was conducted to check mass balance, model connectivity, and water depth and velocity against best knowledge of the swamp. The test showed that the model was properly set up and all simulated results were reasonable.

It should be pointed out that no model calibration and validation were conducted due to lack of field data.

L2.5.8 Existing Condition Simulation

In the existing condition, the existing canal/channel system conveys/drains the surrounding watershed flow and wetland flow into the Blind River when the Blind River stage is low. However, when the river stage is higher than the swamp bottom elevation due to the higher stage of Lake Maurepas, the river flows backward and floods the swamp.

In the model simulation for the existing condition, represented by simulation of the year 2003, the HEC-HMS simulated surrounding watershed runoffs were treated as point sources feeding into the project area at various locations and the HEC-RAS simulated stages at Conway Canal and I-10 on the Blind River were used as stage boundaries. The locations of the flow and stage boundaries are indicated on Figure L2.5.1-1.

Each simulation ran for the first 300 days of 2003. The simulated water depth and elevation, sediment, and water quality results of the swamp are summarized and discussed in the following sections.

L2.5.8.1 Water Depth and Elevation

Table L2.5.8-1 summarizes the simulated average water depth for different hydrologic response units (HRUs) as shown on Figure L2.5.1-1 and the project area excluding the canals and Blind River for different scenarios. The largest and smallest water depth occurred in Subbasins 200 and 150 with a depth of 1.45 ft and 0.64 ft, respectively. The initial model condition for the Existing Conditions (2003) lasted for almost eight months due to the stagnant swamp flow with very small velocity; therefore, the average water depth and elevation and flow velocity shown in Table L2.5.8-1 were calculated based on the results of the last two months of the 10-month model run. The average water depth for the project area excluding the canals and Blind River was 0.90 ft. The water elevations for various HRUs in the project are also summarized in Table L2.5.8-1. Except for Subbasin 150, all other HRUs have a similar water elevation of 2.40 ft NAVD88.

The model simulated spatial distributions of water depths and elevations throughout the project area are presented on **Figure L2.5.8-1** and **Figure L2.5.8-2**, respectively.

Table L2.5.8-1 Average EFDC Results by Hydrologic Response Unit

Hydrologic Response Unit/Subbasin	Water Depth (ft)	Velocity (ft/day)	Sediment Volume (cubic yards)	Hydraulic Residence Time (days)
Project Area	0.90	256	-2.78E+04	-
100	0.74	154	-6.24E+00	42.0
110	0.78	158	0.00E+00	37.8
120	0.86	149	-1.09E+01	37.4
140	1.02	416	-1.71E+02	37.4
150	0.64	2,127	-2.76E+04	8.1
160	0.83	258	0.00E+00	37.4
200	1.45	263	-1.66E+01	38.3
210	0.81	200	0.00E+00	38.3
220	0.80	318	0.00E+00	37.8
300	1.25	294	0.00E+00	37.4
320	0.76	357	0.00E+00	37.2
330	1.08	383	0.00E+00	37.4

L2.5.8.2 Water Velocity

The model simulated existing conditions average velocity for different HRUs and the project area excluding the canals and Blind River are also summarized in Table L2.5-6. The largest and smallest velocity occurred in Subbasins 150 and 120 with a velocity of 2,127 ft/day and 149 ft/day, respectively.

Existing wetland flow velocity was extremely small and most of the water in the wetland was stagnant during dry periods. However, during or shortly after a storm event, wetland velocity could be relatively higher due to runoff from the surrounding watershed. **Figure L2.5.8-3** shows the spatial distribution of the flow velocity in the project area at day 300. On that specific day, the flow velocities were very small, except those near the river exit at I-10.

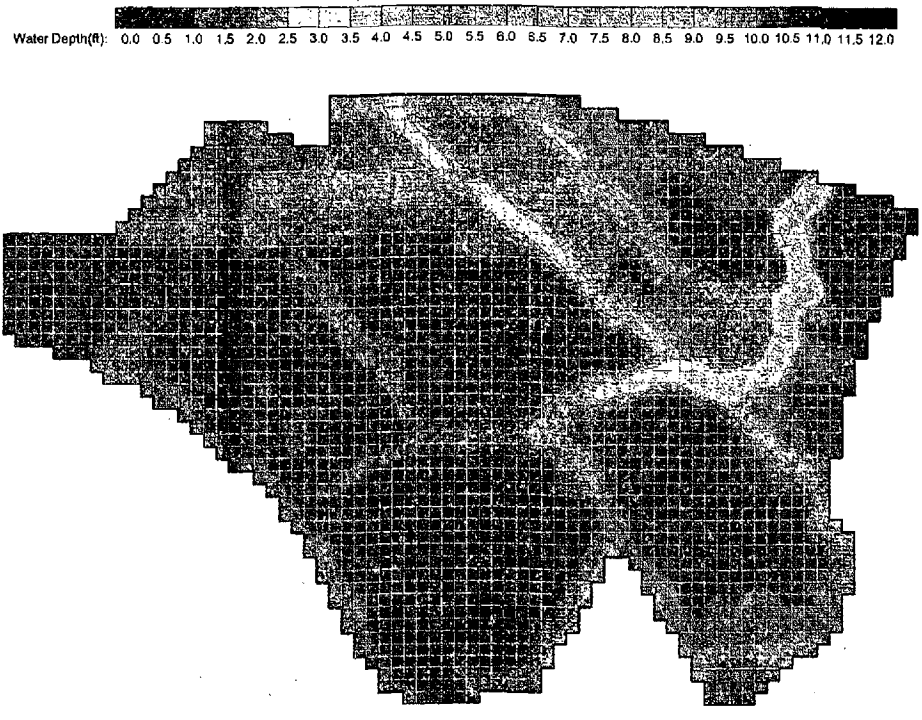


Figure L2.5.8-1 Simulated Water Depth (Day 300)

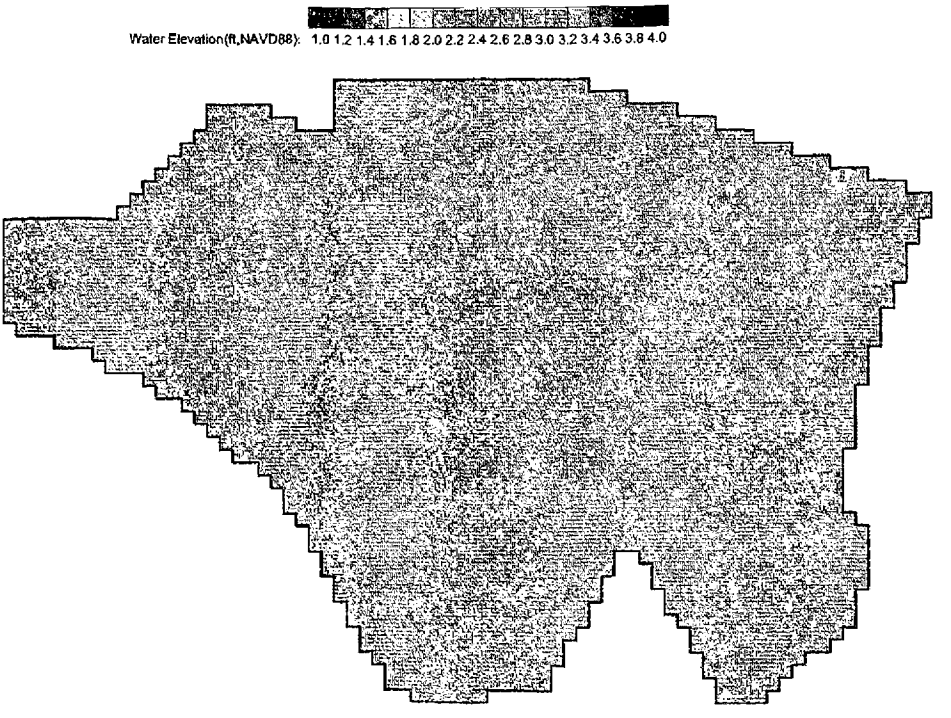


Figure L2.5.8-2 Simulated Water Elevation (Day 300)

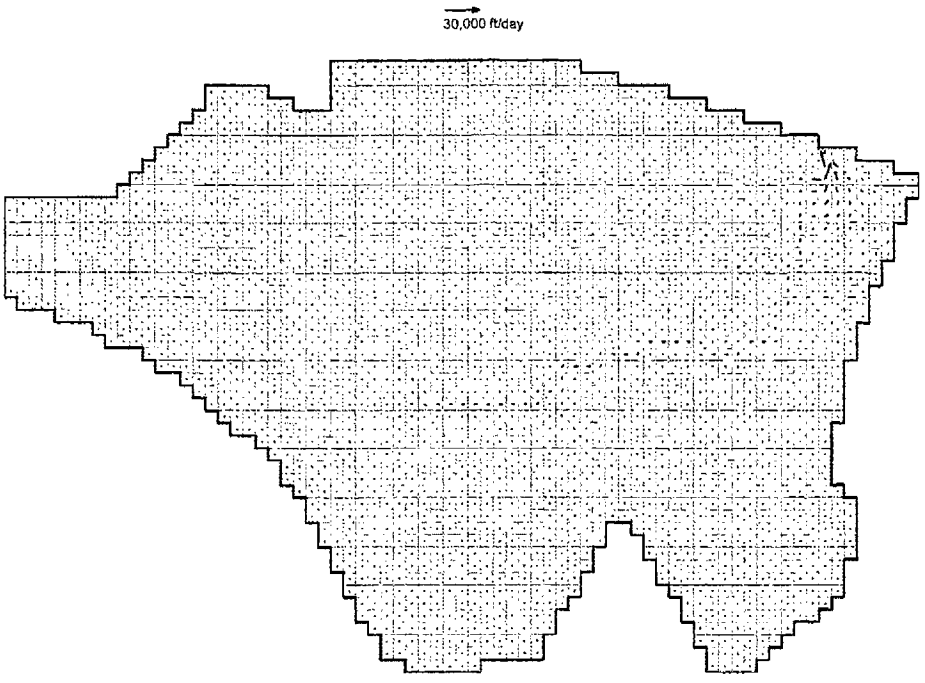


Figure L2.5.8-3 Simulated Flow Velocity (Day 300)

L2.5.8.3 Hydraulic Residence Time

Hydraulic residence time (HRT) is another target parameter in wetland restoration. HRT is defined as the time a fluid parcel takes to travel from its initial location to one of the model domain exits. Therefore, HRT is a function of velocity and can vary spatially and temporally. In general, higher velocity results in lower HRT. However, if water flows circularly, the HRT can still be large.

For each HRU, an EFDC conservative dye model was set up to accurately simulate the HRT. In this approach, both flow advection and diffusion were evaluated in the EFDC model during calculation of the HRT for each HRU; therefore, it is more accurate than other methods, such as calculating HRT using particle tracking technique, which only accounts for advection.

For existing conditions, HRT depends on how long a storm event occurs after dye release. Therefore, it is expected that the HRT will be very big during the dry season and will be relatively small during the wet season. For consistency, the time

when the peak dye concentration exited from the river at I-10 was used in calculating the HRT for each HRU. The simulated average HRTs for different HRUs are also summarized in Table L2.5.8-1. For Existing Conditions (2003), the HRTs are generally larger due to stagnant or very low velocity flow, with the largest HRT (42 days) at Subbasin 100 and the smallest HRT (8 days) at Subbasin 150.

Figure L2.5.8-4 shows an example of the dye concentration plot at the I-10 Bridge on the Blind River for the Subbasin 100. It should be noted that none of the dye releases at any of the subbasins completely exit from the I-10 Bridge during one storm event, but rather after several storm events. **Figure L2.5.8-5** shows the spatial distribution of HRT for each model cell for the Existing Conditions (2003) at day 300. Although the color shaded HRT map only shows the HRT at the model cell scale, not the subbasin scale, it does indicate which part of the wetland has large or small HRTs, with pink-orange color for HRT around 2 hours and purple color for HRT around 168 hours (one week). The gray shaded area on Figure L2.5.8-5 indicates that the HRT is higher than one week. Based on the definition of HRT, the HRT for each subbasin is the integration of the HRT at each model cell along the path of fluid parcel traveling from each HRU to the river exit at I-10 Bridge. Therefore, the HRT for each subbasin is very large as shown in Table L2.5.8-1.

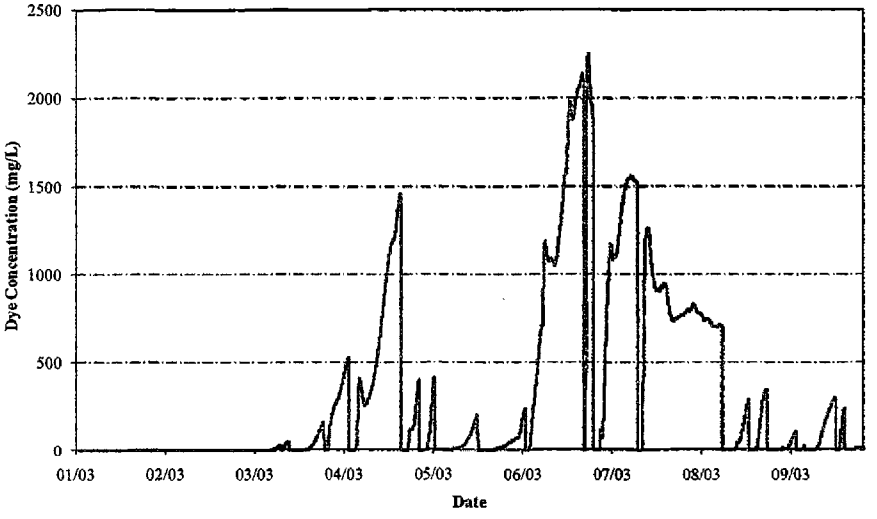


Figure L2.5.8-4 Simulated Dye Concentration (Blind River at I-10)

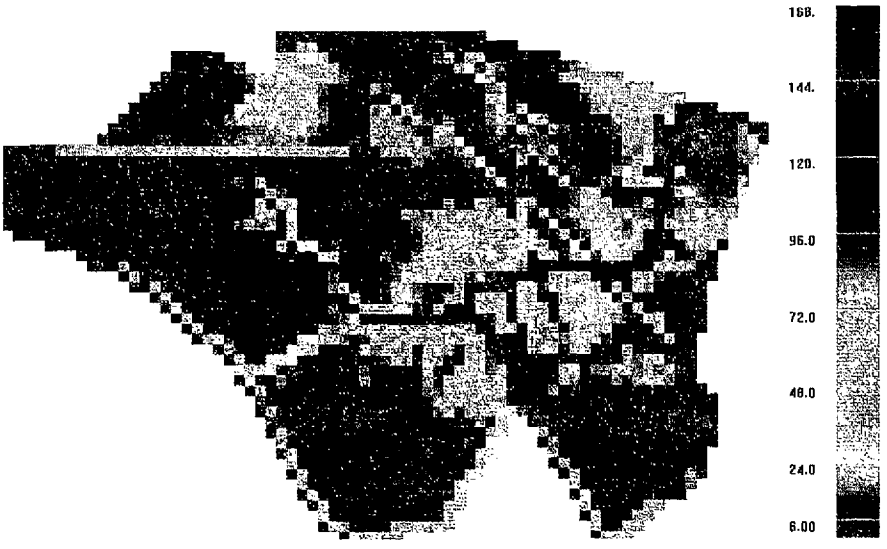


Figure L2.5.8-5 Model Simulated Hydraulic Residence Time (Day 300)

L2.5.8.4 Sediment

For existing conditions, minimal sediment was brought into the project area from surrounding watershed runoff with very low sediment concentration. It is interesting to note, however, that some sediment erosion was simulated in Subbasins 140 and 150. The erosion occurred during the largest storm events during 2003 when relatively high flow velocity developed in the Blind River near the I-10 Bridge. Without any field data, however, it cannot be confirmed if the erosion truly occurred in these areas and if so, at what degree the erosion occurred. If no erosion actually occurred in these areas, then the shear stress for erosion used in the model should be increased to better reflect existing conditions. Spatial distribution of sediment cumulative erosion map for year 2003 is presented on **Figure L2.5.8-6**.

For the current sediment model, the five key parameter values used in the model are listed in **Table L2.5.8-2**.

Table L2.5.8-2 Key Sediment Parameters and Assigned Model Values

Parameter	Value	Unit
Sediment bulk density	1.66	g/cm^3
Settling velocity	2.89E-05	m/s
Boundary shear stress for deposition	1.0E-05	m^2/s^2
Parameter	Value	Unit
Surface erosion rate	5.0E-05	$g/m^2/s$
Boundary shear stress for erosion	1.2E-05	m^2/s^2

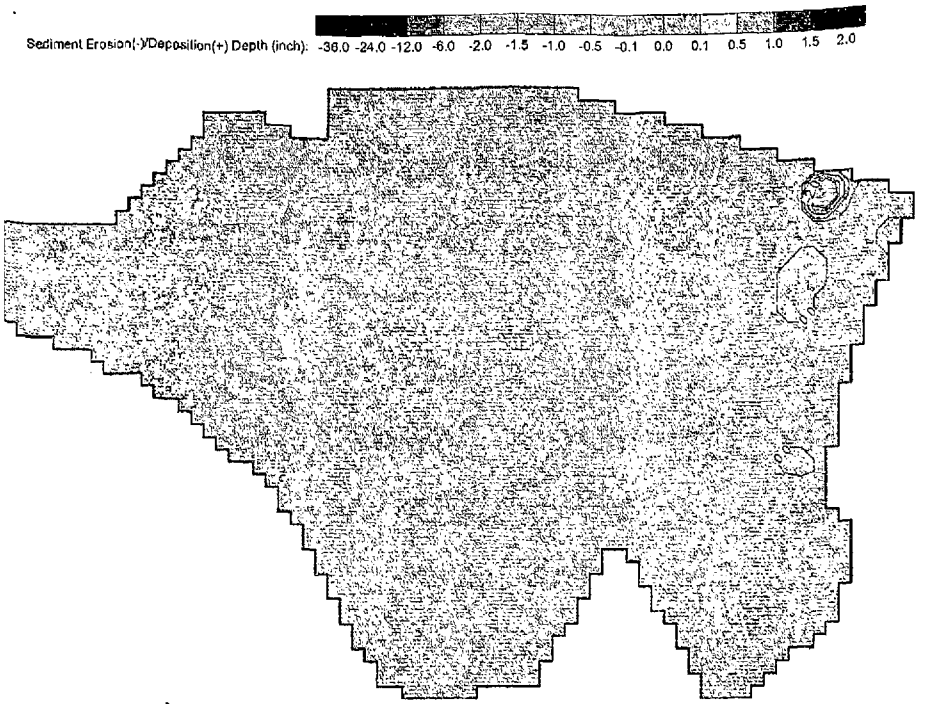


Figure L2.5.8-6 Cumulative Sediment Deposition and Erosion

L2.5.8.5 Water Quality

For existing conditions, no water quality data were collected. However, monthly-average total phosphorus (TP), total nitrogen (TN), and nitrate concentration data from the Maurepas swamp (Lane, et al., 2003) were available. The average concentrations of nitrate, TN, and TP were 0.008, 0.58, and 0.055 mg/L, respectively.

Furthermore, continuous water temperature and dissolved oxygen (DO) data were collected in the Blind River at Highway 61 Bridge during November and December of 2009. **Figures L2.5.8-7** and **L2.5.8-8** show the variations of the measured water temperature and DO, respectively. During this period, DO varied greatly from 0.6 mg/L up to 7.7 mg/L, which is primarily attributed to the local sediment oxygen demand (SOD) and low DO water exchange with the swamp by advection and diffusivity.

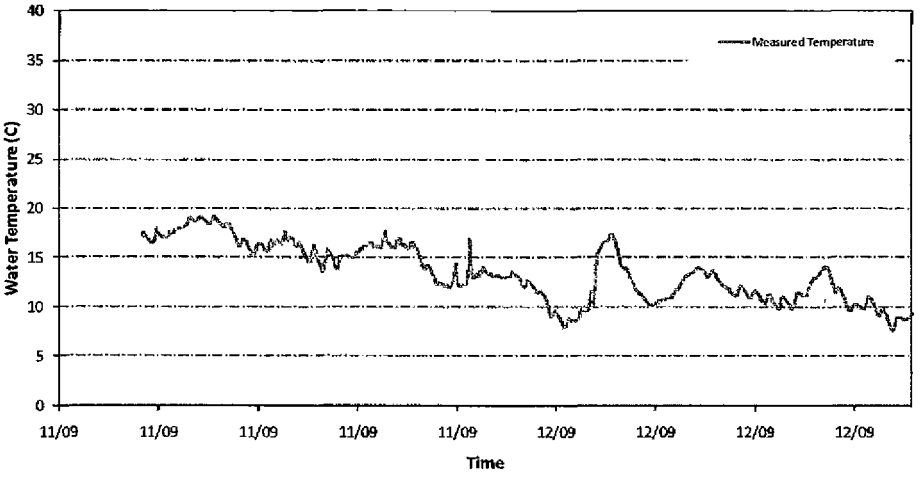


Figure L2.5.8-7 Measured Blind River Water Temperature (November-December 2009)

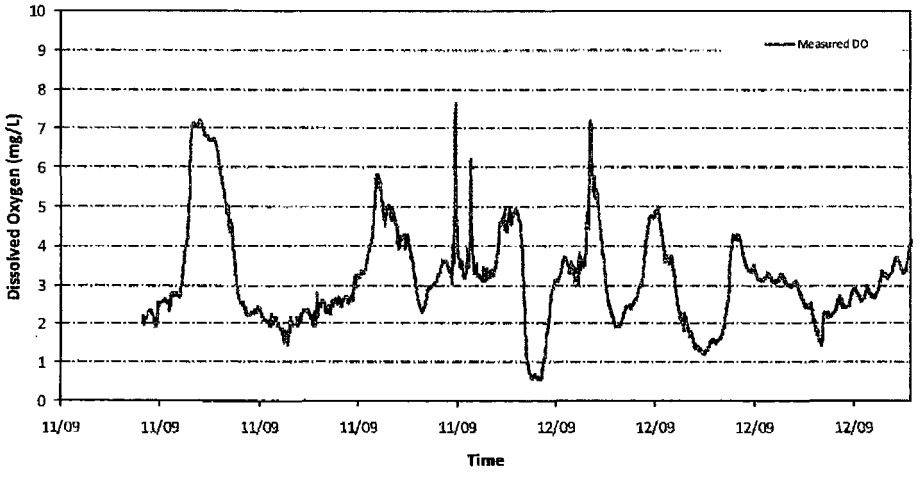


Figure L2.5.8-8 Measured Blind River DO Concentrations (November-December 2009)

L2.6 Hydraulic Analysis of Romeville Diversion and Transmission Components

The proposed Romeville diversion point is located on the east bank of the Mississippi River near Mile 162.0 (2004 Hydrographic Survey), as shown on **Figure L2.6-1**.

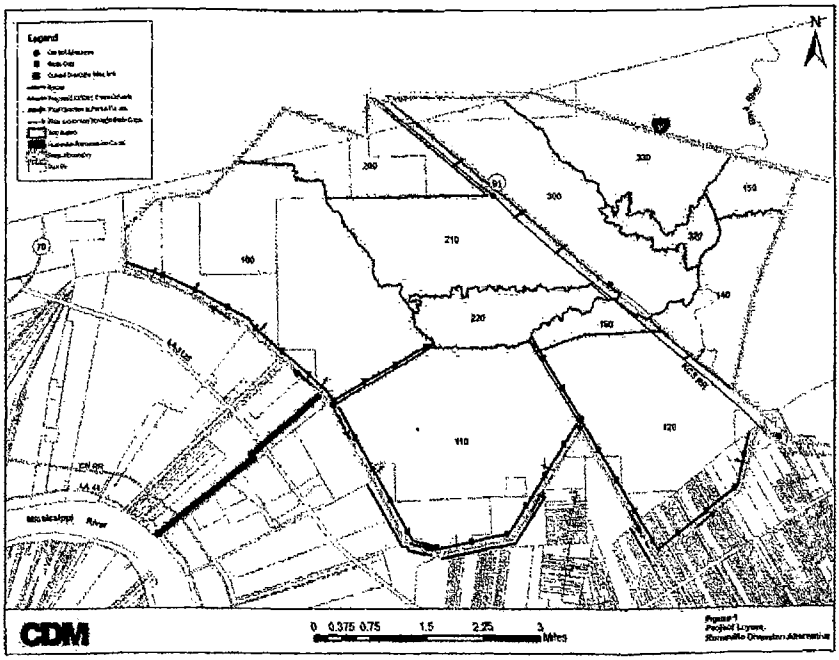


Figure L2.6-1 Romeville Diversion Project Layout

The diversion project requires several different types of management measures, or components, serving different functions, which will be combined to form the alternative plans. The major components are:

- Diversion facility;
- Transmission canal;
- Control structures;
- Berm gaps;
- Cross culverts at the Highway 61corridor; and
- Instrumentation.

This section presents the preliminary hydraulic analysis and design of the diversion facility and transmission canal components for the Romeville alignment. These two components were combined in this section as the design of both is based on the diversion flow rate, and both have a common hydraulic grade line.

The analysis addressed the full range of potential flow rates, management measures, and alternative plans considered as the project developed and the evaluation and screening occurred. The initial array of alternatives included diversion flow rates from 500 cfs to 20,000 cfs, and the preliminary hydraulic designs were prepared for this full range of flows. The specific flow rates being used in the initial alternative arrays are in 500 cfs increments from 500 cfs up to 5,000 cfs, then in 5,000 cfs increments to 20,000 cfs.

The proposed Blind River Diversion Project is on the NAVD 88 vertical datum. Other major topographic datasets being used on the project are also on the NAVD 88 vertical datum, including the 2001 LiDAR data and the 2004 Hydrographic Survey.

L2.6.1 Mississippi River Stage Analysis at Romeville

The Mississippi River stage was analyzed to determine the statistical characteristics at the Romeville diversion point. The stage data will be used as input data to:

- Develop the overall diversion system hydraulic grade line (HGL);
- Hydraulically design the diversion structure;
- Hydraulically design the transmission canal;
- Determine probable diversion flow rates, total diversion volumes, and the likely operational characteristics throughout the calendar year; and
- Identify constraints to the diversion project, such as stage trends during each season, and limits to the diversion period and flow rates.

Mississippi River Stage Data

The proposed Romeville diversion point, near Mile 162.0 on the Mississippi River, is located between the College Point Landing Gage (Mile 156.9) and the Donaldsonville Gage (Mile 173.6). The river miles are from the Mississippi River Hydrographic Survey of 2004. Stage records were obtained for both gages from the USACE New Orleans Engineering Division website.

The lower Mississippi River flow management was changed by the USACE in 1977 when the Old River Control Structure (ORCS) was completed and put into service. This resulted in a revision to the balance of flow rates between the Atchafalaya River and the Mississippi River. Therefore, gage data was collected and analyzed for only the time period after the flow management change in 1977. The period of records analyzed covered 31 years from January 1, 1978 through December 31, 2008.

The stage records at the two gage sites are incomplete, with 258 and 96 data points missing at the College Point Landing and the Donaldsonville gages, respectively. Values were created for the missing data by linear interpolation and extrapolation from adjacent values and adjacent gages. Such values are high-lighted in the electronic files containing the data analysis. The approach to interpolate values was considered reasonable, as the Mississippi River stage varies slowly day to day.

The Mississippi River stage data is on the NGVD 29 vertical datum. The stage elevations were converted to NAVD 88, the project datum, using the vertical datum adjustment, as follows. The USACE provided a vertical adjustment value of -0.8 feet for the Donaldsonville gage. The USACE stated that a datum adjustment value is not available for the College Point Landing gage, but indicated that it is likely to be less than the adjustment at the Donaldsonville gage. Therefore a value of -0.7 feet was assumed for the College Point Landing gage, and will be used until an updated adjustment value is provided. The vertical datum conversion equations are as follows:

- College Point Landing Gage: NAVD 88 = NGVD 29 - 0.7 feet
- Donaldsonville Gage: NAVD 88 = NGVD 29 - 0.8 feet

The daily stage data, on both the original NGVD 29 vertical datum and adjusted to the NAVD 88 vertical datum is in the electronic files. The analysis and all stage data presented in this report is on the NAVD 88 vertical datum. **Table L2.6.1-1** provides a summary of the gage information.

Table L2.6.1-1 Gage Data Summary

Item	Gage at College Point Landing	Gage at Donaldsonville
Gage ID	01240	01220
Vertical Datum (for data on website)	NGVD 29	NGVD 29
Gage 0	Elev. 0	Elev. 0
River Mile (1962 Survey)	157.4	175.4
River Mile (2004 Survey)	156.9	173.6
Vertical Datum Adjustment (from NGVD 29 to NAVD 88)		
Adjustment value	-0.7	-0.8
Adjustment equation	NAVD 88 = NGVD 29 - 0.7	NAVD 88 = NGVD 29 - 0.8
Start of Records	Dec. 18, 1879	June 9, 1890
Records used	1/1/78 thru 12/31/08	1/1/78 thru 12/31/08

Stage Data at Diversion Point

Mississippi River stage data was developed for the proposed Romeville diversion point by linear interpolation between the two gage locations, based on river miles from the 2004 Hydrographic Survey. This resulted in new set of daily stage data at Romeville. The interpolated stage data at Romeville is in the electronic files and

plotted on **Figure L2.6.1-1**. The plot of the Mississippi River stage data indicates two very distinct three-month periods, as follows:

- High Stage – Spring (March 1 through May 31)
- Low Stage – Summer-Fall (mid-August through mid-November)

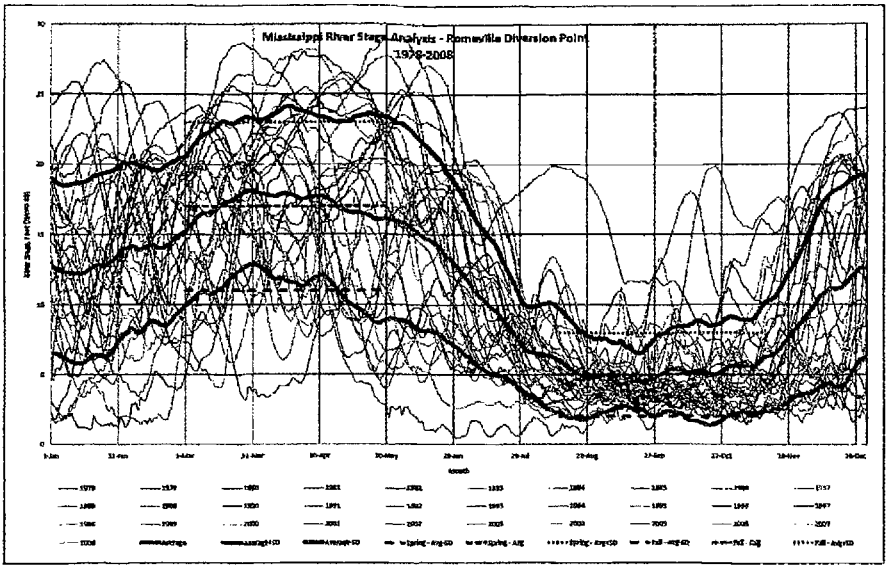


Figure L2.6.1-1 Interpolated Stage Data (Romeville Diversion)

Statistical Analyses

Three sets of statistical analyses were performed on the daily stage data at Romeville to determine trends and typical values for use in the analysis and design of the diversion system. The analyses included averages and standard deviations, percent exceedance, and histograms.

Averages and Standard Deviations

The average and standard deviation was calculated for each day of the year, using 31 values from the daily stage data. This analysis considered a normal distribution of the data. The daily average stage, the average stage minus one standard deviation, and the average stage plus one standard deviation are plotted on Figure L2.6.1-1. The averages and standard deviations were also calculated separately for the 3-month low-stage and high-stage periods, as shown in the following **Table L2.6.1-2** and plotted on Figure L2.6.1-1.

Table L2.6.1-2 Standard Statistics for Stage

Period	Standard Deviation	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	7.03	4.29	11.32	18.35
Spring (Mar. 1 – May 31)	5.99	11.14	17.13	23.12
Summer-Fall (Aug. 16 – Nov. 15)	3.07	2.09	5.16	8.23

Percent Chance Exceedance

A percent chance exceedance curve (**Figure L2.6.1-2**) was developed for the Romeville diversion point using the Weibull formula. A Pearson Type III analysis was not used, as this stage and diversion analysis is not concerned with the extreme events. The stage values at selected statistical points are included in **Table L2.6.1-3**.

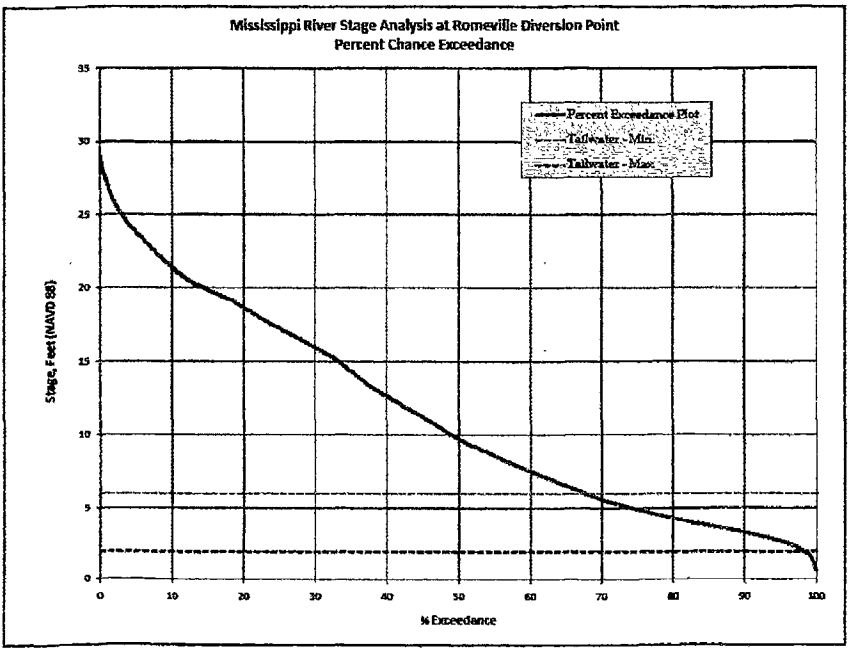


Figure L2.6.1-2 Percent Chance Exceedance Curve (Romeville Diversion)

Table L2.6.1-3 Stage vs. Percent Exceedance

Period	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	3.86	9.73	19.66
Spring (Mar. 1 – May 31)	10.31	17.79	23.42
Summer-Fall (Aug. 16 – Nov. 15)	3.00	4.21	7.17

Of interest, is the relation of the diversion structure tail water conditions versus the Mississippi River stage. The Mississippi River stage will be at or above the following elevations:

- Elev. 2 – lower tail water limit – 98% Exceedance
- Elev. 6 – design tail water – 67% Exceedance

Histograms

Histograms were created by grouping the stage data into 1-foot increments and plotted to visually observe distribution trends in the stage data. **Figure L2.6.1-3** is a plot of all of the data, and indicates a distinct peak at Elev. 4 and a lesser peak at Elev. 20. **Figure L2.6.1-4** is a plot of the spring stage from March 1 through May 31, indicating a relatively wide range of values during the spring period. There is a peak at Elev. 20, with a generally even distribution from Elev. 11 to Elev. 24. **Figure L2.6.1-5 is** a plot of the summer-fall stage data from August 16 through November 15, showing a distinct peak at Elev. 4, and demonstrates that most of the stage values are well below Elev. 8. In reviewing Figure L2.6.1-1, the late summer and early fall stages are consistently low, corresponding to the histogram on Figure L2.6.1-5, and indicates that diversions may be difficult during the late summer and early fall period.

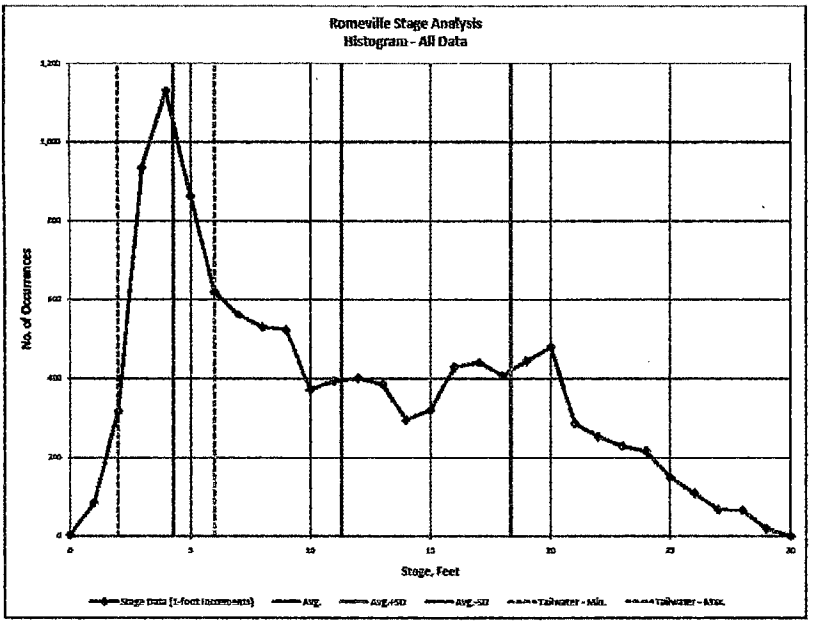


Figure L2.6.1-3 Stage Histogram – All Data

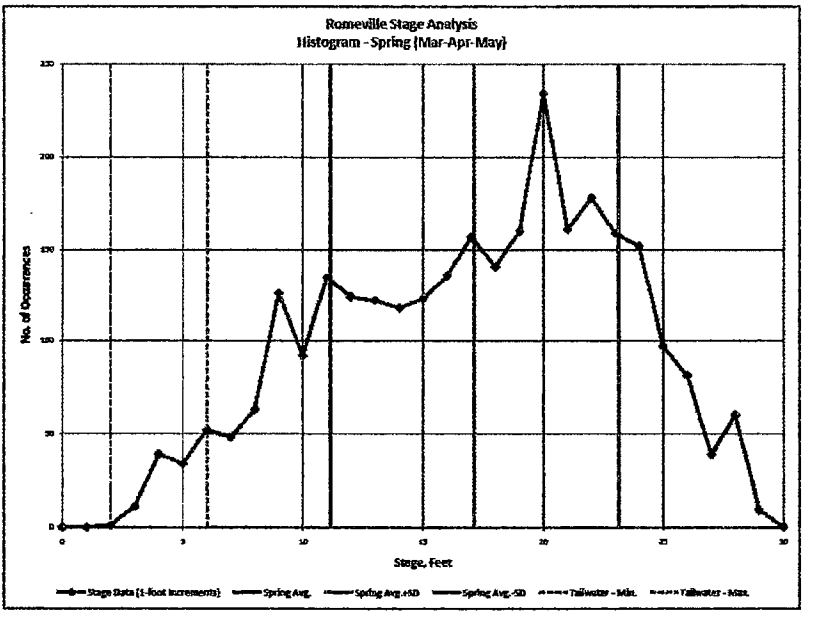


Figure L2.6.1-4 Stage Histogram - Spring

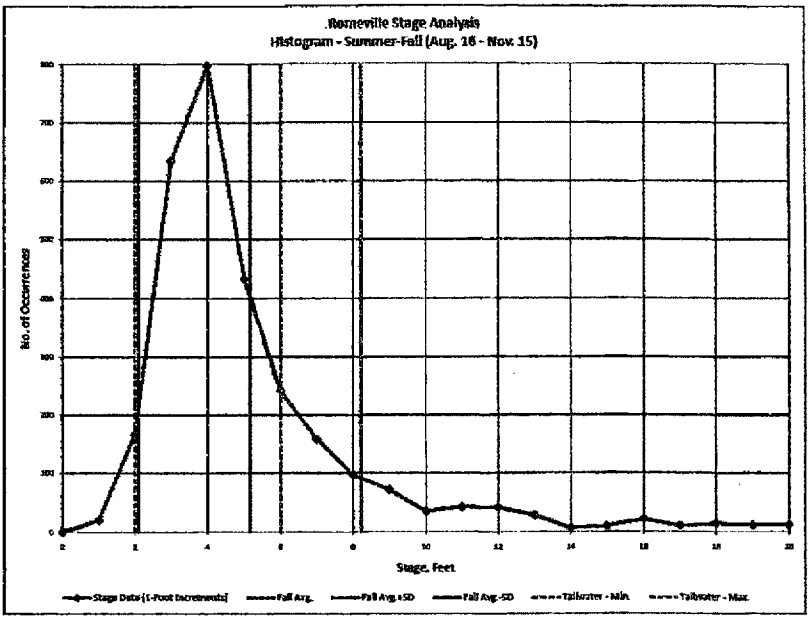


Figure L2.6.1-5 Stage Histogram – Summer-Fall

Approximate Values for Design

Based on the statistical analyses, the following approximate values (**Table L2.6.1-4**) are recommended for design purposes.

Table L2.6.1-4 Summary Stage Statistical Values

Period	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	4	10	19
Spring (Mar. 1 – May 31)	11	17	23
Summer-Fall (Aug. 16 – Nov. 15)	3	5	8

L2.6.2 Romeville Hydraulic Grade Line

The hydraulic head available from the Mississippi River is the driving force for flow of the diverted water through the entire system. The principle hydraulic elements and segments of the overall system are:

- Mississippi River stage – the upstream boundary condition for the hydraulic grade line;

- Diversion Structure – to divert the flow through/under the east levee of the Mississippi River via a culvert or siphon;
- Transmission Canal – to transfer the flow from the diversion structure to the edge of the Swamp;
- Distribution System – to distribute flow into the Swamp;
- Overland Flow and Drainage System – to direct the diverted water through the Swamp, and then to drain it from the Swamp to the Blind River; and
- Blind River stage – the downstream boundary condition for the hydraulic grade line.

Based on the conceptual and preliminary design analyses, the following water surface elevations were used for the preliminary hydraulic design of the system components, thus establishing the system's hydraulic grade line (HGL). These values will be revised as the hydrodynamic modeling progresses and the designs for the various project components progress and are refined in the final design phase. **Figure L2.6.2-1** illustrates the HGL profile.

- Elev. 11 – The recommended design stage in the Mississippi River. The development of this recommendation is documented in the hydraulic design analyses for the culvert and siphon diversion structures.
- Elev. 7 – The proposed design tail water elevation at the diversion structure outlet. This allows a 1-foot drop in the HGL from the culvert or siphon outlet to the head of the transmission canal to route flows through a water quality treatment basin or a settling basin, if necessary.
- Elev. 6 – The approximate design water surface elevation at the head (upstream end) of the transmission canal, based on a 2-foot drop in the HGL for the canal. This hydraulic grade results in moderate velocities below 2 feet per second in the transmission canal.
- Elev. 4 – Water surface elevation at the downstream end of the transmission canal
- Elev. 4 – The proposed operating design water surface elevation in the existing drainage canals at the edge of the Swamp, providing a 2-foot driving head into and through the Swamp. This elevation will be set by the proposed control gates in the existing perimeter drainage channels.
- Elev. 1.5 to Elev. 2 – The approximate static water surface elevation throughout the Swamp, the drainage system, and Blind River between storm events.

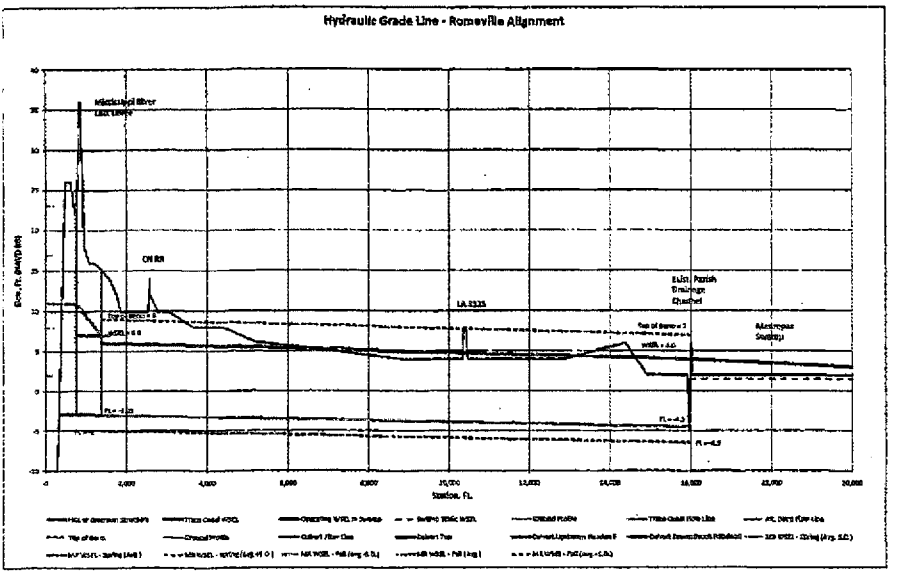


Figure L2.6.2-1 Hydraulic Grade Line Profile (Romeville Diversion)

The static HGL described above is to establish a single hydraulic design basis to size the diversion structure and the transmission canal. During actual operation, the HGL will vary significantly as the following items change: Mississippi River stage, Lake Maurepas stage, Blind River stage conditions, control gate settings, and diversion flow rates. In recognizing the variability in flow rate and HGL, the diversion culvert analysis and siphon analysis determined flow rates at other HGL conditions to indicate facility performance under the varying conditions.

Minimum Stage Limits for Diversions

The Mississippi River experiences saltwater intrusions from the Gulf of Mexico along the river bottom during extended periods of low flow in the river. The USACE installed an earthen/sand saltwater barrier or sill to approximately Elev. -55 to reduce the magnitude of the saltwater intrusions in 1988 and 1999. At the diversion point, the Mississippi River channel bottom is near Elev. -120 and the intake invert will be in the range of Elev. 0 to Elev. -10, and will not be extended to near the river bottom. For these two reasons, it is not anticipated that saltwater will be diverted into the Swamp.

For this analysis, it was considered that regulatory authorities may limit diversions at low stages in the Mississippi River. Other users may have prior rights, or more critical needs, such as for municipal water supplies or industrial uses. Therefore, the hydraulic analysis assumes there will be no diversion below a Mississippi River stage at Elev. 5. No attempts were made to make special provisions for hydraulic capacity below that elevation.

L2.6.3 Diversion and Transmission System Flow Line Profile

The diversion facility and transmission canal flow line profile was established by existing physical conditions and the need to maximize depth at the Mississippi River to allow diversions during low stages in the river. The transmission canal will discharge into the existing St. James Parish drainage channels along the south and west perimeter of the Maurepas Swamp. At the Romeville diversion alignment, the existing drainage channel has a flow line of approximately Elev. -4.5, and this elevation was used as the limiting depth for the transmission canal. The diversion culvert flow line was set at Elev. -3.0 at the levee to have a minimum of an 8-foot depth to operate at Elev. 5 in the Mississippi River. Figure L2.6.2-1 illustrates the HGL profile.

Alternate Flow Line Profile

The 2009 bathymetric survey data for the existing drainage channel at the transmission canal discharge point has a flow line at Elev. -4.5. The bathymetric data indicates that the Blind River has a flow line deeper than Elev. -6.5 where the existing drainage channel discharges into it. The drainage channel plans from 1973 show a flat flow line at Elev. -10, indicating that there is several feet of silt in the existing drainage channels. If the existing drainage channels are lowered to Elev. -6.5, the transmission canal and diversion culvert could be lowered 2 feet, possibly reducing facility size and right-of-way requirements. During final design, a comparison of facility sizes should be done to determine cost and operational benefits of de-silting the existing outfall drainage channel, allowing the flow line for the diversion culvert and transmission canal to be lowered.

L2.6.4 Romeville Diversion Culvert

The diversion culvert drawings for the Tentatively Selected Plan are included in **Annex L-5**. The diversion culvert will consist of a multi-cell box culvert. The culvert will cross under the east levee of the Mississippi River, and will be extended east under the local road, LA 44, which is located at the exterior base of the levee. The culvert will be extended an additional 100 feet east of the road right-of-way for a safety buffer, and to allow space for future potential widening of the road. The batture crossing, from the east Mississippi River bank to the inside base of the levee, can be either an extension of the culvert to the bank of the Mississippi River, or an inlet canal, as done with the Davis Pond diversion structure. Based on an initial cost comparison, an inlet canal was used for this preliminary design analysis. **Figure L2.6.4-1** illustrates the Romeville Diversion culvert profile.

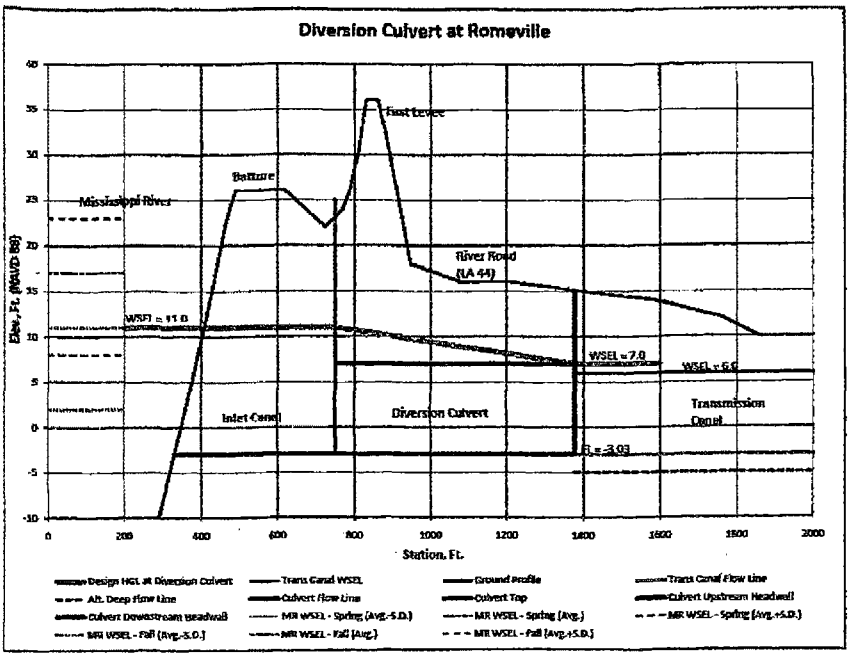


Figure L2.6.4-1 Romeville Diversion Culvert Profile

Configuration

The size and number of the culvert cells (or barrels) has a wide range of possibilities to accommodate the large range of potential design flow rates and Mississippi River stages. The initial diversion culvert design development used the following constraints:

- The lower design flow rates should have a minimum of two barrels to allow a degree of flow control by taking one or more barrels out of operation;
- The higher design flow rates should have a minimum of three barrels to allow a degree of flow control by taking one or more barrels out of operation;
- No limit on the maximum number of barrels;
- The culvert is expected to be a monolithic cast-in-place reinforced concrete structure; therefore shipping size limitations on pre-cast units are not applicable;
- Culvert sizes are limited to 14 feet, the largest sluice gates readily available;
- The culvert sections should be square, or nearly square, to maximize hydraulic efficiency;

- The top of the culverts are to be below the design WSEL in the Mississippi River to fully utilize the hydraulic capacity at design conditions; and
- No stand-by barrels or excess capacity are included, as the installation is non-critical for health and safety, such as would be the case for water supply, wastewater, or flood control pumps.

Hydraulic Calculations

A HEC-RAS model was developed for the diversion culvert and the transmission canal, extending from the Mississippi River, across the east levee, to the existing drainage channel at the perimeter of the Swamp. For the culvert analysis, this model was truncated at the downstream end of the levee culvert. Separate HEC-RAS geometry files, flow files, and plans were developed for each design flow rate to develop the culvert configurations (size and number of cells). The upstream channel (the inlet canal) and the downstream channel (transmission canal) widths were varied, corresponding to the widths determined for the preliminary transmission canal designs.

The headlosses through the culvert structure were calculated, as follows:

- Manning's n value – 0.035 for earthen channels and 0.015 for concrete channels and the concrete box culverts;
- Expansion and Contraction Losses – typical values were obtained from the HEC-RAS manual;
- Entrance and Exit Losses – typical entrance and exit loss coefficients were obtained from the HEC-RAS manual. Both the inlet and the outlet will be at a concrete headwall; and
- Trash Racks – trash racks will be included in the installation, but these were not included in the preliminary hydraulic calculations. Headlosses for trash racks should be included in the final design.

The diversion culvert will operate in a system with changing head and flow rates, as the Mississippi River stage varies through the year, and the tail water stage varies as the flow rate varies. For each design scenario, a set of flow rates were used in the hydraulic analysis to establish a rating curve for each culvert design option. At the downstream end of the culvert, the variable tail water conditions were incorporated into the HEC-RAS model. The starting water surface elevations for the truncated HEC-RAS model were linearly interpolated between the HGL parameters stated previously, using the following key values:

- Elev. 2.0 – no flow in the system;
- Elev. 7.0 – design flow rate; and
- Elev. 11.0 – maximum possible water surface elevation on the transmission canal, at the approximate adjacent ground elevations.

Design and Analysis Process

As shown on Figure L2.6.1-1, the Mississippi River stage varies through the year. However, in order to size the diversion culvert, a single Mississippi River stage needs to be selected. The culvert design can then be evaluated, to determine the availability of the design flow rate at other stages. For the preliminary analysis, two sets of diversion culvert designs were developed to provide the design flow rate at either Elev. 11 or Elev. 17 in the Mississippi River. For each design configuration, flow rates were then determined for three stages of interest in the Mississippi River:

- Elev. 5 – Average stage in late summer and early fall. This indicates the capabilities to provide a base flow rate during the summer and fall low stages in the Mississippi River;
- Elev. 11 – 84% exceedance stage (average stage minus one standard deviation) during the spring high water period; and
- Elev. 17 – 50% exceedance stage (average stage) during the spring high water period.

The flow rate characteristics were then reviewed to assist in selecting and recommending a single design stage in the Mississippi River. **Figure L2.6.4-2** illustrates a plot of the flow rate versus the culvert area for the three stages of interest in the Mississippi River. The plots indicate linear characteristics for flow rate versus culvert area. Based on the data, the culverts have relatively uniform unit flow rates for each design river stage (**Table L2.6.4-1**).

Table L2.6.4-1 Mississippi River Design Stage vs. Unit Flow Rate

Mississippi River Design Stage (ft)	Unit Flow Rate cfs/SF (or fps)
Elev. 5	4.5
Elev. 11	10.7
Elev. 17	16.3

Table L2.6.4-2 shows the percent of design flow rate diverted at each Mississippi River stage for the two design conditions.

Table L2.6.4-2 Mississippi River Design Stage vs. Percent of Design Flow Rate

Mississippi River Design Stage (ft)	Percent of Design Flow at Each Mississippi River Stage (%)		
	Elev. 5	Elev. 11	Elev. 17
Elev. 11	35	100	155
Elev. 17	29	73	100

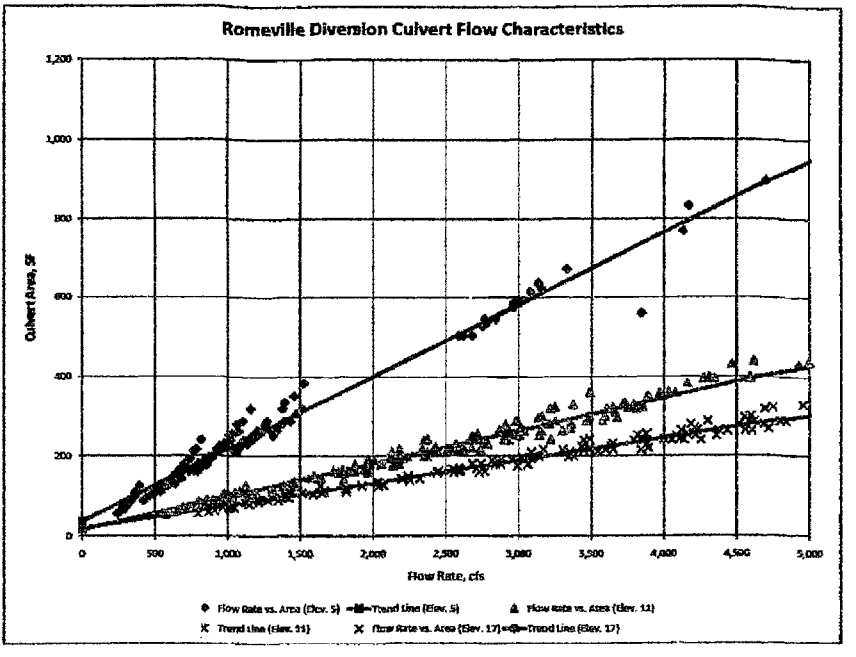


Figure L2.6.4-2 Culvert Flow Characteristics (Romeville Diversion)

Based on a comparison of the culvert sizes (area), changing the design basis from Mississippi River Elev. 17 to Elev. 11 results in a 52% increase in culvert size. Limited culvert designs were prepared for Elev. 5. This design level was considered impractical, as the box culvert flow area would have to be 2.4 times the size designed to Elev. 11.

It is recommended that the diversion be designed to deliver the design flow rate at Mississippi River stage Elev. 11, as this provides a higher flow rate potential during summer periods.

Table L2.6.4-3 has the recommended culvert configurations for the potential design flow rates in the initial alternative arrays.

The primary design basis for the recommended configurations is as follows:

- Design water surface in the Mississippi River is Elev. 11.0;
- Design tail water is Elev. 7.0; and
- Culvert flow line is Elev. -3.0 at the levee.

Rating curves for the diversion culvert are plotted on **Figure L2.6.4-3** for the 1,500 cfs and 3,000 cfs designs for Elev. 11.

Table L2.6.4-3 Recommended Culvert Configurations for Alternate Design Flow Rates

Design Flow Rate, cfs	Culvert Size, ft (height x width)
500	2 - 6 x 6
1,000	2 - 8 x 7
1,500	2 - 9 x 9
2,000	3 - 9 x 8
2,500	3 - 9 x 9
3,000	3 - 10 x 10
3,500	3 - 11 x 10
4,000	3 - 12 x 11
4,500	4 - 11 x 10
5,000	4 - 11 x 11
10,000	7 - 12 x 12
15,000	10 - 12 x 12
20,000	13 - 12 x 12

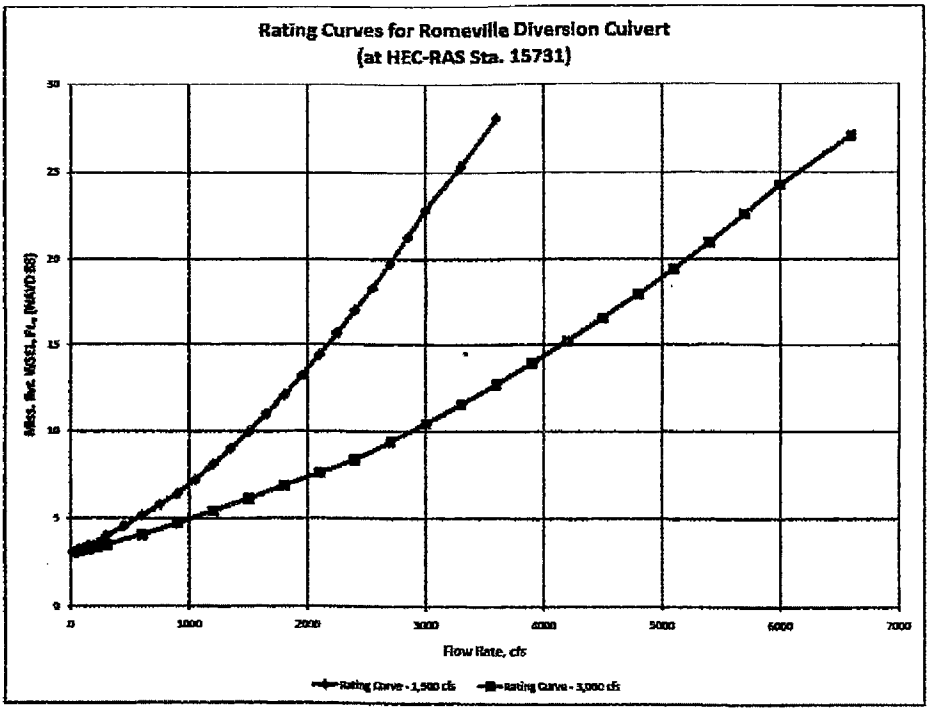


Figure L2.6.4-3 Rating Curves for Romeville Diversion Culvert

L2.6.5 Romeville Diversion Siphon

A siphon was considered as a viable diversion structure. The siphon structure will consist of multiple independent siphon barrels operating in parallel. The siphon structure will require other facilities, which are addressed in Section L2.7.

Design Basis

The siphon pipe was extended across the batture and down the east bank of the Mississippi River for the preliminary hydraulic design. As an option, if the siphon is selected for the final design, an inlet canal could be considered from the Mississippi River to near the inside base of the levee. The siphon p;ipes were extended east across LA 44 to discharge into the transmission canal at a similar location as described for the diversion culvert.

The range of flow rates being considered for the Romeville diversion point is from 500 cfs to 20,000 cfs, or higher. The siphon design analysis covers a range of flows from 500 cfs to 5,000 cfs, as the siphon installation becomes too large and impractical at higher flow rates.

The HGL for the siphon is described in Section L2.6.2 and shown on Figure L2.6.2-1.

A siphon has a theoretical lift of 34 feet, and a practical maximum lift of 28 feet. To be conservative, 25 feet was used as the limiting value in this analysis, as the siphon will have large-diameter pipes.

Siphon Profile

Optional profiles were considered for routing the siphon at the Mississippi River levee, as shown on the following figures (a 72" diameter pipe was used for the example profiles):

- **Figure L2.6.5-1** – Route the siphon over the levee.
- **Figure L2.6.5-2** – Route the siphon over the River Road, to reduce the number of bends, and related headlosses. The River Road pavement is at approximately Elev. 16 and the bottom of the siphon pipe will be at Elev. 32 to provide the standard 16-foot clearance for trucks. The siphon pipe would be routed through the levee, to reduce the number of pipe bends.
- **Figure L2.6.5-3** – Route the siphon through the levee at an elevation allowing diversion down to minimal stages in the Mississippi River. If Elev. 5 is the minimum stage in the River for diversions, the siphon top-of-pipe would be at Elev. 30.

Table L2.6.5-1 summarizes the siphon elevations and resultant lowest operating WSELs in the Mississippi River for the range of pipe sizes being considered.

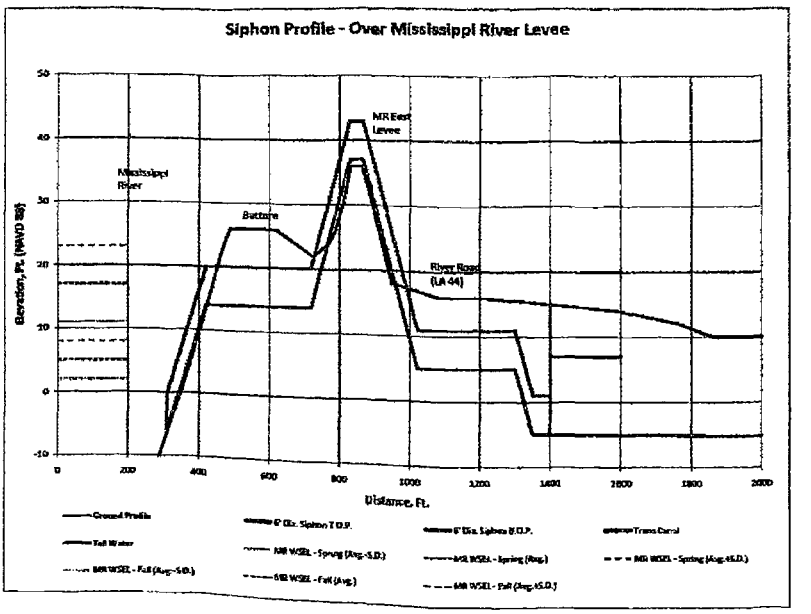


Figure L2.6.5-1 Siphon Profile (Over Mississippi River Levee)

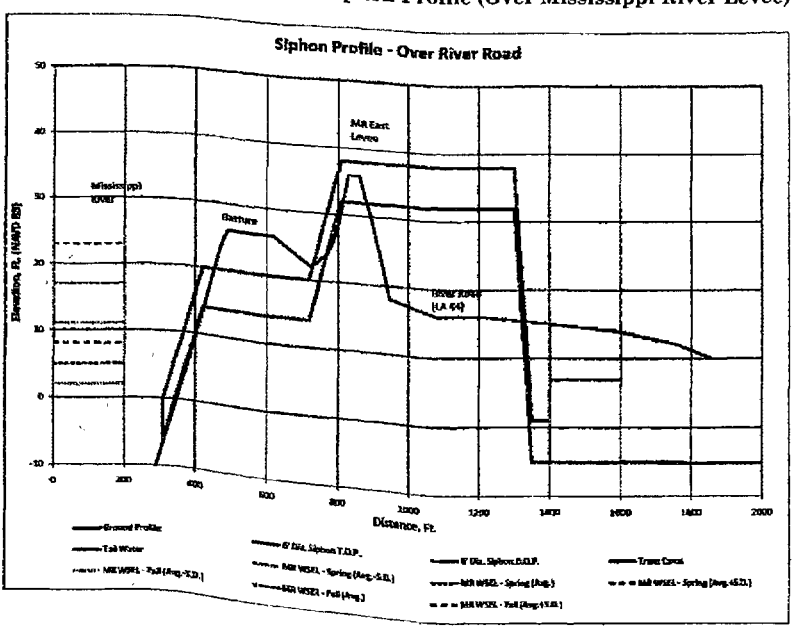


Figure L2.6.5-2 Siphon Profile (Over River Road)

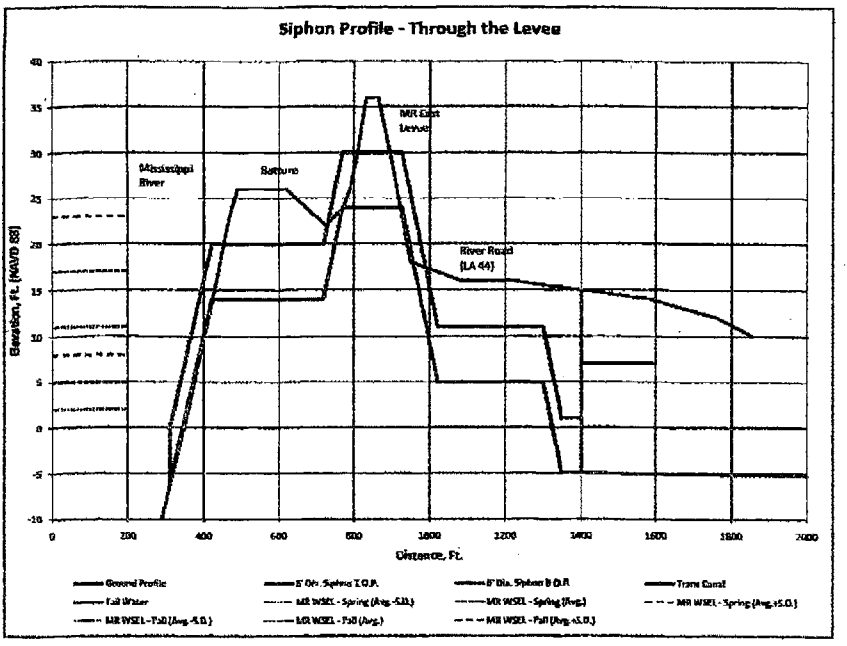


Figure L2.6.5-3 Siphon Profile (Through the Mississippi River Levee)

Table L2.6.5-1 Siphon Profiles versus Minimum Operating WSEL in Mississippi River

Siphon Profile at Levee	Pipe Size, ft	B.O.P. at Levee	T.O.P. at Levee	Minimum Operating WSEL in Mississippi River
Siphon Over Levee	5	37	42	17
	6	37	43	18
	7	37	44	19
	8	37	45	20
Siphon over River Road	5	32	37	12
	6	32	38	13
	7	32	39	14
	8	32	40	15
Siphon Through Levee	5	25	30	5
	6	24	30	5
	7	23	30	5
	8	22	30	5

Notes:

1. Top of levee is approximately Elev. 36.
2. Use 25 feet as the maximum practical siphon lift for large diameter pipe.
3. Calculate the siphon lift from the top of pipe (not centerline).
4. B.O.P = Bottom of Pipe.
5. T.O.P. = Top of Pipe.

Analysis of the alternate siphon profiles:

- Routing the siphon over the levee will require high stages in the Mississippi River for operation. This will severely limit the potential diversion periods, and practically eliminate the possibilities of base flow diversions during the summer and fall periods when the Mississippi River stage is low.
- The option over the levee will block the existing access road on top of the levee. Other accommodations may need to be incorporated into the site design to provide access to the top of the levee.
- The option over the River Road is also relatively high, and will limit the diversion period and ability to operate during low stages in the Mississippi River. This option also blocks access along the top of the levee.
- The options at lower elevations will penetrate the existing flood control levee, and may require a cut-off wall, filter diaphragms, and other seepage control measures, designed to USACE requirements, to protect the integrity of the levee.

The recommended siphon design is based on routing the siphon through the levee with the top-of-pipe at Elev. 30, as shown on Figure L2.6.5-3, in order to divert flows down to Elev. 5 in the Mississippi River. The following hydraulic calculations are based on this profile.

Siphon Configuration

The size and number of the siphon pipes ("barrels") has a wide range of possibilities to accommodate the large range of potential design flow rates. The State of Louisiana has two large siphon diversion installations in operation, Naomi and West Pointe a la Hache. Both of these installations have 8 – 72" diameter barrels, which are routed over the top of the levee. The initial Blind River siphon designs used the same concept of multiple barrels, with the following constraints:

- The installation should have a minimum of 3 barrels to allow a degree of flow control by taking one or more barrels out of operation.
- There is no limit to the number of barrels, although more than 12 to 15 barrels will result in large site.
- No stand-by barrels or excess capacity are included, as the installation is non-critical for health and safety, such as would be the case for water supply, wastewater, or flood control pumps.
- Pipe sizes of 60" through 96" were considered to cover the large range of potential design flows.

Hydraulic Calculations

An Excel spreadsheet was developed for the siphon hydraulic calculations, and is available electronically. The hydraulic design calculations are set up to readily change input data and assumptions, as the project design progresses.

The following items were considered to be included in the siphon installation:

- Grate/bar screen – located at the inlet end in the Mississippi River to block debris from entering the siphons. The initial concept is to provide a coarse bar screen to block large debris (tree limbs, etc.) At this point in the design development and in the environmental analysis process, fine screens (i.e. to block fish passage) are not required.
- Control valve – to control flow rates. See later discussion on potential needs for a throttling valve.
- Shut-off valve – to provide positive shut-off. The proposed siphon profile penetrates the Mississippi River levee and special measures may be required to maintain the levee flood protection integrity, as the pipe will be partially below maximum flood stages in the river. Therefore, it is considered that an isolation valve will be required by the regulatory authorities to provide redundancy in the event either the control valve or the shut-off valve gets damaged or blocked by debris.
- Pipe bends – consider mitered bends, typically 22.5 degrees or less.

The headlosses through the siphon structure were calculated, as follows:

- Pipe Friction Losses – The Hazen-Williams equation was used to calculate the headlosses in the siphon pipe. A friction factor of C = 110 was used to represent moderately aged, but not old steel pipe with an appropriate protective coating.
- Miscellaneous Losses – The velocity head method was used to calculate the headlosses for the valves, fittings, and appurtenances. The Excel design file includes a table of loss coefficients for each pipe size considered.
- Entrance and Exit Losses – Typical entrance and exit loss coefficients were obtained from hydraulic manuals. The inlet will be protruding into the Mississippi River. The outlet is considered to be flush with a concrete headwall at the discharge into the transmission canal.
- Bar Screens –The standard bar screen headloss equation, found in the USACE EM 1110-3-172 (May 11, 1984), page 7-6, was used for the headloss calculations. The initial design assumes 1" wide bars on a 12"x12" grid, and debris blocking 10% of the bar screen opening. A typical blockage would likely be higher on individual pipes; however, the analysis assumes that not all intakes would be blocked at the same time. The bar screen characteristics can be varied in the Excel design file, as design decisions are made on the bar width, grid spacing, and level of blockage.

The driving head for the siphon is the Mississippi River WSEL minus the tail water elevation in the transmission canal, as shown on Figure L2.6.2-1, the HGL profile. As the Mississippi River stage increases, the flow rate will increase, and the tail water elevation will increase. The design spreadsheet incorporates a tail water rating curve from the HEC-RAS model for the transmission canal, based on the design for a 1,000 cfs flow rate. The maximum possible tail water was set at Elev. 8

at the siphon outlet. For single barrel operation, the flow rates in the siphon and the canal are the same. For multi-barrel operation, the siphon losses are based on the flows in one barrel, but the transmission canal tail water WSEL is based on the total flow.

Due to the high potential head differential from the Mississippi River to the transmission canal, the siphon has high potential velocities. A control valve, or throttling valve, may be required to limit velocities when the Mississippi River stages are high.

Siphon Design
The siphon will operate in an environment with changing head and flow rates, as the Mississippi River stage varies through the year. As the River stage varies, more, or less siphon barrels will need to be in service to provide the design flow rate. The siphon design file contains a second set of spreadsheets to determine the number of siphon barrels for a given design flow rate, pipe size, and Mississippi River stage. These spreadsheets were then used to select the size and number of barrels required for each design flow rate at a given River stage.

Design Stage in the Mississippi River
An analysis was performed to evaluate and recommend a single design stage for the Mississippi River as the basis for the siphon hydraulic design. The operating characteristics were then reviewed for other elevations to assist in the evaluation. This analysis considered Elev. 11 and 17 as the optional design WSEL's. Additional analyses were then done to determine flow rate at lower elevations. Of interest are flow rates in the summer period at low River stages, and the capability to divert a base flow to the Blind River down to a stage of Elev. 5 in the Mississippi River.

- Elev. 11 Design WSEL
- **Table L2.6.5-2** has the number of siphon barrels required for 60", 72", 84", and 96" diameter pipes for the full range of design flows with a Mississippi River design stage at Elev. 11. This design will also provide the full design flow rate at Mississippi River stages above Elev. 11, with a reduced number of siphon barrels in operation. For a Mississippi River stage at Elev. 5, the design will provide approximately 40% of the design flow rate.
- Elev. 17 Design WSEL
- **Table L2.6.5-3** has the number of siphon barrels required for 60", 72", 84", and 96" diameter pipes for the full range of design flows with a Mississippi River design stage at Elev. 17. This design will also provide the full design flow rate at Mississippi River stages above Elev. 17, with a reduced number of siphon barrels in operation. For a Mississippi River stage at Elev. 11, the design will provide approximately 70% of the design flow. At a stage of Elev. 5, the design will provide approximately 30% of the design flow rate.

Table L2.6.5-2 Siphon Barrels Required versus Design Flow Rate (Mississippi River WSEL = 11 Ft)

Design Flow Rate, cfs	No. of Siphon Barrels Required at Mississippi River WSEL = 11 ft			
	60"	72"	84"	96"
500	4	3	2	1
1,000	9	6	4	3
1,500	13	9	6	5
2,000	17	11	8	6
2,500	22	14	10	8
3,000	26	17	12	9
3,500	30	20	14	11
4,000	35	23	16	12
4,500	39	26	18	14
5,000	43	28	20	15

Table L2.6.5-3 Siphon Barrels Required versus Design Flow Rate (Mississippi River WSEL = 17 Ft)

Design Flow Rate, cfs	No. of Siphon Barrels Required at Mississippi River WSEL = 17 ft			
	60"	72"	84"	96"
500	3	2	1	1
1,000	6	4	3	2
1,500	8	6	4	3
2,000	11	7	5	4
2,500	14	9	7	5
3,000	17	11	8	6
3,500	19	13	9	7
4,000	22	15	10	8
4,500	25	17	12	9
5,000	28	18	13	10

The siphon hydraulic performance is very similar to the diversion culverts. Based on a comparison of the hydraulic capacity of the siphons, changing the design basis from Mississippi River Elev. 17 to Elev. 11 results in a 50% increase in siphon size.

We recommend designing the diversion to deliver the design flow rate at Mississippi River stage Elev. 11, as this provides a higher flow rate potential during summer periods.

Operation through Typical Annual Cycles

The daily stage statistics from the Mississippi River Stage Analysis were used to demonstrate the operation of the siphon diversion structure through an annual cycle of varying stages. A 72" siphon designed for 1,000 cfs was used for the example. The three statistical daily stages shown on Figure L2.6.1-1 were used for the analysis: the average stage, the average minus the standard deviation, and the average plus the standard deviation. **Figure L2.6.5-4** shows the number of siphon barrels in operation, and **Figure L2.6.5-5** illustrates the daily flow rate (cfs).

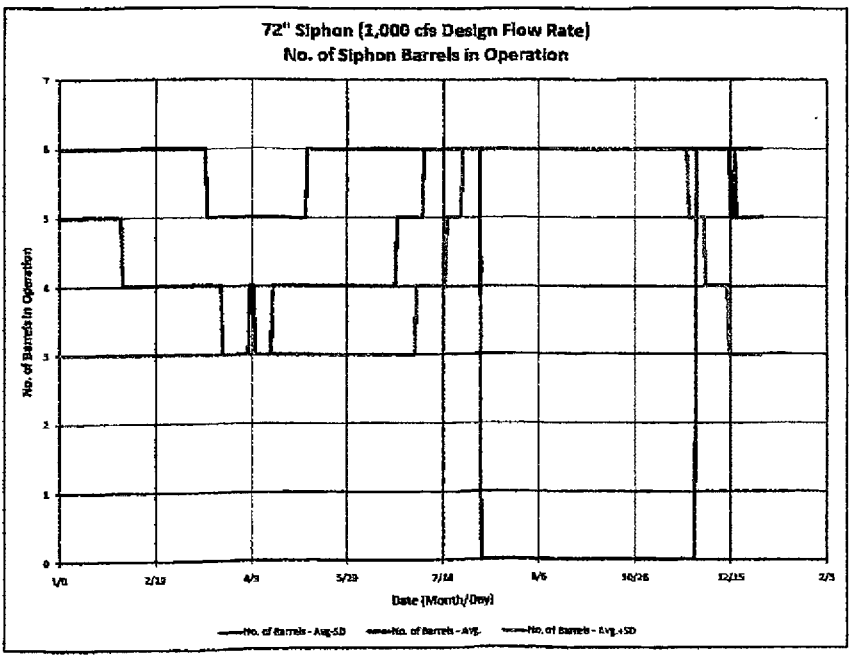


Figure L2.6.5-4 Summary of 72" Siphon Barrels in Operation (1,000 cfs Design Flow Rate)

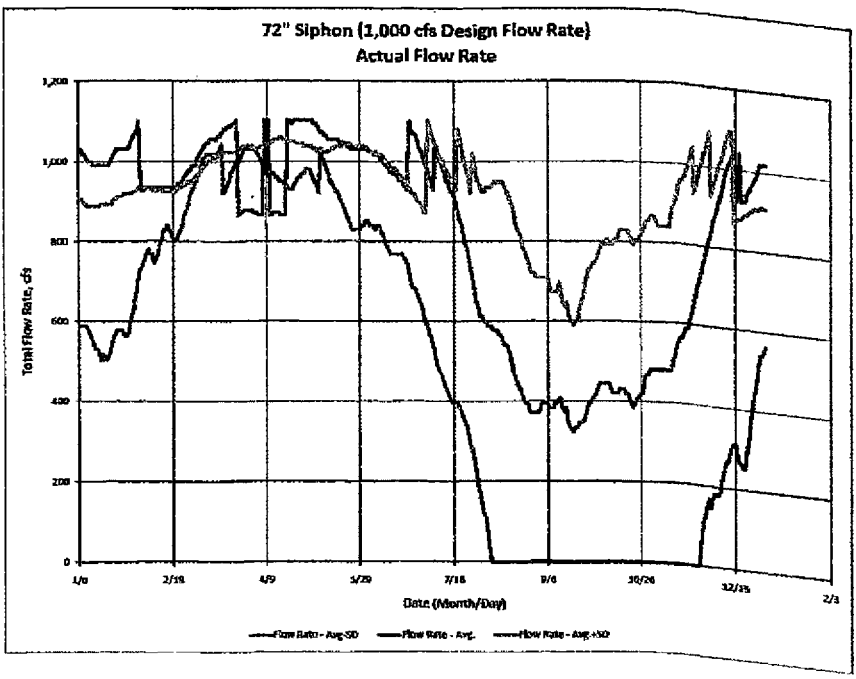


Figure L2.6.5-5 Actual Flow Rate of 72" Siphon (1,000 cfs Design Flow Rate)

Summary and Recommendations

Table L2.6.5-4 has the recommended siphon size and number of barrels for each potential design flow rate.

Table L2.6.5-4 Recommended Siphon Configurations for Alternate Design Flow Rates

Design Flow Rate, cfs	Siphon Size, in.	No. of Barrels
500	60	4
1,000	72	6
1,500	72	9
2,000	84	8
2,500	84	10
3,000	84	12
3,500	96	11
4,000	96	12
4,500	96	14
5,000	96	15

The primary design basis for the recommended configurations is as follows:

- Design water surface in the Mississippi River is Elev. 11; and
- Design tail water is Elev. 7.

L2.6.6 Romeville Transmission Canal Analysis

The transmission canal layout for the Tentatively Selected Plan is included in **Annex L-5**. The transmission canal will transfer the diverted water from the diversion facility to the existing drainage channels along the south and west perimeter of the Swamp. The alignment is approximately 15,300 feet long, and will cross one road (LA 3125) and one railroad (Canadian National Railroad). The canal will have the following features:

- Stilling basin at head of the canal (hydraulic design addressed elsewhere);
- Earthen canal with a flat bottom and 4:1 side slopes (H:V);
- Earthen berms – the canal design HGL will be above ground for most of the alignment, requiring earthen berms on both sides;
- Railroad crossing – reinforced concrete box culverts; and
- LA 3125 crossing – reinforced concrete box culverts.

Design Basis

The canal design is based on the following:

- See Section L2.6-2 and Figure L2.6.2-1 for the hydraulic grade line.
- See Section L2.6-3 and Figure L2.6.2-1 for the flow line profile.
- At the design flow rate, the HGL will be Elev. 4.0 at the downstream end and Elev. 6.0 at the upstream end.
- The proposed flow line will be from Elev. -4.5 at the downstream end to Elev. -3.0 at the upstream end.
- Side slopes are 4:1 (H:V) to be conservative. The geotechnical investigation may allow steeper side slopes.
- Erosion protection – the design velocities are low, and erosion potential is minimal. Concrete channel lining and riprap will be used at the upstream and downstream sides of the culverts, and at the outfall into the existing Parish drainage channel.
- Manning's n value – 0.035 for a well-maintained vegetative lined or earthen canal.
- Design for steady-state flow.
- Freeboard – The conceptual civil design and construction estimate were based on a 3-foot freeboard at the design flow rate.

- Berms – 12-foot wide top width to allow maintenance vehicle access, 4:1 side slopes (interior), and 4:1 or 5:1 exterior side slopes for mowing safety.
- Right-of-way width –
- Without berms – minimum of 30 feet each side for access by large maintenance equipment and for drainage
- With berms – minimum of 10 feet beyond the outer toe of berm on each side, for a local drainage swale and mowing access
- ROW drainage – provide a small drainage swale at the ROW line and discharge to local drainage.

Options considered:

- Match flow line at existing outfall drainage channels (Elev. -4.5);
- Desilt the existing outfall drainage channel 2 feet and lower the transmission canal downstream end flow line to Elev. -6.5. This should be reviewed during final design; and
- Concrete-lined channel. Preliminary cost comparisons indicate that a concrete-lined canal will increase costs; however, this option should be reviewed during final design.

The range of flow rates being considered for the Romeville diversion point is from 500 cfs to 25,000 cfs, or higher. The preliminary design analysis for the transmission canal covers a range of flows from 500 cfs to 20,000 cfs.

The system HGL provides a 2-foot differential for the transmission canal from the upstream end to the downstream end.

HEC-RAS Model for Canal Design

A HEC-RAS model was developed to analyze the transmission canal hydraulics. The cross sections were cut from the 2001 LiDAR-based DEM obtained from the State of Louisiana. The DEM has gaps and cells with no elevation data. CDM adjusted the cross section data at such locations, based on best available data and engineering judgment.

The headlosses for the canal were calculated, as follows:

- Manning's n value – 0.035 for earthen channels and 0.015 for concrete channels and the concrete box culverts;
- Expansion and Contraction Losses – typical values were obtained from the HEC-RAS manual; and
- Entrance and Exit Losses – typical entrance and exit loss coefficients were obtained from the HEC-RAS manual. All culverts are considered to have concrete headwalls.

To develop a canal section for each design flow rate, the canal bottom width was adjusted to obtain a water surface profile meeting the HGL criteria noted above. The flow line profile and berm elevations remained the same for all design flow rates.

For each design, a series of flow rates was used in the design analysis to determine the operating characteristics of the canal through the expected flow rates. Starting water surface elevations were linearly interpolated, matching the HGL design basis stated above.

- Elev. 2.0 – With no flow in the system, the starting WSEL is the same as the static WSEL in the Swamp;
- Elev. 4.0 – Design flow rate; and
- Elev. 5.5 – Assumed maximum WSEL in the Swamp, under a high diversion flow rate.

Based on the HEC-RAS analysis, the recommended channel design sections are included in **Table L2.6.6-1**. The right-of-way widths vary throughout the length of the canal, as natural ground elevations vary. The table below uses the maximum width. Actual right-of-way acquisitions could be less in certain reaches.

Table L2.6.6-1 Recommended Channel Design Sections

Diversion Design Flow Rate, cfs	Bottom Width, ft	Proposed ROW Width, ft
500	12	170
1,000	40	195
1,500	70	230
2,000	100	260
2,500	125	290
3,000	155	315
3,500	185	345
4,000	215	375
4,500	240	405
5,000	270	430
10,000	555	710
15,000	840	1,000
20,000	1,125	1,285

Freeboard and Excess Capacity

The diversion structure will operate with a varying driving head, varying diversion structure capacity in service, and possible with variable control, all resulting in the likelihood that flow rates will not be finely controlled to the design flow rate. Therefore, the transmission canal needs excess capacity to avoid overtopping the berms. With the 3-foot freeboard design, the canal has the excess capacity as shown

in **Table L2.6.6-2**. For the 3,000 cfs transmission canal design with berms set to provide a 3-foot freeboard, the channel could be overtopped at 5,100 cfs, or 1.7 times the diversion design flow rate.

Table L2.6.6-2 Freeboard Summary

Flow Rate, cfs	Design Flow Rate Multiple	Freeboard Reduction, ft	Freeboard Remaining, ft	Comments
3,000	1.0	0	3	Design diversion flow rate
3,900	1.3	1	2	-
4,500	1.5	2	1	-
5,100	1.7	3	0	Berms overtopped

The rating curves (flow rate vs. WSEL) for the 1,500 cfs and 3,000 cfs designs are on **Figure L2.6.6-1**.

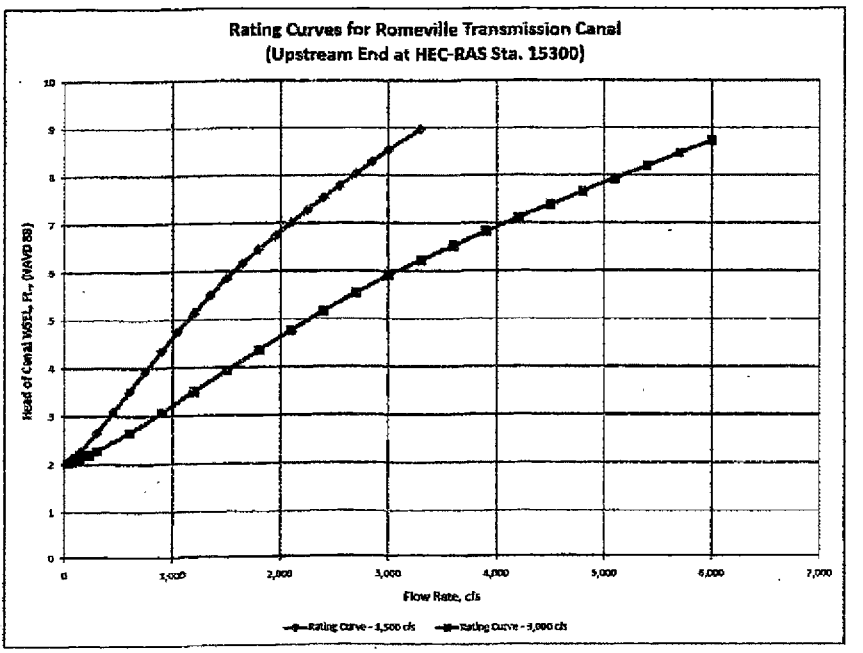


Figure L2.6.6-1 Romeville Transmission Canal Rating Curves

The velocities in the canal are relatively low, due to the restrictions on the HGL. These will need to be reviewed in the next design phase, as the Mississippi River sediment data becomes available. **Figure L2.6.6-2** has the velocity plots for the 1,500 cfs and 3,000 cfs designs.

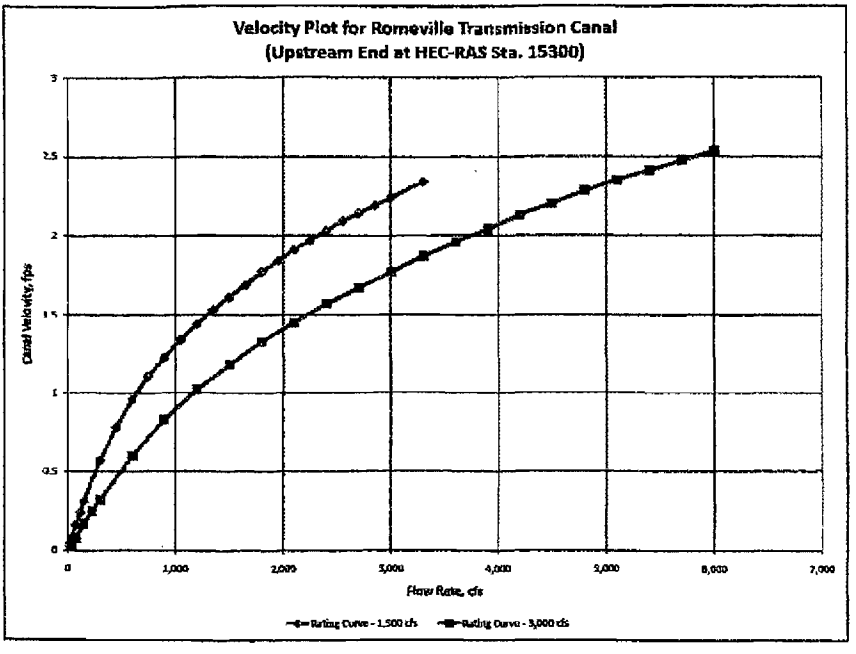


Figure L2.6.6-2 Romeville Transmission Canal Velocity Plots

Road and Railroad Crossings

For the initial transmission canal design, culverts were placed into the HEC-RAS model at the LA 3125 and CN RR crossings for only the 1,000 cfs design. That analysis showed that minimal headlosses in the order of 0.2 feet occur with velocities of approximately 4 fps through the culverts. Culvert designs were omitted from all remaining canal geometry design files, on the assumption that reasonable culvert designs are possible to have low head losses. Reinforced concrete box culverts will be used to cross the existing transportation facilities for the lower design flow rates. Bridges could be used for the higher design flow rates. For preliminary design and costs, culverts were sized for 4 fps. As noted in **Table L2.6.6-3**, the water depths are less than 9 feet; therefore, the box culverts will have a maximum height of 8 feet to fully utilize conveyance capacity at the design flow rate.

Table L2.6.6-3 Culvert Data at Transportation Crossings

Item	CN RR Crossing	LA 3125 Crossing
HEC-RAS Station	13760	5600
Road/Track Elevation	12	8
Natural Ground in Area	6 - 10	6
Proposed Flow Line Elevation	-3.13	-3.95
Proposed Design WSEL	5.8	4.73
Depth of Water	8.93	8.68

All elevations and dimensions in feet.

Based on these criteria, the initial culvert sizes for both the CN RR and the LA 3125 crossings are the same size, as summarized in **Table L2.6.6-4**.

Table L2.6.6-4 Proposed Culvert Sizes at Transportation Crossings

Design Flow Rate, cfs	Required Area at 4 fps, SF	Recommended Size, ft (WxH)	Recommended Area, SF
500	125	2 – 8 x 8	128
1,000	250	3 – 11 x 8	264
1,500	375	4 – 12 x 8	384
2,000	500	6 – 11 x 8	528
2,500	625	7 – 12 x 8	672
3,000	750	8 – 12 x 8	768
3,500	875	10 – 11 x 8	880
4,000	1,000	11 – 12 x 8	1,056
4,500	1,125	12 – 12 x 8	1,152
5,000	1,250	13 – 12 x 8	1,248
10,000	2,500	26 – 12 x 8	2,496
15,000	3,750	39 – 12 x 8	3,744
20,000	5,000	52 – 12 x 8	4,992

L2.7 Hydraulic Analysis of South Bridge Diversion and Transmission Components

The Diversion project requires several different types of management measures, or components, serving different functions, which will be combined to form the alternative plans. This section presents the preliminary hydraulic analysis and design of the diversion and transmission components for the South Bridge alignment. The analysis of the South Bridge alignment in this section includes a distribution canal that is routed across the northern portion of the proposed target area in the Maurepas Swamp. The diversion and transmission components were combined in this section as the design of both is based on the diversion flow rate, and both have a common hydraulic grade line.

The analysis addressed the full range of potential flow rates, management measures, and alternative plans considered as the project developed and the evaluation screening occurred. The initial array of alternatives considered diversion flow rates from 500 cfs to 20,000 cfs, and the preliminary hydraulic designs were prepared for this full range of flows. The specific flow rates being used in the initial alternative arrays are in 500 cfs increments from 500 cfs up to 5,000 cfs, then in 5,000 cfs increments to 20,000 cfs.

The proposed South Bridge diversion point is located on the east bank of the Mississippi River near Mile 167.0 (2004 Hydrographic Survey), as shown on **Figure L2.7-1** and **Figure L2.7-2**.

The proposed Blind River Diversion Project is on the NAVD 88 vertical datum. Other major topographic datasets being used on the project are also on the NAVD 88 vertical datum, including the 2001 LiDAR data and the 2004 Hydrographic Survey.

L2.7.1 Development of the South Bridge Diversion Alignment

As the Blind River diversion project developed, multiple diversion alignments were considered to divert the flow from the Mississippi River and transfer it to the Swamp. The Romeville diversion alignment will transfer water to the existing perimeter drainage channels along the south and west perimeter of the Swamp. The diverted water will then be forced into the Swamp by control structures in the existing channels, flow overland and discharge into the Blind River. Without transfer canals, pipe lines, inverted siphons, or other means such as pump stations, the diverted water cannot be moved across the Blind River and be applied to approximately half of the targeted service area on the north and east side on Blind River. Such facilities would be expensive and highly disruptive to the environmental conditions in the Swamp. Therefore, the Romeville alignment primarily serves the Series 100 HUs, as shown on Figure L2.6-1, the layout for Alternative 2.

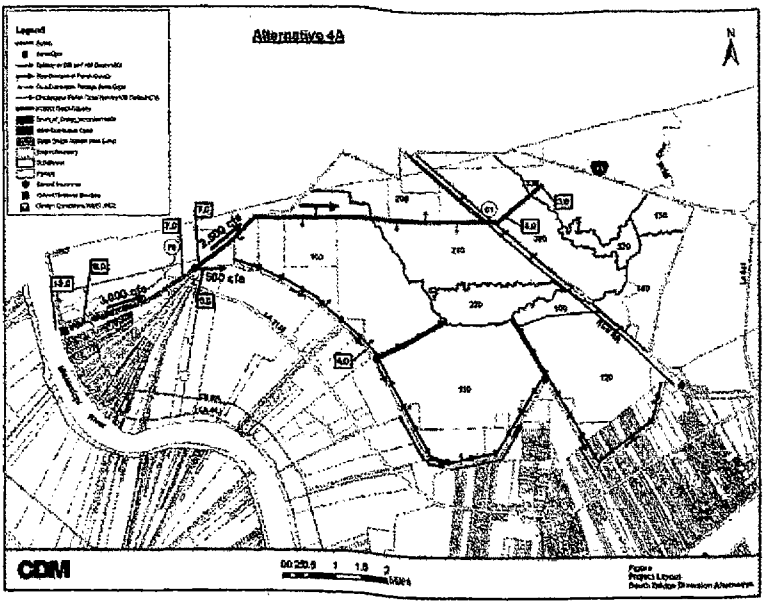


Figure L2.7-1 South Bridge Diversion Project Layout (Alternative 4A)

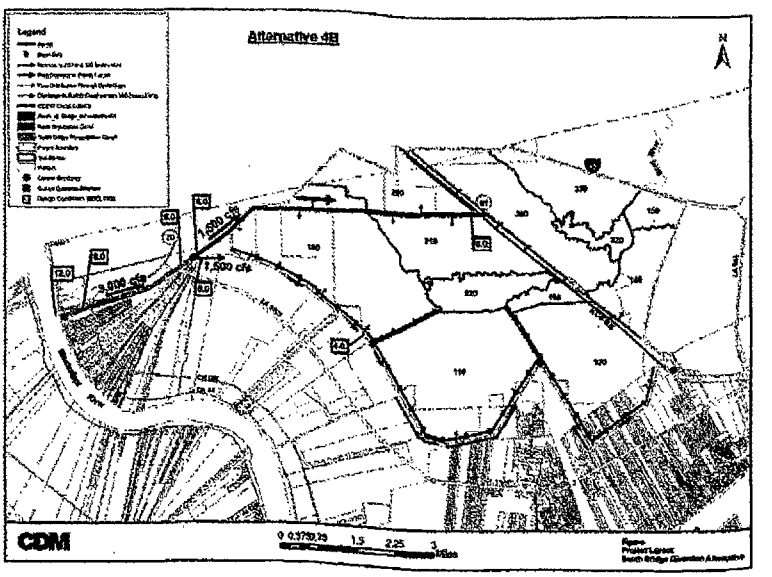


Figure L2.7-2 South Bridge Diversion Project Layout (Alternative 4B)

Several alignments were reviewed to divert water into the upstream area of the targeted Swamp to expand the potential area of influence to include the area north and east of the Blind River, the Series 200 and 300 Hydrologic Units (HUs). The intent was to divert the water into the northwest part of the targeted service area, and then transfer the water across the Blind River headwaters to the north and east side of the Blind River. Diversion alignments on both the north and south sides of Highway 70 at the Sunshine Bridge were initially considered. The South Bridge alignment, the most direct and shortest route, was selected for the more detailed analysis. Figure L2.7-1 and Figure L2.7-2 for Alternatives 4A and 4B illustrate this approach to expand the influence area.

The optional transmission canal alignments in the area of the Sunshine Bridge terminate near a common point, at an existing Parish drainage channel near the far west corner of the proposed Swamp service area. At that point, the flow will be split at the downstream end of the transmission canal, as follows:

- A portion of the flow will be discharged into the existing Parish drainage channel. This water will then be forced into the Swamp with control structures in the existing Parish drainage channels, with locations, designs, and functions very similar to the ones for the Romeville alignment. This portion of the flow will primarily go to the 100 Series HU's.
- The remainder of the flow will continue east in a canal tentatively identified as the North Distribution Canal. The flow would go to part of Hydrologic Unit 100 and to the 200 and 300 Series HUs. The canal will be designed for a decreasing flow rate from west to east, as water will be released into the Swamp along the entire alignment, as with an irrigation canal.

The flow split will be at a control structure with sluice gates controlling flow in both directions. The control structure will be located approximately 2,200 feet east of LA 3125 and 3,500 feet west of the far west corner of the project service area, as shown on the figures for Alternative 4A and Alternative 4B.

The South Bridge transmission canal could have the following optional service areas:

- 100 Series HUs - Discharge all flow into the existing Parish drainage channels
- 100 and 200 Series HUs – Split the flow, as described above. End the North Distribution Canal near the west side of the KCS RR.
- 100, 200, and 300 Series HUs – Split the flow, as described above. Extend the North Distribution Canal across the KCS RR and Highway 61 to serve the 300 Series HUs.

In the later phases of the feasibility study, the array of alternative plans considered four diversion alignment options. In the final array of alternative plans, these were identified as follows:

- Alternative 2 – 1,500 or 3,000 cfs diversion at the Romeville Alignment near Mississippi River Mile 162.0
- Alternative 4 – 1,500 or 3,000 cfs diversion to the South Bridge Alignment near Mississippi River Mile 167.0
    - Alternative 4A – 500 cfs to the existing Parish drainage channel and 2,500 cfs to the North Distribution Canal (Figure L2.7-1)
    - Alternative 4B – 1,500 cfs to the existing Parish drainage channel and 1,500 cfs to the North Distribution Canal (Figure L2.7-2)
- Alternative 6 – Dual Alignment, consisting of a total 3,000 cfs diversion, using a 50/50 flow split between the Romeville Alignment and the South Bridge Alignment

L2.7.2 Mississippi River Stage Analysis at River Mile 167.0

A Mississippi River stage analysis was prepared for the South Bridge diversion point at River Mile 167.0. This analysis used the same source data and procedures described for the Romeville stage analysis in Section L2.6.2. The statistical results are very similar to the Romeville values, but are slightly higher, as shown in **Table L2.7.2-1** and **Table L2.7.2-2**.

Table L2.7.2-1 Standard Statistics for Stage

Period	Standard Deviation	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	7.33	4.48	11.81	19.14
Spring (Mar. 1 – May 31)	6.24	11.63	17.87	24.11
Summer-Fall (Aug. 16 – Nov. 15)	3.23	2.11	5.34	8.57

Table L2.7.2-2 Stage vs. Percent Exceedance

Period	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	4.01	10.25	20.42
Spring (Mar. 1 – May 31)	10.68	18.54	24.50
Summer-Fall (Aug. 16 – Nov. 15)	3.11	4.34	7.40

Approximate Values for Design

Based on the statistical analyses, we recommend using the following approximate values in **Table L2.7.2-3** for design purposes:

Table L2.7.2-3 Summary Stage Statistical Values

Period	Avg. - 1 SD (84.14% Exceedance)	Average (50% Exceedance)	Avg. + 1 SD (15.86% Exceedance)
Full Year	4	11	20
Spring (Mar. 1 – May 31)	11	18	24
Summer-Fall (Aug. 16 – Nov. 15)	3	5	8

L2.7.3 South Bridge Hydraulic Grade Line

The diversion facility and the transmission canals are part of an overall hydraulic system being designed to divert water from the Mississippi River, transfer it to the Maurepas Swamp, distribute it within the Swamp, and drain it to the Blind River. The South Bridge alignment is different from the Romeville alignment in that the flow will be split and discharged to the existing St. James Parish drainage channel, and to an extension of the transmission canal named the North Distribution Canal, as shown on Figure L2.7-1 and Figure L2.7-2.

The hydraulic head available from the Mississippi River is the driving force for flow of the diverted water through the entire system. The principal hydraulic elements and segments of the overall system are:

- Mississippi River stage – the upstream boundary condition for the hydraulic grade line;
- Diversion Structure – to divert the flow over or through the east levee of the Mississippi River;
- Transmission Canal – to transfer the flow from the diversion structure to the edge of the Swamp;
- North Distribution Canal – to transfer flow across the Blind River headwaters and distribute the flow to the hydrological units east of the Blind River;
- Distribution System – to distribute flow into the Swamp;
- Overland Flow and Drainage System – to direct the diverted water through the Swamp, and then to drain it from the Swamp to the Blind River; and
- Blind River stage – the downstream boundary condition for the hydraulic grade line.

The plan to transfer the water long distances across the north portion of the project area and then release it into the Swamp results in a need for a higher HGL with a flatter slope than the Romeville diversion alignment. Based on conceptual and preliminary design analyses, the following water surface elevations are being used for the hydraulic design of the system components for the South Bridge alignment. These values may be revised as the hydro-dynamic modeling progresses and as the designs for the various components of the project progress.

North Distribution Canal – Alternative 4A
The canal service area for Alternative 4A is both west of the KCS RR and east of Highway 61.

- Elev. 1.5 to Elev. 2 – The approximate static WSEL throughout the Swamp, the drainage system, and Blind River between storm events.
- Elev. 3 – The minimum WSEL in the North Distribution Canal for release into the Swamp, providing a 1-foot driving head through the Swamp. This results in a minimum WSEL of Elev. 3 at the downstream (east) end, or terminal end, of the canal.
- Elev. 4 – The minimum WSEL in the North Distribution Canal immediately east of Highway 61, to allow for an extension of the North Distribution Canal further to the east to serve the 300 Series hydrologic units (HU's).
- Elev. 7 – The minimum WSEL at the upstream end of the North Distribution Canal, resulting in 3 feet of head driving the North Distribution Canal system from the end of the transmission canal to the east side of Highway 61.

North Distribution Canal – Alternative 4B
The canal service area for Alternative 4B is west of the KCS RR.

- Elev. 1.5 to Elev. 2 – The approximate static WSEL throughout the Swamp, the drainage system, and Blind River between storm events.
- Elev. 3 – The minimum water surface elevation (WSEL) in the North Distribution Canal for release into the Swamp, providing a 1-foot driving head through the Swamp. This results in a minimum WSEL of Elev. 3 at the downstream (east) end, or terminal end, of the canal near the west side of the KCS RR.
- Elev. 6 – The minimum WSEL at the upstream end of the North Distribution Canal, resulting in 3 feet of head driving the North Distribution Canal system from the transmission canal to the west side of the KCS RR.

Existing Parish Drainage Channels

- Elev. 1.5 to Elev. 2 – The approximate static WSEL throughout the Swamp, the drainage system, and Blind River between storm events.
- Elev. 4 – The proposed design WSEL in the existing drainage channels at the edge of the Swamp near the Romeville diversion alignment, providing a 2-foot driving head into and through the Swamp.
- Elev. 5 – The assumed WSEL in the existing drainage channel at the discharge point from the South Bridge transmission canal. This provides a 1-foot head differential to force flow south in the existing drainage channel.

South Bridge Transmission Canal – Alternative 4A

- Elev. 7 – The minimum WSEL at the downstream end of the transmission canal, based on the controlling WSEL in the North Distribution Canal for Alternative 4A.

- Elev. 9 – The approximate design WSEL at the head (upstream end) of the transmission canal, based on a 2-foot drop in the HGL for the canal.
- Elev. 9 – The proposed design tail water elevation at the diversion structure outlet. At this phase of the preliminary design analysis, a 1-foot drop in the HGL has not been provided from the diversion structure outlet to the head of the transmission canal to route flows through a potential water quality treatment basin or a settling basin.
- Elev. 12 – The recommended design stage in the Mississippi River. The development of this recommendation is documented in the hydraulic design analyses for the culvert and siphon diversion structures.

South Bridge Transmission Canal – Alternative 4B

- Elev. 6 – The minimum WSEL at the downstream end of the transmission canal, based on the controlling WSEL in the North Distribution Canal for Alternative 4B.
- Elev. 8 – The approximate design WSEL at the head (upstream end) of the transmission canal, based on a 2-foot drop in the HGL for the canal.
- Elev. 8 – The proposed design tail water elevation at the diversion structure outlet. At this phase of the design analysis, a 1-foot drop in the HGL has not been provided from the diversion structure outlet to the head of the transmission canal to route flows through a potential water quality treatment basin or a settling basin.
- Elev. 12 – The recommended design stage in the Mississippi River.

The controlling WSEL values listed above are shown on Figure L2.7-1 for Alternative 4A and on Figure L2.7-2 for Alternative 4B. The proposed HGL for both Alternative 4A and Alternative 4B values are also listed in **Table L2.7.3-1** and plotted on **Figure L2.7.3-1**.

The steady-state HGL described above is to establish a single hydraulic design basis to size the diversion structure and the transmission canal. During actual operations, the HGL will vary significantly as the following items change: Mississippi River stage, Lake Maurepas stage, Blind River stage conditions, control gate settings, and diversion flow rates. In recognizing the variability in flow rate and HGL, the diversion culvert analysis and siphon analysis determined flow rates at other HGL conditions to indicate facility performance under the varying conditions.

Table L2.7.3-1 Hydraulic Grade Line Data for Alternatives 4A and 4B

HGL options for South Bridge Diversion Alignment			
	WSEL's for South Bridge Options		
Description	(a)	Alt. 4B	Alt. 4A
Diversion Structure and Transmission Canal			
Design stage in Mississippi River	12.0	12.0	12.0
Tail water at downstream end of Diversion Structure	7.0	8.0	9.0
WSEL at upstream end of Transmission Canal	7.0	8.0	9.0
WSEL at downstream end of Transmission Canal	5.0	6.0	7.0
North Distribution Canal			
WSEL at upstream end on N. Distribution Canal	N/A	6.0	7.0
WSEL at west side of KCS RR	N/A	3.0	
WSEL at east side of Hwy 61	N/A	N/A	4.0
WSEL at 300/330	N/A	N/A	3.0
Static WSEL in Swamp	2.0	2.0	2.0
Release to Existing Drainage Channel			
Operating WSEL in channel at release point	5.0	5.0	5.0
Operating WSEL in Channel at control gates	4.0	4.0	4.0
Static WSEL in Swamp	2.0	2.0	2.0

HGL Options:
(a) - Discharge to perimeter Parish drainage channel, only.
Alt. 4A - Serve Series 200 and 300 HU's, and discharge to perimeter Parish drainage channels
Alt. 4B - Serve Series 200 HU's, and discharge to perimeter Parish drainage channels

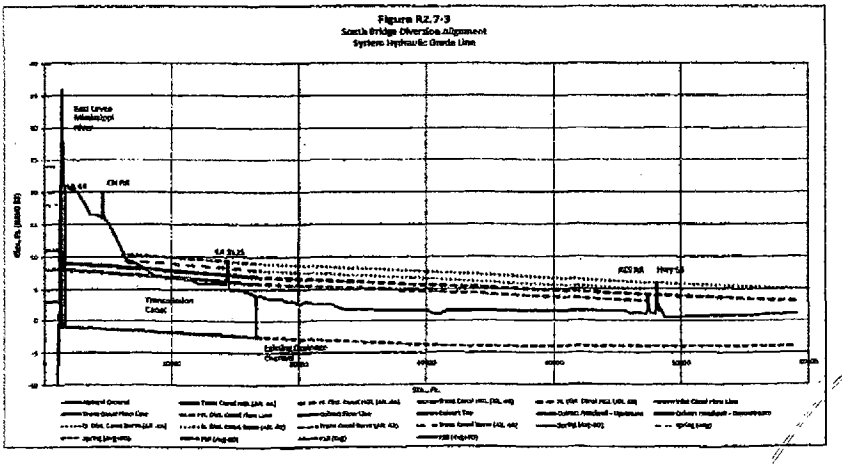


Figure L2.7.3-1 System Hydraulic Grade Line (South Bridge Diversion)

Minimum Stage Limits for Diversions
Section L2.6.2 previously provided a discussion of stage limits in the Mississippi River for diversion.

L2.7.4 Diversion and Transmission System Flow Line Profile

The diversion facility and transmission canal flow line profile was established by existing physical conditions and the need to maximize depth at the Mississippi River to allow diversions during low stages in the river. The transmission canal will discharge into an existing St. James Parish drainage channel along the west perimeter of the Maurepas Swamp. Bathymetric flow line data was obtained for much of the existing perimeter drainage channels; however, elevations were not obtained at the South Bridge alignment. The nearest elevation is over one mile downstream. Based on that elevation, it was considered that the existing drainage channel flow line is Elev. -2.5 at the South Bridge alignment, and this elevation was used as the limiting depth for the transmission canal. The diversion culvert flow line was set at Elev. -1.0 at the levee to have a minimum of a 6-foot depth to operate at Elev. 5 in the Mississippi River. The flow line profile is included in the HGL profile (Figure L2.7.3-1).

Alternate Flow Line Profile
If the existing drainage channels are lowered to Elev. -6.5, the transmission canal and diversion culvert could be lowered 2 feet, possibly reducing facility size and right-of-way requirements. During final design, a comparison of facility sizes should be done to determine cost and operational benefits of de-silting the existing outfall drainage channels, allowing the flow line for the diversion culvert and transmission canal to be lowered.

L2.7.5 South Bridge Diversion Culvert

The system HGL for the South Bridge diversion culvert is provided on **Figure L2.7.5-1.** The head loss through the culvert is similar to the Romeville Diversion Culvert discussed in Section L2.6.4.. The similarity was noted and enabled cost to be determined for each of the alternatives.

L2.7.6 South Bridge Diversion Siphon

The South Bridge Diversion Siphon is similar to the Romeville Diversion Siphon discussed in section L2.6.5. The cost estimate for comparison of alternatives was based on similar configurations.

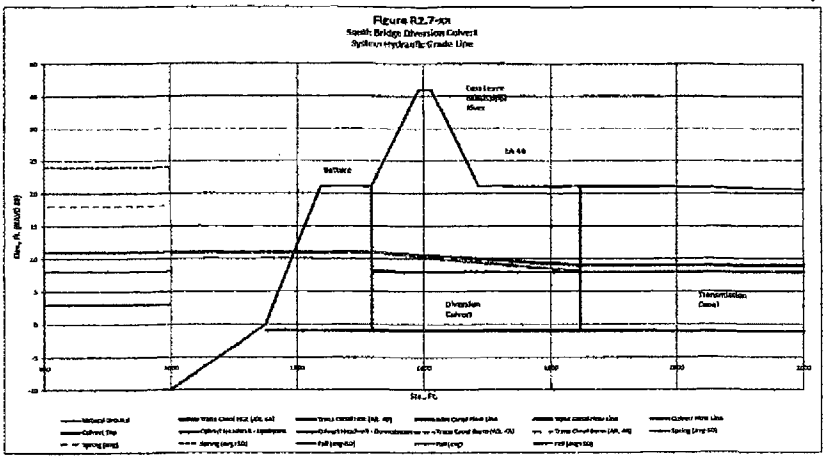


Figure L2.7.5-1 System Hydraulic Grade Line (South Bridge Diversion Culvert)

L2.7.7 South Bridge Transmission Canal

The transmission canal will transfer the diverted water from the diversion facility to the existing drainage channel near the northwest corner of the target project area in the Swamp. The South Bridge transmission canal alignment is approximately 14,800 feet long, and will cross one road (LA 3125) and one railroad (Canadian National Railroad). The canal will have the following features:

- Stilling basin at head of the canal (hydraulic design addressed elsewhere);
- Earthen canal with a flat bottom and 4:1 side slopes (H:V);
- Earthen berms – the canal design HGL will be above ground for approximately 2/3 of the alignment, requiring earthen berms on both sides;
- Railroad crossing – reinforced concrete box culverts; and
- LA 3125 crossing – reinforced concrete box culverts.

Design Basis

The canal design is based on the following:

- See Section L2.7.3 and Figure L2.7.3-1 for the hydraulic grade line.
- See Section L2.7.4 and Figure L2.7.3-1 for the flow line profile.
- Side slopes are 4:1 (H:V) to be conservative. The geotechnical investigation may allow steeper side slopes.

- Erosion protection – the design velocities are low, and erosion potential is minimal. Concrete channel lining and riprap will be used at the upstream and downstream sides of the culverts, and at the outfall into the existing Parish drainage channel.
- Manning's n value – 0.035 for a well-maintained vegetative lined or earthen canal.
- Design for steady-state flow.
- Freeboard – Provide 3 feet of freeboard.
- Berms – 12-foot wide top width to allow maintenance vehicle access, 4:1 side slopes (interior), and 4:1 or 5:1 exterior side slopes for mowing safety.
- Right-of-way width –
  - Without berms – minimum of 30 feet each side for access by large maintenance equipment and for drainage
  - With berms – minimum of 10 feet beyond the outer toe of berm on each side, for a local drainage swale and mowing access
- ROW drainage – provide a small drainage swale at the ROW line and discharge to local drainage.

Options to be considered for the transmission canal design:

- Match the proposed transmission canal flow line to the existing outfall drainage channel assumed flow line (Elev. -2.5). This option is used for the current design recommendation.
- Design the proposed transmission canal flow line to be lower than the existing drainage systems.
- Desilt the existing outfall drainage channel and lower the transmission canal downstream end flow line. This should be reviewed during final design.
- Concrete-lined channel. Preliminary cost comparisons indicate that a concrete-lined canal will increase construction costs substantially; however, this option should be reviewed during final design.

The range of flow rates being considered for the South Bridge diversion point is from 500 cfs to 25,000 cfs, or higher. The preliminary design analysis for the transmission canal covers a range of flows from 500 cfs to 20,000 cfs.

For this analysis, the transmission canal was designed for the Alternative 4B conditions.

HEC-RAS Model for Canal Design

A HEC-RAS model was developed to analyze the transmission canal hydraulics. The cross sections were cut from the 2001 LiDAR-based DEM obtained from the State of Louisiana. The headlosses for the canal were calculated, as follows:

- Manning's n value – 0.035 for earthen channels and 0.015 for concrete channels and concrete box culverts.
- Expansion and Contraction Losses – typical coefficients were obtained from the HEC-RAS manual.
- Entrance and Exit Losses – typical coefficients were obtained from the HEC-RAS manual. All culverts are assumed to have concrete headwalls perpendicular to the flow.

For each design, a series of flow rates were used in the design analysis to determine the operating characteristics of the canal through the expected range of flow rates. Starting water surface elevations were linearly interpolated, matching the HGL design basis stated above.

- Elev. 2.0 – With no flow in the system, the starting WSEL is the same as the static WSEL in the Swamp
- Elev. 7.0 – WSEL at the design flow rate
- Elev. 8.5 – Assumed maximum WSEL in the North Distribution Canal, under a high diversion flow rate

To develop a canal section for each design flow rate, the canal bottom width was adjusted to obtain a water surface profile meeting the HGL criteria noted above. The flow line profile and berm elevations remained the same for all design flow rates. The HEC-RAS model was used to create canal designs for 500, 1000, 2000, 5000, and 10000 cfs flow rates. A plot of these bottom widths versus the design flow rates approximates a straight line; therefore, the bottom widths for other flow rates were interpolated. The recommended channel design sections are in the following table. The right-of-way widths vary throughout the length of the canal, as natural ground elevations vary. The table below uses the maximum right-of-way width. Actual right-of-way acquisitions could be less in certain reaches.

Freeboard and Excess Capacity

The diversion structure will operate with a varying driving head, varying diversion structure capacity in service, and possible with variable control, all resulting in the likelihood that flow rates will not be finely controlled to the design flow rate. Therefore, the transmission canal needs excess capacity to avoid overtopping the berms. With the 3-foot freeboard design, the canal has the excess capacity as shown in **Table L2.7.7-2**. For the 3,000 cfs transmission canal design with berms set to provide a 3-foot freeboard, the channel could be overtopped at 4,800 cfs, or 1.6 times the diversion design flow rate.

Table L2.7.7-1 Recommended Channel Design Sections

Design Flow Rate, cfs	Bottom Width, ft	Proposed ROW Width, ft
500	10	250
1,000	30	270
1,500	60	295
2,000	80	320
2,500	105	345
3,000	130	370
3,500	150	395
4,000	175	420
4,500	200	440
5,000	220	460
10,000	450	690
15,000	685	930
20,000	920	1,160

Table L2.7.7-2 Freeboard Data

Flow Rate, cfs	Design Flow Rate Multiple	Freeboard Reduction, ft	Freeboard Remaining, ft	Comments
3,000	1.0	0	3	Design diversion flow rate
3,600	1.2	1	2	-
4,200	1.4	2	1	-
4,800	1.6	3	0	Berms overtopped

The rating curves (flow rate vs. WSEL) at the upstream end of the transmission canal for the 1,500 cfs and 3,000 cfs designs are shown on **Figure L2.7.7-1**. The rating curves presented are the averages for the designs performed in HEC-RAS.

The velocities in the canal are relatively low, due to the restrictions on the HGL. These low velocities will need to be reviewed in the next design phase, as the Mississippi River sediment data becomes available. **Figure L2.7.7-2** has the velocity plots for the 1,500 cfs and 3,000 cfs designs at the upstream end of the transmission canal. The values are interpolated from the HEC-RAS designs for other flow rates.

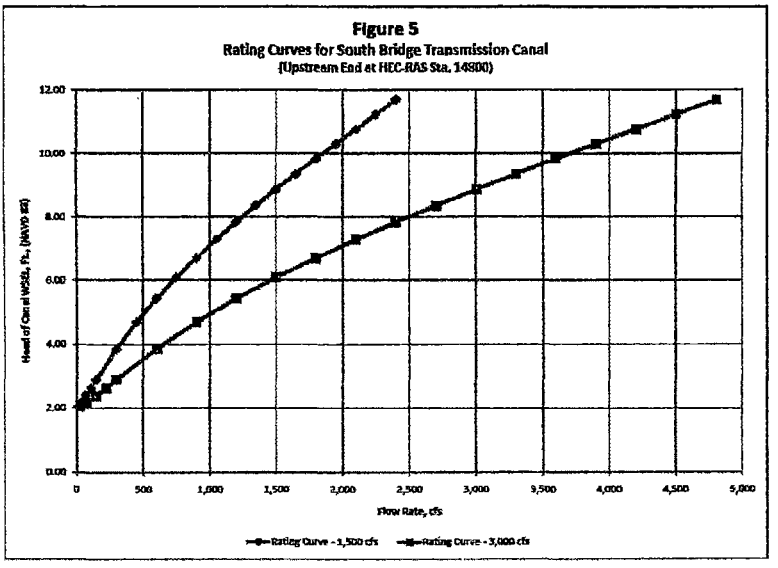


Figure L2.7.7-1 Rating Curves for South Bridge Transmission Canal

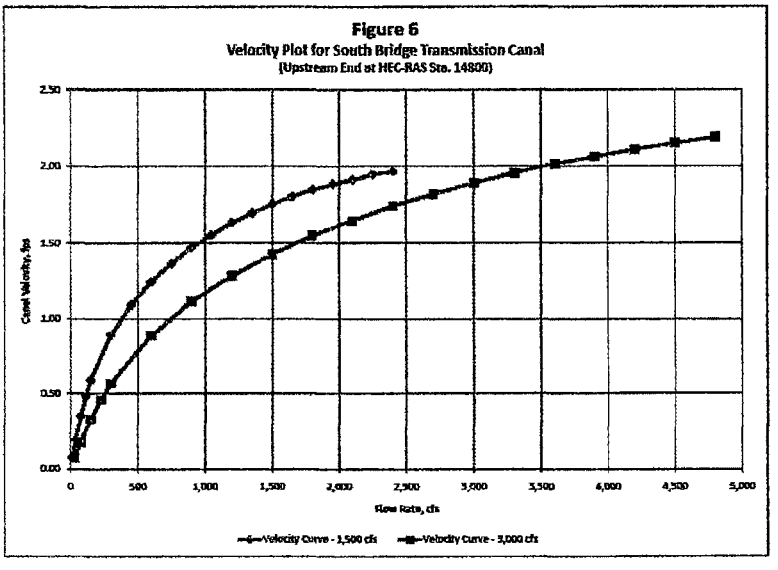


Figure L2.7.7-2 Velocity Plots for South Bridge Transmission Canal

Road and Railroad Crossings

For the initial transmission canal designs, culverts were not placed into the HEC-RAS model at the LA 3125 and CN RR crossings, on the assumption that the culverts will be sized to have low head losses. Reinforced concrete box culverts will be used to cross the existing transportation facilities for the lower design flow rates and bridges could be used for the higher design flow rates. For preliminary design and costs, culverts were sized for 4 fps. As noted in **Table L2.7.7-3**, the water depths are less than 10 feet; therefore, the box culverts could have a maximum height of 9 feet. The CN RR crossing has sufficient clearance for 9-foot high boxes. The LA 3125 top of pavement is below the proposed HGL, and either shallower boxes or an inverted siphon will be required.

Table L2.7.7-3 Transportation Crossing Data

Item	CN RR Crossing	LA 3125 Crossing
HEC-RAS Station	12015	2177
Road/Track Elevation	16 +	9
Natural Ground in Area	16	5 - 6
Proposed Flow Line Elevation	-1.30	-2.32
Proposed Design WSEL	8.6	7.3
Depth of Water	9.9	9.6

All elevations and dimensions in feet.

Using 9-foot high boxes for both the CN RR and the LA 3125 crossings, the initial box culvert sizes are summarized in **Table L2.7.7-4.**

Table L2.7.7-4 Proposed Culvert Sizes

Diversion Design Flow Rate, cfs	Required Area at 4 fps, SF	Recommended Size, ft	Recommended Area, SF
500	125	2 - 8 x 8	128
1,000	250	3 - 10 x 9	270
1,500	375	4 - 12 x 9	432
2,000	500	5 - 12 x 9	540
2,500	625	6 - 12 x 9	648
3,000	750	7 - 12 x 9	756
3,500	875	9 - 12 x 9	972
4,000	1,000	10 - 12 x 9	1,080
4,500	1,125	11 - 12 x 9	1,188
5,000	1,250	12 - 12 x 9	1,296
10,000	2,500	24 - 12 x 9	2,592
15,000	3,750	35 - 12 x 9	3,780
20,000	5,000	47 - 12 x 9	5,076

L2.7.8 North Distribution Canal

The north distribution channel extends into the Maurepas Swamp from the west corner of the project area to the KCS RR and Hwy 61 corridor. For the segment west of the KCS RR, most if the alignment is immediately south of and parallel to an existing pipeline easement. Flow will be released from the canal into the Swamp at multiple locations, as with irrigation canals. Two options were considered for the north distribution canal capacity and service area, as follows:

- Alternative 4A – Extend the canal east across the KCS RR and Highway 61 to add hydrologic units east of Highway 61 to the service area. To serve the eastern 300 Series HUs, the canal would be approximately 39,000 feet long (Figure L2.7-1).
- Alternative 4B – End the canal west of the KCS RR and serve the areas west of the RR. The canal will be approximately 30,900 feet long (Figure L2.7-2).

The canal will have the following features:

- Earthen canal with a flat bottom and 3:1 side slopes (H:V).
- Earthen berms – the canal HGL will be above natural ground for the entire alignment, requiring earthen berms on both sides.
- An inverted siphon will be required at the existing Parish drainage channel, at the start of the north distribution canal. The initial design concept is to put the drainage channel through an inverted siphon under the canal (and not put the canal in an inverted siphon).
- Additional inverted siphons may be required at other drainage features in the service area.
- KCS RR crossing – inverted siphon (reinforced concrete box culverts).
- Hwy 61 crossing – inverted siphon (reinforced concrete box culverts).

Design Basis

The North Distribution Canal design is based on the following:

- The flow line of upstream end of the north distribution canal will match the downstream end of the transmission canal.
- The flow line of the north distribution canal will be flat, and the bottom width will be reduced as the flow rate is reduced with releases into the Swamp.
- Side slopes are 3:1 (H:V), as the channel is relatively shallow. The geotechnical investigation may recommend flatter side slopes.
- Erosion protection – the design velocities are low, and erosion potential is minimal. Concrete channel lining and riprap will be used at the upstream and downstream sides of the culverts, and at the outfall into the existing Parish drainage channel.

- Manning's n value – 0.035 for a well-maintained vegetative lined or earthen canal.
- Design for steady-state flow.
- Freeboard – Provide 2 feet of freeboard.
- Excess capacity – see discussion below.
- Berms – 12-foot wide top width to allow maintenance vehicle access, 3:1 side slopes (interior), and 4:1 or 5:1 side slopes (exterior). The berm height is generally low, and steeper exterior side slopes should be stable.
- Right-of-way width – A separate right-of-way may not be required on State land in the Wildlife Management Area (WMA). The following criterion is an approximation of area required for construction and maintenance of the canal system.
    - Without berms – minimum of 30 feet each side for large maintenance equipment and drainage
    - With berms – minimum of 10 feet beyond the outer toe of berm on each side, for a local drainage swale and mowing access
- ROW drainage – typically none, as the Swamp normally is saturated and has standing water. If necessary, provide a small drainage swale outside of the berm and discharge to local drainage.

Excess Capacity

The north distribution canal is in the Swamp, where overflows are non-critical to the area. Protect the canal with control sections in the berms, such as weir sections set at one foot above the design HGL. At the overflow area, line the berm with erosion protection, such as rip rap or concrete channel lining. This would protect the canal from uncontrolled overflows and berm washout, without oversizing the canal. A primary overflow control section could be placed at the upstream end of the north distribution canal and direct the overflow into the existing Parish drainage channel.

Design Flow Rates

The following flow rates were used for the preliminary canal design, as the alternative plans were developing:

- Alternative 4A – 900, 1,000, 1,500, 2,000, and 2,500 cfs;
- Alternative 4B – 500, 1,000, and 1,500 cfs;
- Option 1 – 500 cfs to serve the 200 Series HUs; and
- Option 2 – 900 cfs to serve the 200 and 300 series HUs.

The flow rates were uniformly reduced through the canal reach, to represent multiple releases to the Swamp service area, as with irrigation canals. For Alternative 4A, it was considered that 40% of the flow in the north distribution canal would be transferred across the KCS RR/Hwy 61 corridor to the Series 300

HUs. This flow proration will need to be adjusted as the hydro-dynamic modeling progresses.

HEC-RAS Model for Canal Design

A HEC-RAS model was developed to size and analyze the canal hydraulics. The cross sections were cut from the 2001 LiDAR-based DEM obtained from the State of Louisiana. The headlosses for the canal were calculated, as follows:

- Manning's n value – 0.035 for earthen channels, 0.015 for concrete channels, and 0.013 for concrete box culverts.
- Expansion and Contraction Losses – typical values were obtained from the HEC-RAS manual.
- Entrance and Exit Losses – Typical entrance and exit loss coefficients were obtained from the HEC-RAS manual. All culverts are considered to have concrete headwalls.

To develop a section for each design flow rate, the canal bottom width was adjusted to obtain a water surface profile meeting the HGL criteria noted above. The flow line profile and berm elevations remained the same for all design flow rates.

For each design, a series of flow rates were used in the design analysis to determine the operating characteristics of the canal through the expected range of flow rates. Starting water surface elevations are from the HGL design basis stated above.

The recommended channel design sections are summarized in **Table L2.7.8-1**. The right-of-way widths vary throughout the length of the canal, as natural ground elevations vary. The table below uses the maximum right-of-way width. Actual right-of-way acquisitions could be less in certain reaches.

Table L2.7.8-1 Recommended Channel Design Sections

Design Flow Rate, cfs	Bottom Width, Ft.	Proposed ROW Width, Ft.
500	10	250
1,000	30	270
1,500	60	295
2,000	80	320
2,500	105	345
3,000	130	370
3,500	150	395
4,000	175	420
4,500	200	440
5,000	220	460
10,000	450	690
15,000	685	930
20,000	920	1,160

The rating curves (flow rate vs. WSEL) for the 1,500 cfs and 3,000 cfs designs are illustrated on Figure L2.7.7-1. The values presented are the averages for the designs performed in HEC-RAS.

The velocities in the canal are relatively low, due to the restrictions on the HGL. These low velocities will need to be reviewed in the next design phase, as the Mississippi River sediment data becomes available. Figure L2.7.7-2 has the velocity plots for the 1,500 cfs and 3,000 cfs designs. The values are interpolated from the HEC-RAS designs for other flow rates.

Road and Railroad Crossings

For the initial Alternative 4A canal design, culverts were not placed into the HEC-RAS model at the KCS RR and Highway 61 crossings, on the assumption that the culverts will be sized to have low head losses. Reinforced concrete box culverts will be used to cross the existing transportation facilities for the lower design flow rates and bridges could be used for the higher design flow rates. For preliminary design and costs, culverts were sized for 4 fps. As noted in the table below, the water depths are less than 10 feet; therefore, the box culverts could have a maximum height of 9 feet. The CN RR crossing has sufficient clearance for 9-foot high boxes. The LA 3125 top of pavement is below the proposed HGL, and either shallower boxes or an inverted siphon will be required.

Table L2.7.8-2 Transportation Crossing Data

Item	KCS RR Crossing	Hwy 61 Crossing
HEC-RAS Station	1984	1278
Road/Track Elevation	4	6
Natural Ground in Area	1 to 2	1 to 2
Proposed Flow Line Elevation	-4	-4
Max. Inside Top-of-Box Elevation	0	2
Proposed Design WSEL	4	4
Inside Height of Box, max.	4	6
Depth of Water in Canal	8	8

Note: All elevations and dimensions in feet.

At the KCS RR crossing, the boxes would have to be 4' high, maximum. At the Highway 61 crossing, 6' high boxes could be used. At both locations, higher box culverts by dropping the profile and creating inverted siphons, if the overall width becomes excessive. For preliminary hydraulic design, consider 6-foot high box culverts.

Table L2.7.8-3 Proposed Culvert Sizes

At head of canal - Design Flow	At KCS RR/Hwy 61 -	Required Area at 4 fps,	Recommended Size, Ft.	Recommended Area, SF

Rate, cfs	Design Flow Rate, cfs	SF	(WxH)	
500	200	50	2 – 5' x5'	50
900	400	100	3 – 6' x 6'	108
1,000	400	100	3 – 6' x 6'	108
1,500	600	150	3 – 9' x 6'	162
2,000	800	200	4 – 9' x 6'	216
2,500	1,000	250	5 – 9' x 6'	270

L2.7.9 Existing Drainage Channel Improvements

Sufficient topographic surveying data is not yet available to analyze the hydraulic capacity of the existing Parish drainage channel. See Section L7 for assumptions used to develop conceptual sizing, quantities, and costs for screening.

L2.8 Swamp Distribution System Analysis

Various water management measures have been identified to apply freshwater to the swamp to beneficially allow transfer of freshwater, nutrients and sediments to the swamp. The flow rate will need to be controlled at both the inlets and outlets to the swamp in order to control the depth and detention time of the water directed into the swamp. A fluctuating hydroperiod (water depth and duration) with dry periods is critical to the germination and sapling survival of bald cypress and tupelo. A fluctuating hydroperiod will also enhance assimilation and improve the quality of water-released to the Blind River. The benefits of several types of water management facilities have been reviewed including berm gaps/cuts, control structures, and culverts. These facilities are described in further detail below.

L2.8.1 Berm Gaps/Cuts

Following a review of the topographic data and field reconnaissance within the project boundary, it was determined that there are approximately 163 existing berm openings in the man-made berms along the southern border of the project area and the St. James Parish Canal Systems. These berms are spaced at approximately 610 feet and the average dimensions are 10 feet in length (measured parallel to the canal) and 20 feet in width (measured perpendicular to the canal). These natural weirs, presented on **Figure L2.8.1-1**, will allow for some exchange of flow between the canals and the adjacent swamps. In an effort to increase the capacity, the proposed berm cuts will utilize and expand on the existing berm cuts. The proposed berm cuts, however, will be expanded to a length of 500 feet with a width of 20 feet and extend to existing grade. The side slopes of the berm gaps will be protected with articulated concrete block mats or other erosion protection measures. The proposed berm cut locations are displayed on **Figure L2.8.1-2**. The existing spoil from the spoil piles will be excavated at the proposed berm cut locations and placed behind the existing spoil piles on either side of the gap. The spoil material will be used to expand existing berm width, creating more upland habitat.

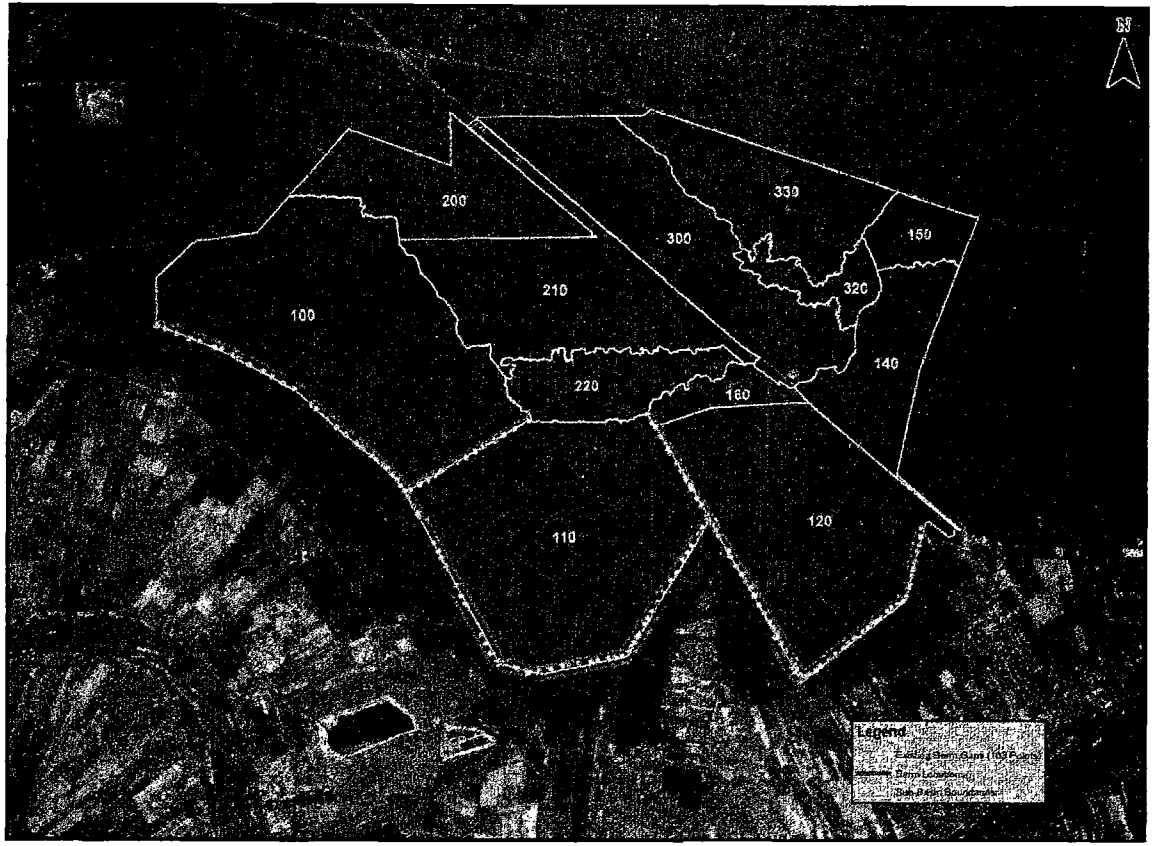


Figure L2.8.1-1 Existing Berm Gaps

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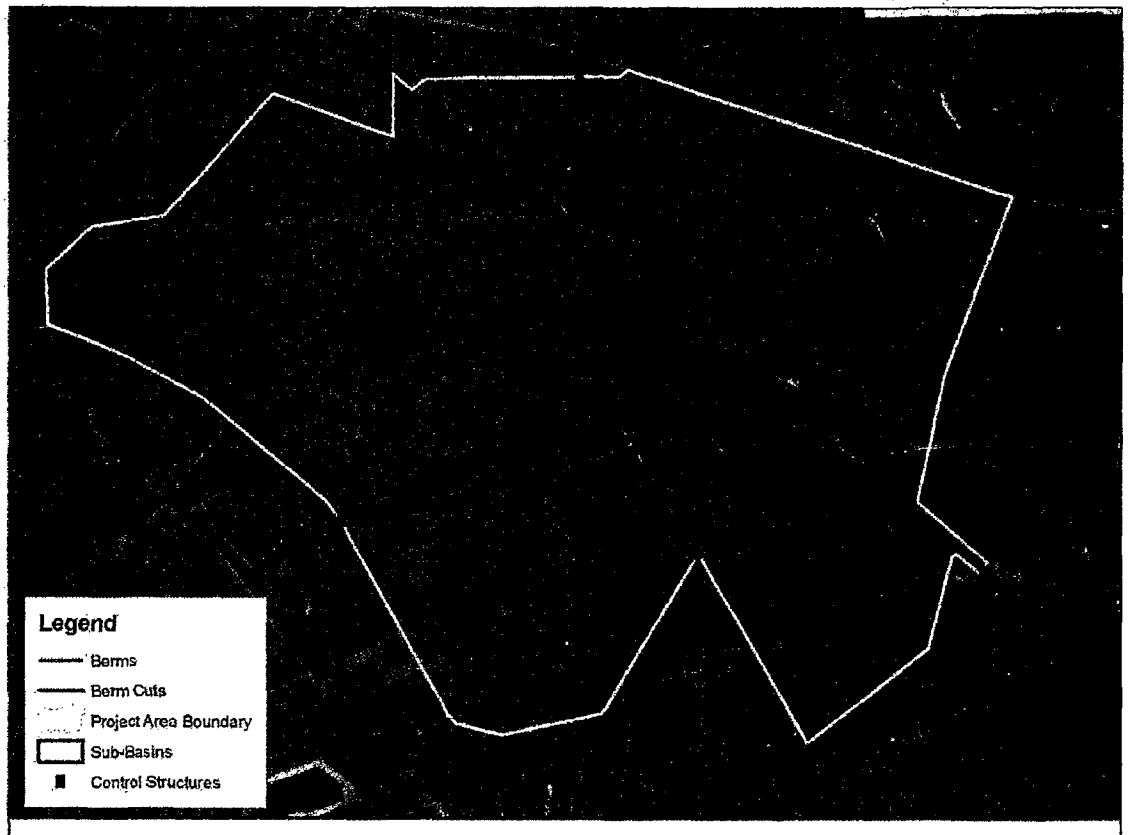


Figure L2.8.1-2 Proposed Berm Gaps

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L2.8.2 Control Structures

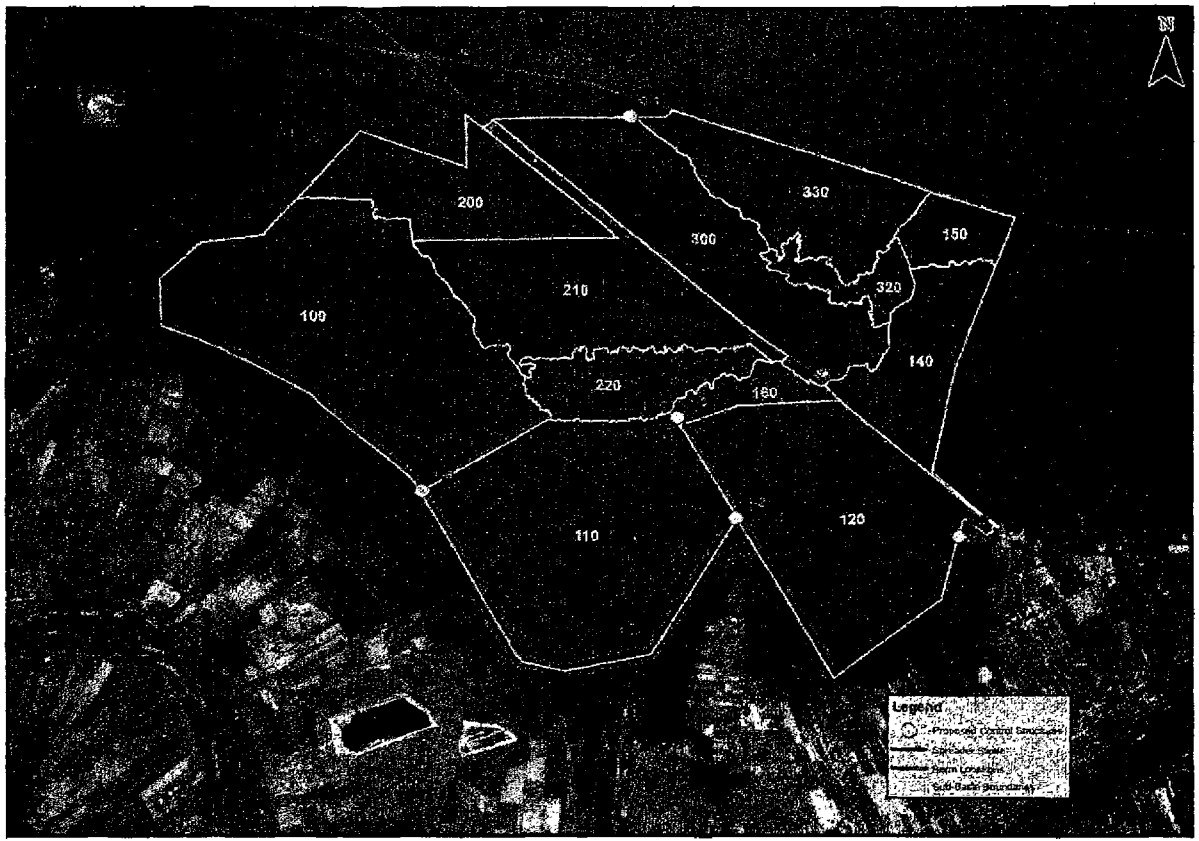
The purpose of adding control structures in the canals is to force water into the Swamp. This dynamic can be achieved by placing a barrier within the existing channel. The structure would allow an increase in the water surface level behind it, providing a hydraulic gradient to force the freshwater into the swamp. The canals currently serve drainage and flood control purposes and measures would be incorporated into the design to accommodate these needs. Active monitoring and management would be required for this management measure to avoid flood impacts to the developed areas adjacent to the swamp.

The type of gate that has been chosen for this application is a rotating gate. Both Rodney Hunt and Obermeyer Hydro, Inc manufacture rotating control gates that have a parabolic configuration rotating from 0 degrees (flush with the canal bottom) to 90 degrees (perpendicular to canal flow) and any angle in between. One of these types of control weirs will be chosen for the application of this project. Initially, the opportunity for control structures was provided at numerous locations. A detailed analysis was performed for all these potential control structure locations and is included in **Annex 6**. This analysis was used to determine which control structures will continue to be used in future alternatives. Structures were eliminated because they didn't control flows, or would require difficult construction and implementation. Five structures will remain in the project and are displayed on **Figure L2.8.2-1**.

Two of the five structures are located a "tee" in the canal system. The control structures at these two locations (1-6 and 1-8) have the capability of controlling flow in three directions. Bathymetric data and LiDAR data were used to determine the dimensions for the control structures and are summarized in **Table L2.8.2-1**. A control structure isometric view is displayed on **Figure L2.8.2-2**.

Table L2.8.2-1 Structure Summary Table

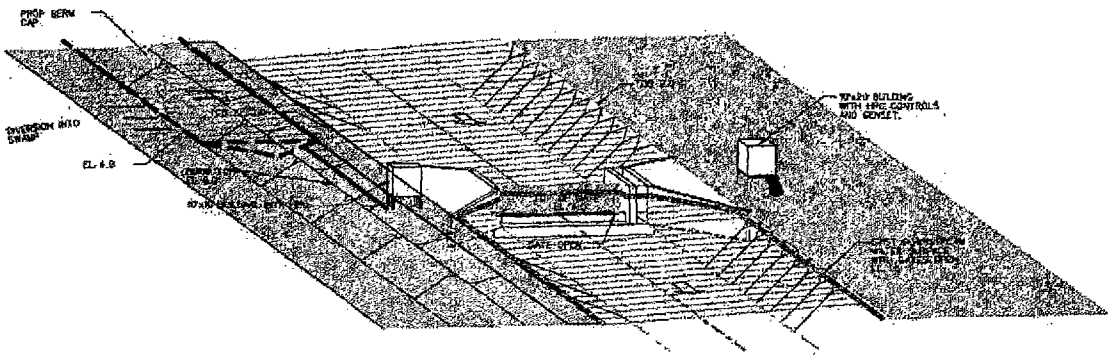
Control Structure	Est. Channel Width (ft)	Est. Channel Depth (from TOB) (ft)	Location Description
1-3	164	8.4	St. James Parish Canal
1-6 East	147	6.7	St. James Parish Canal, At Romeville transmission connection
1-6 South	66	4.9	St. James Parish Canal, At Romeville transmission connection
1-6 North	66	4.7	St. James Parish Canal, At Romeville transmission connection
1-7	65	5.6	St. James Parish Canal near Hwy 61
1-8 Southwest	130	8.1	St. James Parish Canal
1-8 Southeast	130	10.5	St. James Parish Canal
1-8 Northwest	130	10.5	St. James Parish Canal
2-4	65	0	Adjacent to Hwy. 61
3-1	213	12.3	Conway Canal



CDM

Figure L2.8.2-1 Control Structure Locations

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CDM

Figure L2.8.2-2 Control Structure Isometric View

N.T.S.

1350

L2.8.3 Culverts and Bridges

A field survey was performed to verify all the existing culvert and bridge crossings along Highway 61 and Interstate 10. A summary of the findings are included in **Table L2.8.3-1**. In close proximity to the project site, there are five bridge crossings located through Highway 61 and two bridge crossings through Interstate 10. In addition, there are 10 culvert crossings through Interstate 10. These culverts range in size from a 36-inch-diameter reinforced concrete pipe (RCP) to a 6-foot by 4-foot reinforced concrete box culvert (RCBC).

Highway 61 and the KCS Railroad act as barriers between hydrologic units on the northeast and southwest of the project area. In an effort to distribute flow to both sides of the highway and railroad, consideration has been made to the addition of new culvert crossings at four locations along the road. These crossing locations will each consist of four 6-foot by 4-foot RCBCs under Highway 61 and under the KCS Railroad. The culverts will be connected via a 580 foot long channel. The channel will be excavated with a bottom width equal to 27 feet and 4:1 side slopes. The proposed culvert crossing locations are presented on **Figure L2.8.3-1.**

L2.9 Swamp Flow Outlet Control Analysis

Maurepas Swamp and Blind River are part of a regional system that is influence by both rainfall-runoff characteristics of riverine watersheds and coastal processes, such as tidal cycles and storm surge. As noted in Appendix Section L2.4, portions of the existing swamps have subsided and are now persistently inundated. In addition, field observations have revealed that the existing swamp has a limited ability to drain following local and regional rainfall events. Based on this understanding, additional analyses were completed to expand consideration of downstream conditions and how they affect the study area. Downstream water levels were considered in two ways. First, available water elevation data for Lake Maurepas and Lake Pontchartrain were reviewed to determine how existing downstream conditions should be incorporated into the project analyses. Second, information related to projected sea level rise was compiled for incorporation into the project analyses.

L2.9.1 Lake Maurepas

Analysis was completed to determine the statistical characteristics for the two lakes downstream of the Blind River project area in order to understand how downstream conditions affect the study area. Since freshwater diversion flows are primarily anticipated to function during average hydrologic conditions the focus of this analysis was on typical downstream water levels.

Stage Data

There are multiple long-term stage gage locations in the Lake Pontchartrain Basin. The two upstream gages in the basin, nearest to Blind River, were used for this analysis, as follows:

Table L2.8.3-1 Field Survey of Bridges along Highway 61 and Culverts along Interstate 10

Location	Number of Culverts	Culvert Type	Culvert Size	Channel Width	Channel depth	Water Elevation	Additional Comments
64	2	RCBC	6' x 4'	25'	4'-9"	4'-9"	Clear
65	4	RCP	3'	28'	3'	2'-6"	Water surface elevation is at 75% of barrel diameter
66	2	CMP	5'	40'	5'	2'-8"	Heavily vegetated in outfall canal
67	2	CMP	5'	N/A	N/A	2'-6"	
68	N/A	Bridge	N/A	140'		12'-6"	
69	Could not locate culvert						
70	2	CMP	5'	N/A		2'	
71	Could not locate culvert			50'	10'	10'	Channel is relatively deep at this location
72	2	CMP	5'	N/A		3'	Tree debris in inlet drain area
73	3	CMP	5'	30'	5'	3'	Tree debris in inlet drain area
74	Could not locate culvert						
75	2	CMP	5'	30'	5'	3'	Vegetation and tree debris in inlet drain area
76	3	CMP	5'	20'	5'	2'-6"	Vegetation and tree debris in inlet drain area
77	N/A	Bridge	N/A	114'	5'	2'-6"	Water stagnant with heavily vegetated outfall channel/channel is completely full of thick aquatic plants
78	N/A	Bridge	N/A	90'	12'	8'	Clear
79	N/A	Bridge	N/A	104'	13'	8'	Salvania is present throughout the water surface

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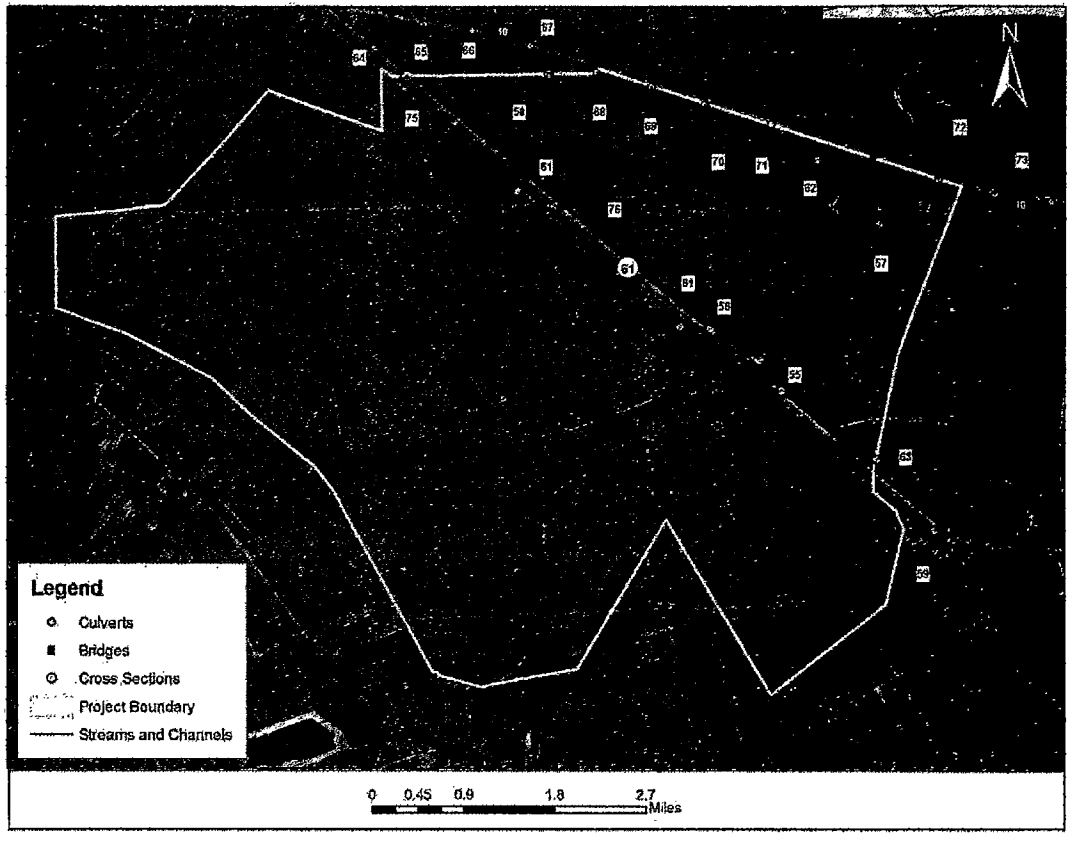


Figure L2.8.3-1 Locations of Culverts, Cross-Sections, and Bridges

- Pass Manchac near Pontchatoula – this gage is located on the upstream side of Pass Manchac and represents the stage in the east end of Lake Maurepas.
- Lake Pontchartrain near Frenier – this gage is located on the west end of Lake Pontchartrain.

Stage data were obtained for both gages from the USACE New Orleans Engineering District website. 30 years of data were collected for each gage. Both gages were apparently out of service part way through 2005 to 2009. Therefore, the data covers the period of January 1, 1975 through Dec. 31, 2004. The stage records at the two gage sites are incomplete, with multiple data points missing at both the Pass Manchac and the Lake Pontchartrain Frenier gages. As the stage varies significantly due to tides, no attempts were made to re-create or fill these missing values.

The available daily stage data at both gages are referenced to the NGVD (1929) vertical datum. For consistency with other project data, the stage data were converted to NAVD (1988). **Table L2.9.1-1** provides a summary of the data available at each gage and the datum adjustment between NGVD and NAVD. These datum conversion values were obtained through correspondence with staff from the USACE New Orleans District. The USACE provided a vertical adjustment value of -0.5 feet for the Pass Manchac gage, but stated that a datum adjustment value is not available for the Lake Pontchartrain Frenier gage. Therefore, for the purpose of this analysis the same value of -0.5 feet was assumed for the Pontchartrain Frenier gage. Note that in mid-2009, the gages were placed back into service, and the stage data is now being reported on the NAVD 88 vertical datum.

Table L2.9.1-1 Downstream Gage Summary

Gage Data Feature	Pass Manchac Gage Near Pontchatoula	Lake Pontchartrain Gage at Frenier
Gage ID	85420	85550
Vertical Datum[1]	NGVD 1929	NGVD 1929
Gage 0 (feet)	Elevation 0	Elevation 0
Vertical Datum Adjustment[2]		
Adjustment Value (ft)	-0.5	
Adjustment Equation (ft)	NAVD = NGVD - 0.5	NAVD = NGVD - 0.5
Period of Record	July 1955 to Aug 2005	Sep 1931 to May 2005
Data Period Used	Jan 1975 to Dec 2004	Jan 1975 to Dec 2004

Notes:

[1]Vertical datum refers to the datum applicable to data obtained from the source website

[2]Vertical datum adjustment from NGVD 1929 to NAVD 1988

Statistical Analyses

Statistical analyses were performed on the stage data to extract values and trends for use in the analysis and design of the diversion system and to gain insight into how downstream conditions influence the study area. Analyses completed included review of data averages, standard deviations, exceedance frequency and tides.

Averages and Standard Deviations

The averages and standard deviations were calculated for each day of the year from the daily stage data and summarized in **Table L2.9.1-2**. The daily average stage, the average stage minus one standard deviation, and the average stage plus one standard deviation are plotted on **Figure L2.9.1-1** for Pass Manchac and **Figure L2.9.1-2** for Lake Pontchartrain Frenier. The stage data for the two gages are daily values recorded at 8:00 AM. Since the locations are tidally influenced, the stage readings will be for different parts of the tide, ranging from the high to low tide. This will impact the statistical values noted in Table L2.9.1-2.

Table L2.9.1-2 Observed Water Surface Elevation Statistics

Gage Summary	Observed Water Surface Elevation Statistics (feet - NAVD)			
	Standard Deviation	Average Minus One Standard Deviation	Average Water Elevation	Average Plus One Standard Deviation
Pass Manchac Gage				
Annual	0.6	0.1	0.7	1.3
Spring (Mar 1 to May 31)	0.7	0.1	0.8	1.5
Summer (Jul 1 to Aug 31)	0.5	0.0	0.5	1.1
Fall (Sep 1 to Nov 30)	0.5	0.4	0.9	1.4
Winter (Dec 1 to Feb 28)	0.6	-0.1	0.5	1.1
Lake Pontchartrain Frenier Gage				
Annual	0.6	0.0	0.6	1.2
Spring (Mar 1 to May 31)	0.6	-0.1	0.6	1.2
Summer (Jul 1 to Aug 31)	0.5	-0.1	0.4	0.9
Fall (Sep 1 to Nov 30)	0.6	0.5	1.1	1.7
Winter (Dec 1 to Feb 28)	0.6	-0.1	0.5	1.1

The plot of the stage values on Figure L2.9.1-1 and Figure L2.9.1-2 indicate subtle trends corresponding to the seasons. The spring period (March through May) tends to have a higher stage compared to the summer and winter. Water levels observed in the fall (September to October) also appear to have higher than average stages, possibly indicating a statistical influence of tropical storm surges or increased seasonal precipitation.

Percent Chance Exceedance

A percent chance exceedance curve was developed for the Pass Manchac gage using the Weibull formula. A Pearson Type III analysis was not used, as the stage analysis is more concerned with long-term trends of typical values, and not with the extreme events. The percent chance exceedance plot for Pass Manchac is on **Figure L2.9.1-3.**

Tide Height Analysis

Limited hourly stage data is available for the Pass Manchac gage for part of 2009 (April 27, 2009 to the present) and plotted on **Figure L2.9.1-4.** Based on this very limited data, the tide height statistics indicated an average tide height of 0.4 feet and a standard deviation of 0.2 feet.

L2.9.2 Sea Level Rise

Based on US Army Corps of Engineers guidance (EC 1165-2-211), potential relative sea-level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. The guidance further states that planning, engineering, and designing for sea level change must consider how sensitive and adaptable 1) natural and managed ecosystems and 2) human systems are to climate change and other related global changes and that planning studies and engineering designs should consider alternatives that are developed and assessed for the entire range of possible future rates of sea-level change. Section L2.9.2.1 describes the projection for relative sea level rise developed for the project, and Section L2.9.2.2 discusses how the projected relative sea level rise values were applied.

L2.9.2.1 Projected Relative Sea Level Rise

Guidance was provided from staff at the USACE New Orleans District regarding projected sea level rise for the study area.

With respect to future sea level rise scenarios the guidance requires project performance to be assessed using three sea level change scenarios, a low estimate, an intermediate estimate, and a high estimate. The low estimate uses a projection of the historic rate for the study area. The intermediate estimate is based on the modified National Research Council (NRC) Curve I and the local historic subsidence rate, and the high estimate is based on the modified NRC Curve III and the local historic subsidence rate.

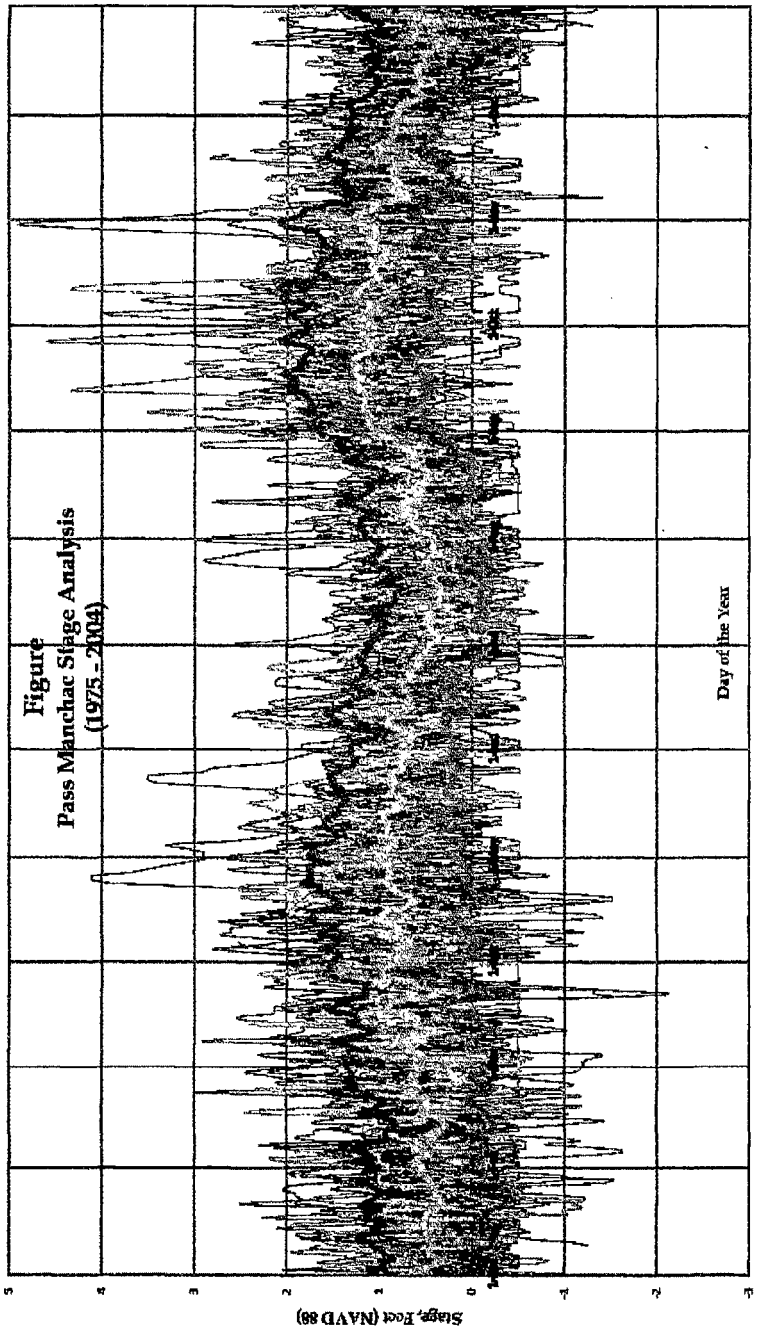


Figure I.2.9.1-1 Pass Manchac Stage Analysis

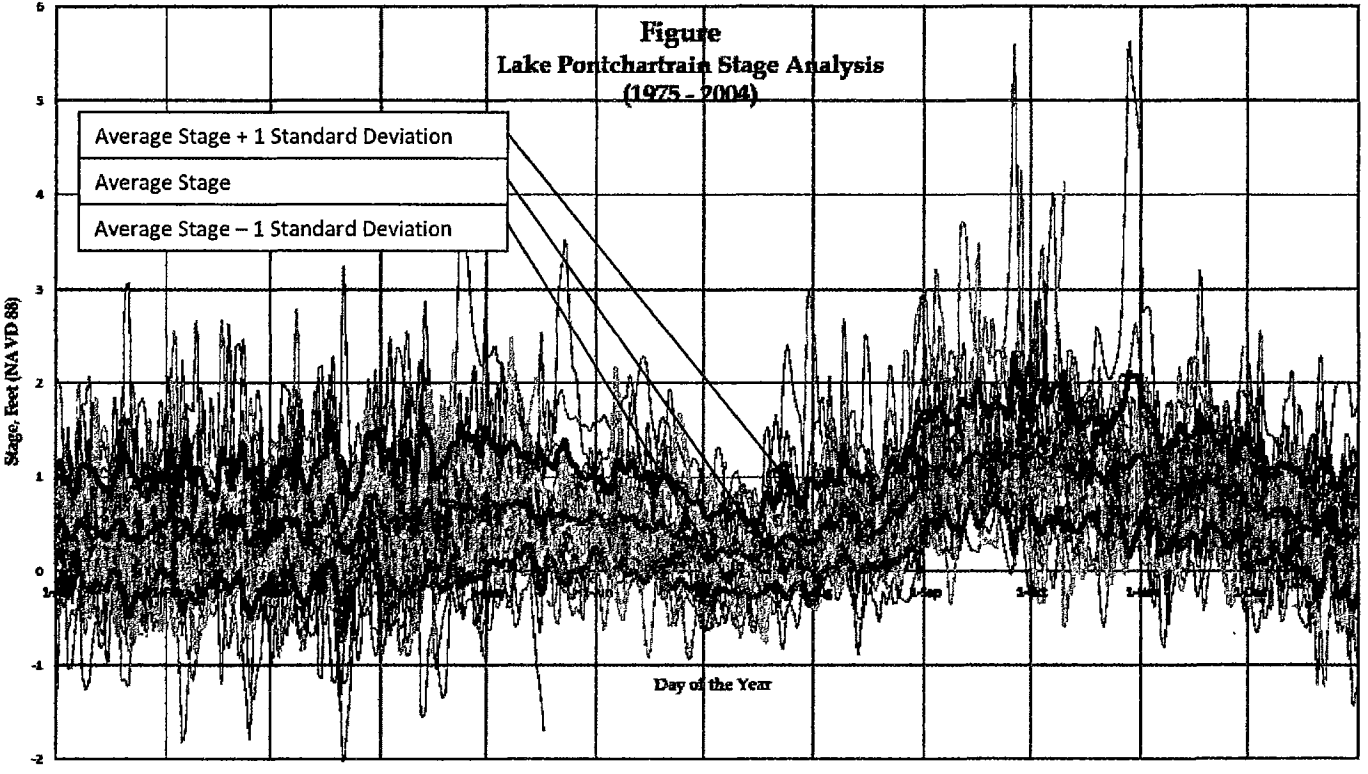


Figure L2.9.1-2 Lake Pontchartrain Stage Analysis

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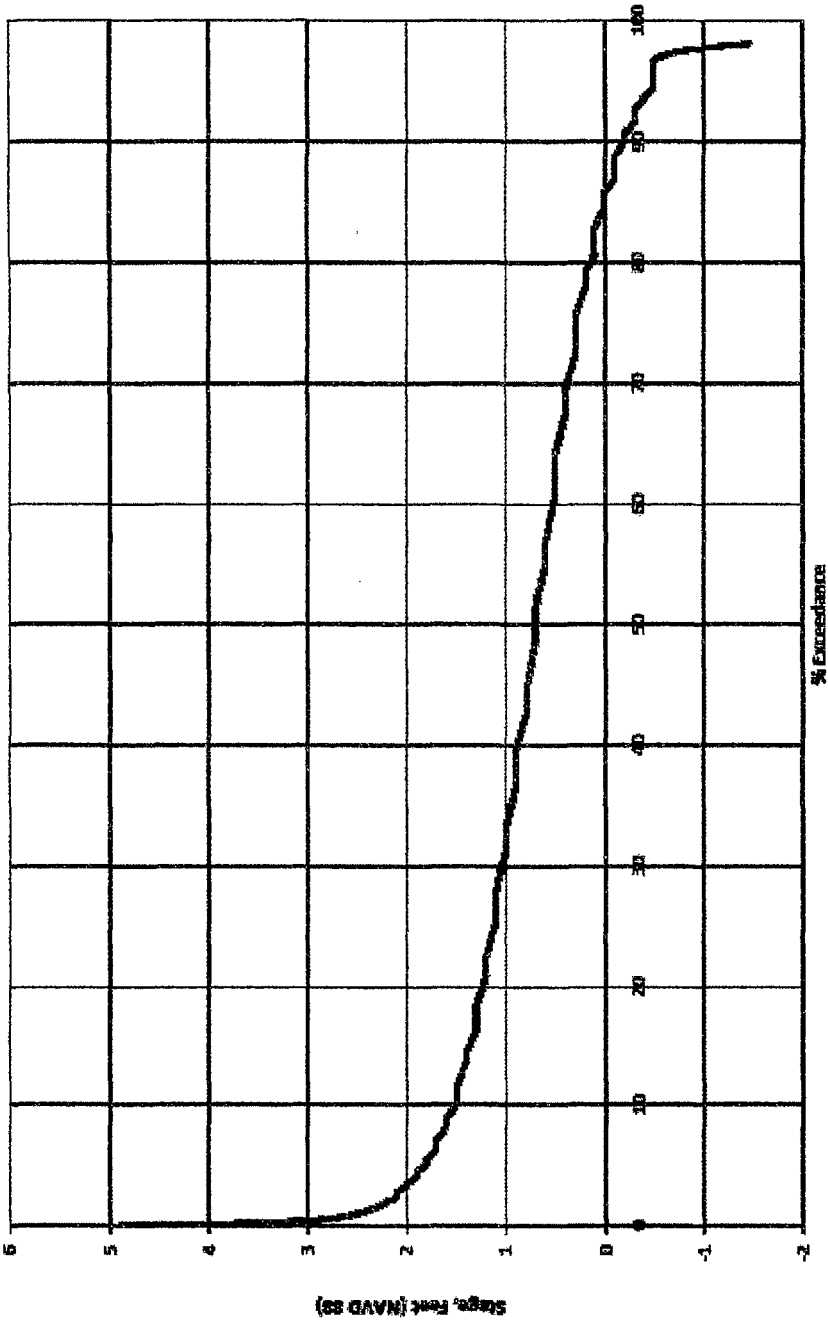
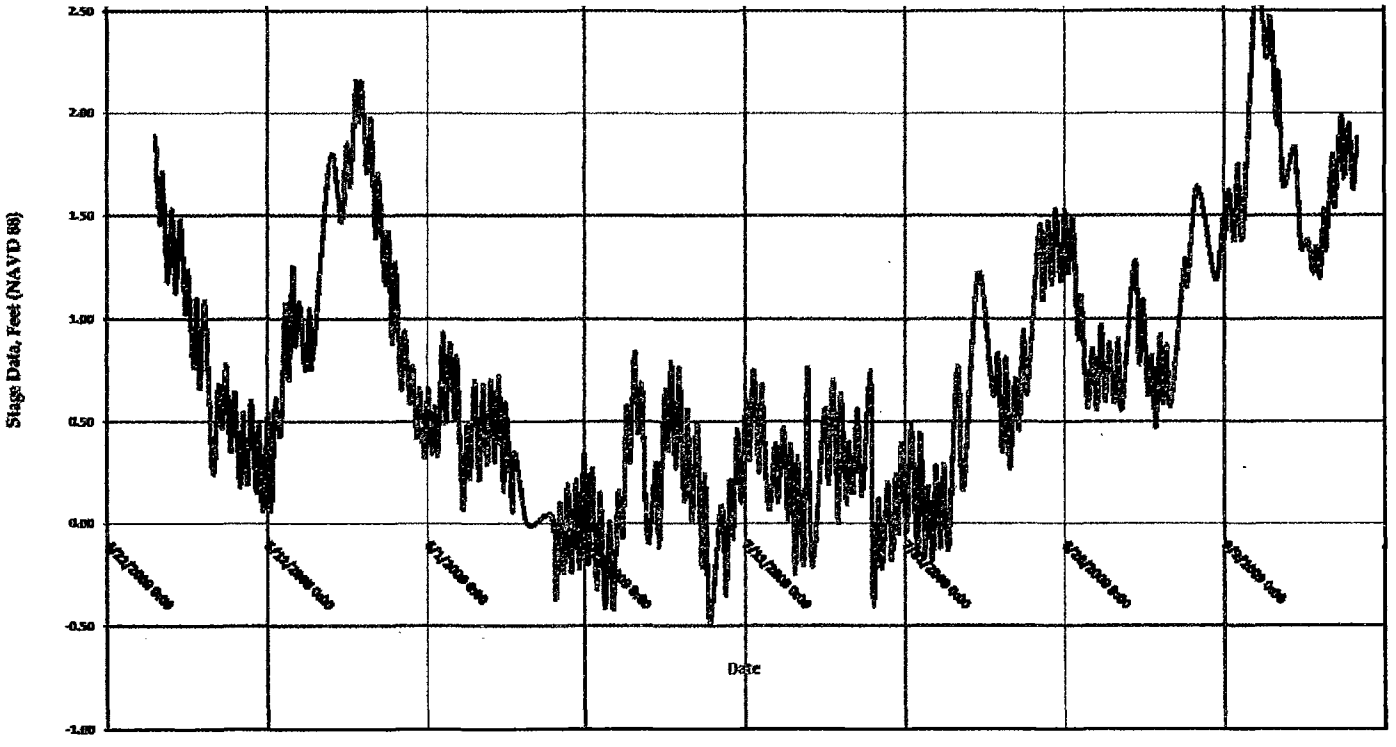


Figure L2.9.1-3 Stage Percent Exceedance at Pass Manchac



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Figure L2.9.1-4 Tidal Influence at Pass Manchac Gage

A historic rate considered to be representative of the project area is calculated using the West End at Lake Pontchartrain gage (85625). Daily stage data over the period 1959 to 2009 indicate a rate of 9.20 mm/year (0.0302 feet/year). The standard error of the linear trend line is 0.65 feet. Using the rate of 9.20 mm/year, a starting year of 2011, and a 50-year project life, a sea-level rise of 1.5 feet is projected for the year 2061. The rate of 9.20 mm/year is considered to include both the eustatic and local subsidence contributions to the estimated total sea-level rise. In order to estimate the local subsidence rate for the project area, the global eustatic rate (1.7 mm/yr) is subtracted from the local sea level rate or:

Local subsidence rate = 9.20 mm/yr – 1.7 mm/yr = 7.50 mm/yr.

The estimate for the local subsidence rate is used in conjunction with estimates for the eustatic rates using NRC curves I and III to determine the intermediate and high projections of sea level rise for the project. The following formula is used to estimate the total rise in eustatic sea level for the project life for the intermediate and high rate scenarios of sea level rise:

$$E(t_2) - E(t_1) = 0.0017(t_2 - t_1) + b(t_2^2 - t_1^2)$$

Where:

b is the acceleration factor related to NRC curves I and III or 2.36E-5 and 1.005E-4 respectively,

t_1 is the time in years between the project's construction date and 1986,

and

t_2 is the time between a future date at which one wants an estimate for sea-level rise and 1986.

These eustatic estimates are added to the local subsidence estimate to calculate the total relative sea-level rise for the intermediate and high rate scenarios.

Table L2.9.2-1 provides a summary of the estimated total sea-level rise for each of the three scenarios through the project life of 50-years.

Table L2.9.2-1 Summary of Estimated Total Sea Level Rise (Low to High Rate) for 50-Year Project Life

Project Year	Scenario 1 Low Rate (feet)	Scenario 2 Intermediate Rate (feet)	Scenario 3 High Rate (feet)
2011	0.0	0.0	0.0
2016	0.2	0.2	0.2
2021	0.3	0.3	0.5
2026	0.5	0.5	0.8
2031	0.6	0.7	1.1
2036	0.8	0.9	1.4
2041	0.9	1.1	1.7
2046	1.1	1.3	2.0
2051	1.2	1.5	2.4
2056	1.4	1.7	2.8
2061	1.5	1.9	3.2

L2.9.3 Application of Relative Sea Level Rise Projection

The final array of alternatives for the LCA Small Diversion at Convent-Blind River project consists of four alternatives. The Tentatively Selected Plan (TSP) will be selected based on wetland valuation assessments coupled with hydrologic, hydraulic, water quality, hydrodynamic, and operations analyses to evaluate the benefits and potential impacts from the alternatives. These benefits were included in an IWR-PLAN analysis that takes into account each alternative's incremental cost versus corresponding average annual habitat units. With the exception of no action, all proposed alternatives involve diversions (re-introduction) of freshwater from the Mississippi River into the swamp and improvements in the swamp to enhance the movement of water through the swamp. All of the proposed alternatives will reintroduce freshwater into the Maurepas Swamp and improve the hydraulic connection between the Blind River and the swamp, thereby allowing inflow to the swamp during periods of high stages and outflow from the swamp into the Blind River and Lake Maurepas during low stages.

From the table above, the projected relative sea-level rise for the 50-year life of the project is 1.5 feet (low), 1.9 feet (Intermediate), and 3.2 feet (High). According to Light Detection and Ranging (LiDAR) elevations observed within the project area, the average natural ground elevations for the benefit areas range from approximately 0.6 to 1.0 feet referenced to North American Vertical Datum of 1988 (ft-NAVD). These elevations will be verified with ongoing field survey data. The changes in elevations due to the projected relative sea-level rise would affect the project area during low flow and low stage conditions by reducing the duration of dry periods in the swamp and in periods when the elevation of Lake Maurepas is higher than the ground elevation in the swamp by increasing the severity and length of backflow from Lake Maurepas into the swamp.

When considering the hydrology and hydraulics modeling requirements for relative sea-level rise predictions, the following considerations were made. First, all alternatives proposed with the final array include diversions of freshwater from the Mississippi River into the swamp and improvements in the swamp to enhance the movement of water through the swamp. Second, all swamp areas to benefit from the proposed alternatives have a similar elevation. It was also determined that all sea-level rise predictions would affect each alternative in the same manor by reducing the dry periods within the swamp and eventually resulting in a permanently flooded swamp. Finally, because the final two alternatives in the final array provide the same capability to reintroduce freshwater into the swamp (i.e. 3,000 cfs), it could be determined that the cost-effective, incremental cost findings from the IWR-PLAN analysis would be the same for an analysis of the year 2012 and year 2062. This is because the affects of relative sea-level rise would be similar for each alternative regardless of the time period analyzed. Therefore, there would be no value added to incorporating all three levels of relative sea-level rise estimates over the next 50 years to the final array of alternatives. The results of modeling with or without relative sea-level rise would result in the same tentatively selected plan.

To further demonstrate the implications of relative sea level rise on the plan selection process and the tentatively selected plan, the intermediate sea level rise forecast was built into the without- and with- project future conditions as the basis for plan formulation, evaluation, and selection with the low and high forecasts analyzed through sensitivity analysis. The intermediate sea level rise forecast has the additional advantage of incorporating a rate of eustatic sea level rise that accelerates over time, which may likely occur due to accelerated global warming (IPCC, 2007). Additionally, the low and high scenarios bracket the intermediate and capture the range of potential outcomes.

L2.10 Project Alternatives Analysis

This section presents hydrologic and hydraulic analyses completed to evaluate the final array of project alternatives. Hydrologic and hydraulic analyses that supported the process to formulate the final array of alternatives were discussed in Appendix Section L2.4. Also relevant to evaluation of the project alternatives is the definition of existing conditions hydrology and hydraulics, which was presented in Appendix Sections L2.3 and L2.5. Sections L2.3 and L2.5 also describe anticipated hydrologic and hydraulic impacts to the existing swamp from projected mean sea level rise, which are indicative of future conditions if the Blind River project is not implemented.

The final array of alternatives for the Small Diversion at Blind River project includes four alternatives:

- Alternative 2 – Romeville Diversion at 3,000 cfs;

- Alternative 4 – South Bridge Diversion at 3,000 cfs;
- Alternative 4B – South Bridge Diversion at 3,000 cfs split between the South Bridge Canal and the St. James Parish Canal; and
- Alternative 6 – Romeville and South Bridge Diversions total of 3,000 cfs (1,500 cfs each).

Analyses were completed to understand and quantify the hydrologic benefits of each of the final alternatives. The hydrologic benefits were then incorporated in the Wetland Value Assessment (WVA) to determine the project benefits for each alternative. As discussed in Section L2.2, a multi-tiered approach was employed to complete hydrologic and hydraulic analyses. Analyses were initially completed with HEC-HMS and HEC-RAS for 2003, which represents average hydrologic conditions. The HEC-HMS and HEC-RAS results were used to calculate freshwater throughput and backwater in each project area hydrologic unit for average hydrologic conditions and provide a base of reference for subsequent analyses. Engineering calculations were used to extend the evaluation of each alternative over a 16-year period of record (1989-2004) and evaluate annual average water depth, backflow prevention, frequency of dry-out conditions, frequency of diversion, and loading of total suspended solids (TSS).

Multi-dimensional hydrodynamic analysis was then completed using EFDC to confirm the distribution of flow, nutrients, and sediment for each alternative. For consistency with USACE water resources planning guidelines for civil works programs, all alternatives and existing conditions were evaluated using a medium rate projection for 20-year, 30-year, and 50-year sea level rise conditions. The results and general observations of the analyses are summarized by alternative in the following subsections.

L2.10.1 Alternative 2

Alternative 2 includes a freshwater diversion of 3,000 cfs that follows the Romeville alignment. A plan view of Alternative 2 is presented on **Figure L2.10.1-1**. This alternative has six major components:

Diversion facility at the Mississippi River. The diversion culvert facility will divert fresh water from the Mississippi River, transfer it beyond the east levee, and discharge to the transmission canal.

Transmission canal. The transmission canal will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The project will use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp.

Control Structures. Approximately six control structures of various sizes with control gates will be installed at key locations in the existing channels to force water out of the drainage channels and into the swamp through the berm gaps.

The proposed control gate is a specialty gate that rotates on a shaft at the bottom of the channel and is operated by large hydraulic cylinders. (One of the gate options, the Obermeyer gates, uses an air-inflated bladder to operate the gates.) The gate will be rotated up to the vertical position to increase the water surface elevation during the flow diversion and promote flow distribution to the swamp. The gate will be rotated down to the channel bottom into the open position when there is no diversion, to allow for normal drainage.

Berm Gaps. When the existing drainage channels were excavated in the Swamp, the excavated material was cast to one side of the channel forming spoil banks. In addition, sediment deposition from past flood events has created high ground that blocks flow into and out of the swamp. These man-made and natural obstructions currently block flow circulation into and out of the swamp, resulting in stagnant areas and poor circulation of water through the hydrologic units. In addition to the existing smaller berm gaps, new 500-foot wide berm gaps will be constructed to improve flow circulation in the swamp.

Highway 61 and KCS Culverts. New culvert crossings will be added under the KCS RR and Hwy 61 at four locations to improve drainage and flow circulation to areas east of US 61. Each installation will consist of 4 – 6' x 4' reinforced concrete box culverts.

Instrumentation. Instrumentation will be required to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the Swamp. Typically, flow rates and water levels will be measured and the feedback data will be used to adjust gate positions to control the desired parameters at the diversion culvert.

L2.10.1.1 HEC-HMS and HEC-RAS

HEC-HMS and HEC-RAS were used to simulate hydrologic and hydraulic conditions associated with each project alternative. For the project alternatives, stormwater runoff within the Blind River watershed is unchanged from the existing conditions HEC-HMS model representation presented in Section L2.3. However, the improvements contained in Alternative 2 required the following modification to the system hydraulics in the HEC-RAS model:

- HEC-RAS lateral structures that allow flow exchange between the drainage canals and the swamp were modified to reflect the berm gaps included in this alternative. The geometry of the lateral structures were modified to lower invert elevations to elevation 0 feet NAVD and widened to represent increased flow capacity compared to existing conditions.
- HEC-RAS culverts were added across US 61 to provide more conveyance capacity between swamp storage areas on both sides of the existing highway embankment.

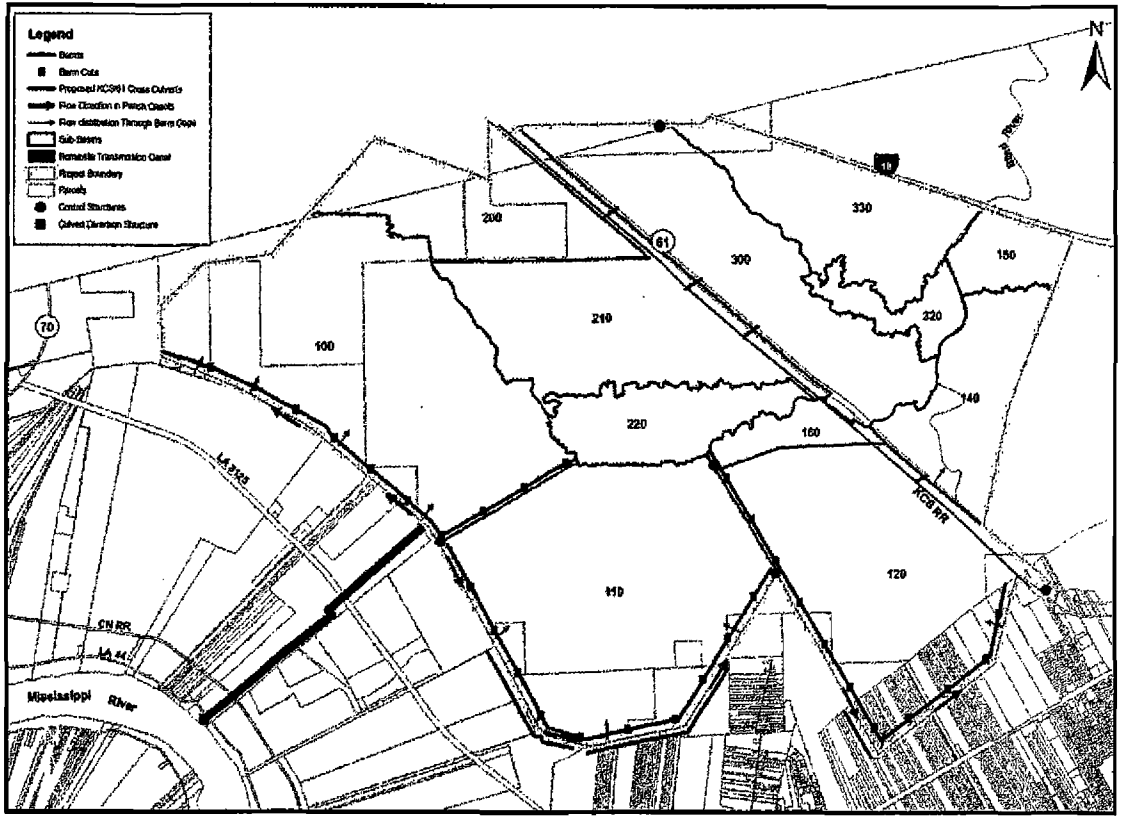


Figure L2.10.1-1 Alternative 2 Layout

1366

- Fixed weirs were added in HEC-RAS at the locations of the control structures to simulate dry conditions when diversion flow will be distributed to the swamp. For simulations of wet weather conditions, the weirs in HEC-RAS were modified to represent the control gates in the lowered position.

Alternative 2 also includes a diversion of 3,000 cfs along the Romeville alignment. Approximately 500 feet of the transmission canal was included in the HEC-RAS model and the diversion flow was added in HEC-RAS as a boundary condition flow time series.

As presented in Section L2.3, two types of HEC-RAS simulations were conducted. Model results produced with the simulation of the year 2003 are intended to establish a swamp hydroperiod with greater fluctuation than the existing hydroperiod. Model results produced with design rainfall depths are intended to define peak water surface conditions in the study area to identify potential adverse drainage impacts from the project. For the purpose of understanding hydrologic benefits to the project area ecosystem, net freshwater throughput and backflow in acre-feet were calculated for each project hydrologic unit from the simulation of 2003, an average hydrologic year. A comparison of Alternative 2 results with existing conditions is presented in **Table L2.10.1-1** and **Table L2.10.1-2**. The net freshwater throughput is calculated as the total inflow to each hydrologic unit minus the inflow volume attributed to backflow from Lake Maurepas. Backflow to each hydrologic unit is the hydrologic unit inflow that coincides with reverse flow in the Blind River due to backflow from Lake Maurepas. **Figure L2.10.1-2** provides a comparison of the net freshwater throughput and backflow for all four alternatives in the final array and existing conditions. Throughput and backflow values are also included for existing and future sea level conditions.

Review of the HEC-HMS and HEC-RAS results indicates that Alternative 2 increases net freshwater throughput compared to existing conditions. Backflow is also reduced, especially with projected increases in sea level. The throughput and backflow values for Alternative 2 are comparable to the other alternatives in the final array. Total system throughput is slightly higher than for the other alternatives because more frequent diversions are required for Alternative to counter backflow. Alternative 2 provides the most throughput to volume to Subbasins 110, 100, and 120, which are all located south of the Blind River. Alternative 2 also provides improved throughput to Subbasin 140.

Table L2.10.1-1 Alternative 2 HEC-RAS Net Freshwater Throughput Volumes

Sea Level Condition	Net Freshwater Throughput (Acre-feet) by Subbasin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	20,700	47,400	55,900	9,400	3,900	172,100	98,300
Berm Gaps (No Diversion)	94,000	33,800	34,000	78,100	64,200	172.700	93,900
Alternative 2	420,500	96,300	152,700	651,800	459,400	267,000	153,100

Note: values based on simulation of hydrologic conditions observed in 2003.

Table L2.10.1-2 Alternative 2 HEC-RAS Backflow Volumes

Sea Level Condition	Backflow (Acre-feet) by Subbasin Number and Hydrologic Unit						
	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Existing	7,900	11,500	7,000	5,400	5,200	42,400	24,000
Berm Gaps (No Diversion)	7,300	17,800	20,900	4,900	4,800	41,800	28,300
Alternative 2	6,900	2,100	1,700	4,100	3,900	41,800	28,300

Note: values based on simulation of hydrologic conditions observed in 2003.

L2.10.1.2 EFDC

Appendix Section L2.5 presented hydrodynamic analysis for existing conditions. This section presents analysis completed using EFDC to evaluate hydrodynamic performance for Alternative 2. As with the HEC-RAS model, the EFDC model for existing conditions was modified to represent the improvements and diversion flow included in the alternative. Refinements incorporated into the model include representation of berm gaps along existing berms adjacent to the drainage canals with evenly distributed spacing and a constant width of 500 ft. Because of the resolution of the model grid, the EFDC model cannot directly simulate flow through the berm cuts; therefore, HEC-RAS simulated stage and flow were used to develop a head difference and flow rating table for each berm cut, which was used in the EFDC model.

For the Alternative 2 EFDC simulations, the downstream stage boundaries at the Conway Canal and Blind River at I-10 Bridge were updated with the HEC-RAS simulated stages which are higher than those in the existing conditions because of additional diversion flow of 3,000 cfs. The Alternative 2 simulation ran the first 300 days of 2003, and results are summarized and discussed in the following sections.

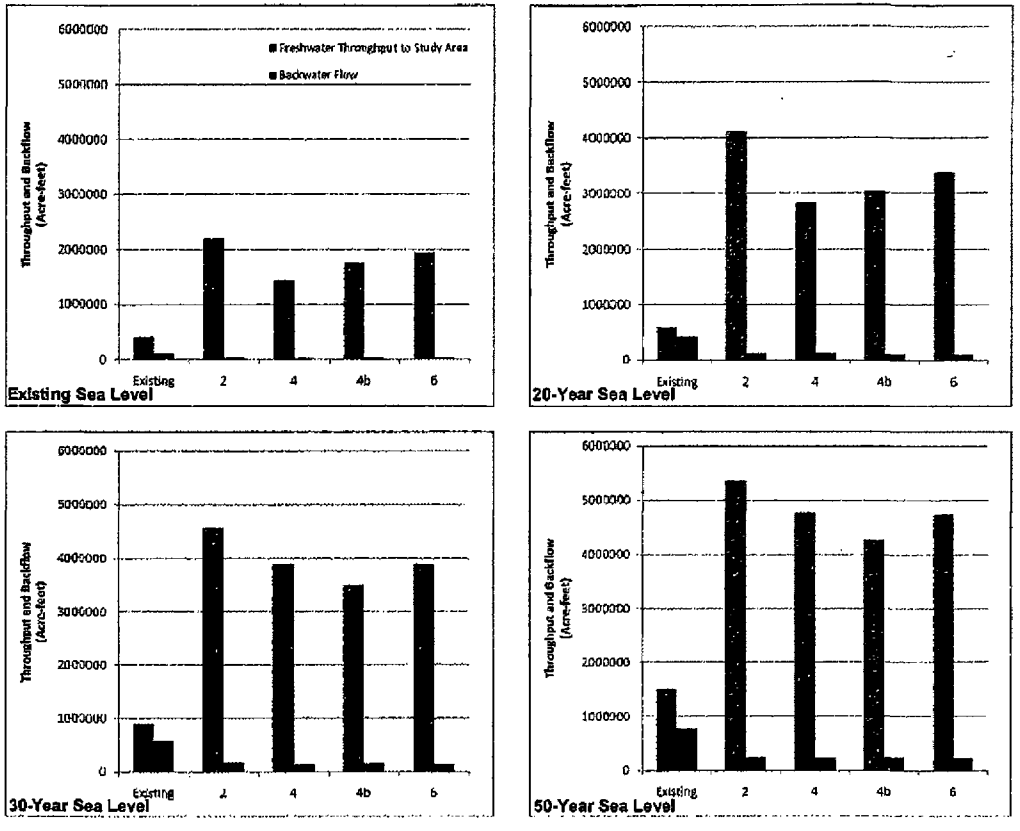


Figure L2.10.1-2 Freshwater Throughput and Backflow for the Final Array of Alternatives

1369

Flow Velocity

Particular focus during the EFDC analysis was placed on evaluating flow velocity, hydraulic residence time and sediment distribution. **Table L2.10.1-3** summarizes the EFDC results for these parameters with Alternative 2. Because of additional 3,000 diversion flow, the average wetland flow velocity for each subbasin in Alternative 2 as shown in Table L2.10.1-3 is more than one order of magnitude larger than for existing conditions. As expected, the highest average flow velocity 13,948 ft/day occurred in the Subbasin 150, which is adjacent to the river exit near I-10 Bridge while the lowest average flow velocity 1,539 ft/day occurred in the Subbasin 120. Compared to existing conditions, the average velocity in Subbasin 110 increased more than 29 times, while the average velocity in the Subbasin 140 only increased about five times. The spatial distribution of flow velocity at day 300 (day 1= 1/1/2003) as shown on **Figure L2.10.1-3** indicated that the highest flow velocity occurred at the diversion flow entry point and near the river exit at I-10 Bridge.

Table L2.10.1-3 Alternative 2 EFDC Summary Results

Subbasin	Velocity (ft/day)	Sediment Volume (cubic yards)	Hydraulic Residence Time (days)
All	3,971	-9.24E+04	-
100	2,948	5.54E+04	13.5
110	4,610	5.06E+04	7.5
120	1,539	3.01E+03	4.2
140	2,065	-3.11E+00	2.3
150	13,948	-2.12E+05	1.5
160	5,934	0.00E+00	2.8
200	4,336	7.58E+02	9.8
210	4,497	7.11E+03	6.6
220	5,557	2.46E+03	4.3
300	3,861	4.57E+02	6.6
320	5,432	0.00E+00	10.2
330	5,453	3.12E+01	2.4

Hydraulic Residence Time

Compared to existing conditions, the hydraulic residence time (HRT) for each subbasin in Alternative 2 reduced significantly due to the increased flow velocity as discussed in the above section. The largest HRT (13.5 days) resulted in Subbasin 100 and the smallest HRT (1.5 days) resulted in Subbasin 150, as shown in Table L2.10.1-3.

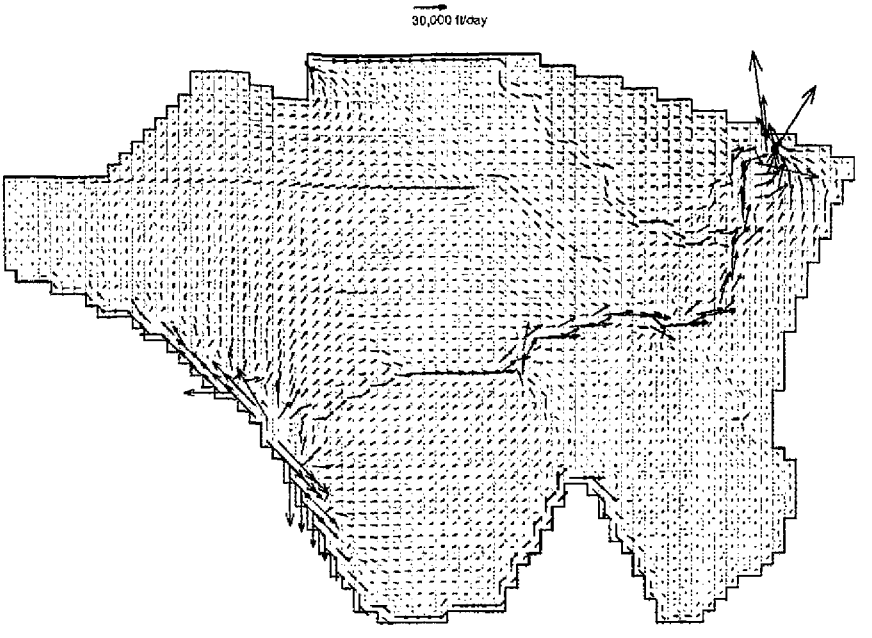


Figure L2.10.1-3 Alternative 2 EFDC Flow Velocity

Based on the simulated HRT for each HRU, it is suggested that the constant diversion flow of 3,000 cfs should be introduced into the project area periodically such that the HRT can be increased to achieve an optimal HRT for each HRU for purpose of wetland restoration,

Figure L2.10.1-4 shows the dye concentration plots at I-10 Bridge on the Blind River for the 12 HRUs. Unlike in the Existing Conditions, the well-defined bell-shaped dye plume in Alternative 2 exited completely from the I-10 Bridge about one month after release. For each subbasin, the HRT was estimated as the time when the peak dye concentration passed the I-10 Bridge on the Blind River minus the time when the dye was released in each subbasin.

Compared to the existing conditions HRTs shown on Figure L2.5-11, the HRTs for Alternative 2 on **Figure L2.10.1-5** indicates that the HRTs at the model cell scale are significantly reduced. It should be pointed that the color shaded HRT scale bar in Figure L2.10.1-6 is different from that on Figure L2.5-11 and the gray shaded area on Figure L2.10.1-5 indicates that the HRT is higher than eight hours.

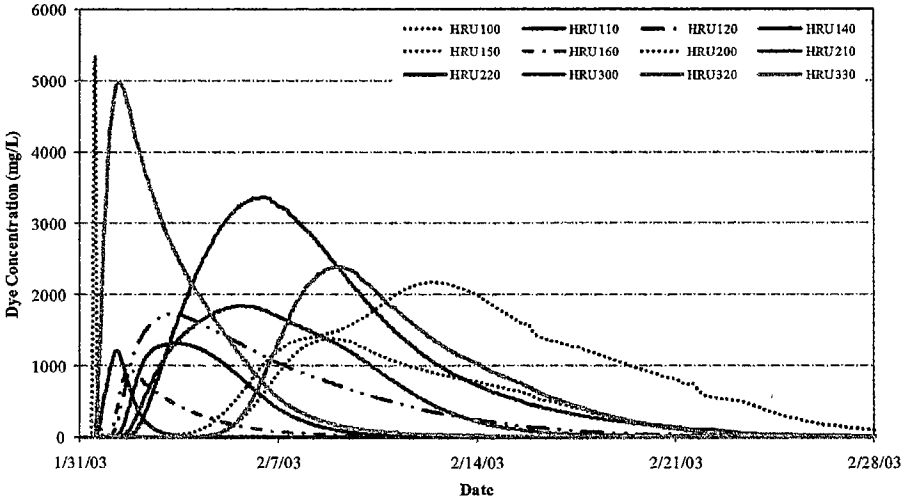


Figure L2.10.1-4 Alternative 2 EFDC Simulated Dye Concentration for Blind River at I-10

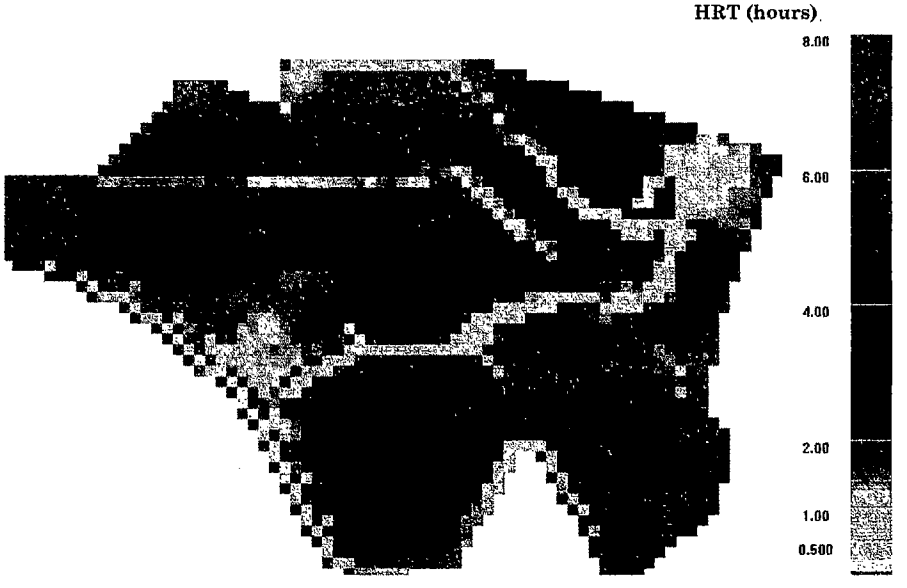


Figure L2.10.1-5 Alternative 2 EFDC Hydraulic Residence Time

Sediment

For Alternative 2, the diversion flow introduced an increase in sediment compared to existing conditions using the sediment concentration basis presented in Section L2.5. With the current sediment model using five key sediment parameter values shown in Table L2.5-7, the simulated sediment deposition as shown in Table L2.10.1-3, Alternative 2 produced sediment deposition in Subbasins 100, 110, 120, 210, and 220, and less sediment deposition in the HRUs 200, 300, and 330. Spatial distribution of sediment cumulative deposition and erosion for Alternative 2 is presented on **Figure L2.10.1-6.**

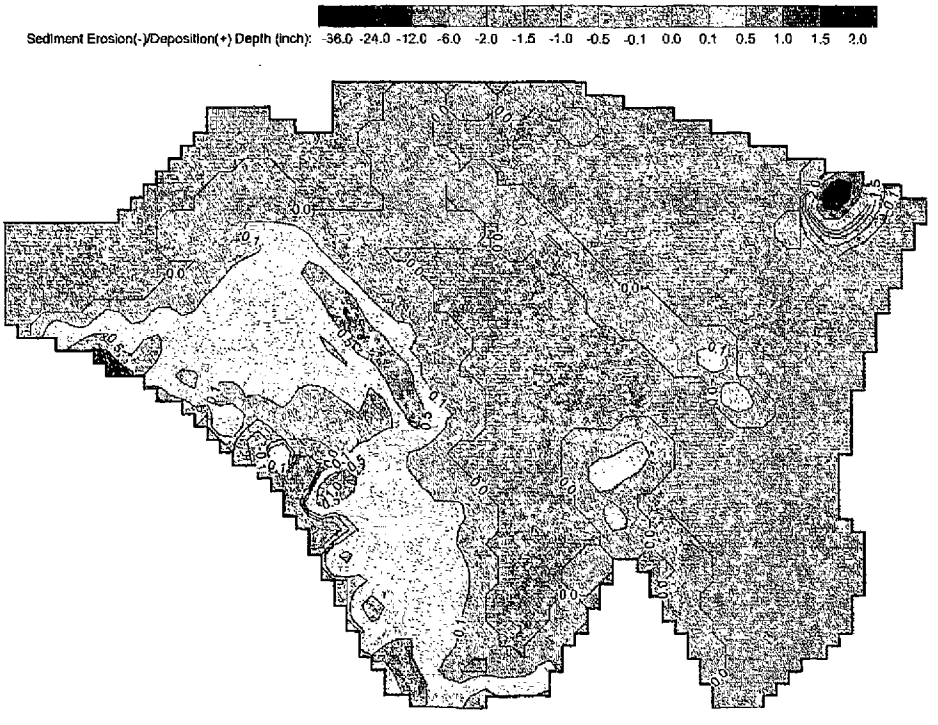


Figure L2.10.1-6 Alternative 2 EFDC Sediment Deposition and Erosion

Water Quality

The average or range of nitrate, ammonium, TN, and TP concentrations reported by Lane et al. (1999) for the Mississippi River compared well with the data collected at Belle Chasse on the Mississippi River. The average concentrations of nitrate, TN, and TP (1.73, 2.26, and 0.22 mg/L, respectively) were used for the diversion flow in the water quality analysis.

Due to the diversion flow over time, the water quality within the swamp and downstream of the swamp will inevitably change. There have been many studies of the relationship between the nutrient loading rate into wetlands and associated removal efficiency. The nutrient (nitrate, TN, and TP) removal efficiency in wetlands primarily depends on the nutrient loading rate and the HRT.

For nitrate, the average nitrogen removal efficiency ranges from 95 to 100 percent when the nitrate:ammonium ration is greater than 1 and loading rate is relatively low (e.g., less than 10 g-N/m^2/yr). The Mississippi River has an average molar nitrate:ammonium ratio of 18 (Lane et al., 1999). Therefore, the removal efficiency of nitrogen in the swamp is expected to be very high. For TN, the average removal efficiency ranges from 50 to 65 percent and for TP, the average removal efficiency ranges from 20 to 35 percent when the average HRT is about seven days.

For this project, the average removal efficiencies for nitrate, TN, and TP were estimated to be 95 percent, 65 percent, and 30 percent, respectively, and the average HRT to achieve the removal efficiencies was estimated to be seven days (Kadlec and Wallace, 2008). Therefore, the first-order decay rates were calculated to be 4.95E-06, 1.74E-06, and 5.89E-07 second^{-1}, respectively. To evaluate how the swamp benefits from the nutrient loadings associated with diversion flow, the first-order decay model was used to evaluate nutrient load reduction and removal efficiency of TP, TN, and nitrate. As discussed in Section L2.5.8.5, the average nitrate, TN, and TP concentration data (0.008, 0.58, and 0.055 mg/L, respectively) were used as initial background water quality concentrations.

For the first-order decay model, the average concentration in each HRU and overall removal efficiency are summarized in **Table L2.10.1-4.** The removal efficiency is defined as:

$$\text{Removal Efficiency (RE)} = (C_i - C_o)/C_i \times 100\%$$

Where C_i is swamp inflow concentration (mg/L) and C_o is swamp outflow concentration (mg/L.)

The simulation results indicate that very high removal efficiencies can be achieved for nitrate and TN (99.4 percent and 90.6 percent), while TP removal efficiency was estimated as high as 66.5 percent. Spatial distributions of nitrate, TN, and TP concentrations presented on **Figures L2.10.1-7, L2.10.1-8,** and **L2.10.1-9,** respectively, indicate that HRUs 330, 320, 300, 150, 140, and 120 will not benefit much from the nutrients brought by the diversion flow compared to other HRUs in the swamp.

Table L2.10.1-4 Average Concentration in each HRU and Overall Removal Efficiency of TP, TN, and Nitrate

Hydrologic Response Unit	Average Concentration			Overall Removal Efficiency (%)		
	NO_3 (mg/L)	TN (mg/L)	TP (mg/L)	NO_3	TN	TP
All	0.292	0.903	0.141	99.4	90.6	66.5
100	0.732	1.563	0.187	-	-	-
110	0.563	1.402	0.180	-	-	-
120	0.060	0.511	0.11Î	-	-	-
140	0.031	0.312	0.083	-	-	-
150	0.034	0.361	0.093	-	-	-
160	0.166	0.904	0.153	-	-	-
200	0.054	0.556	0.123	-	-	-
210	0.208	0.986	0.160	-	-	-
220	0.320	1.181	0.172	-	-	-
300	0.041	0.408	0.102	-	-	-
320	0.023	0.366	0.102	-	-	-
330	0.023	0.258	0.079	-	-	-

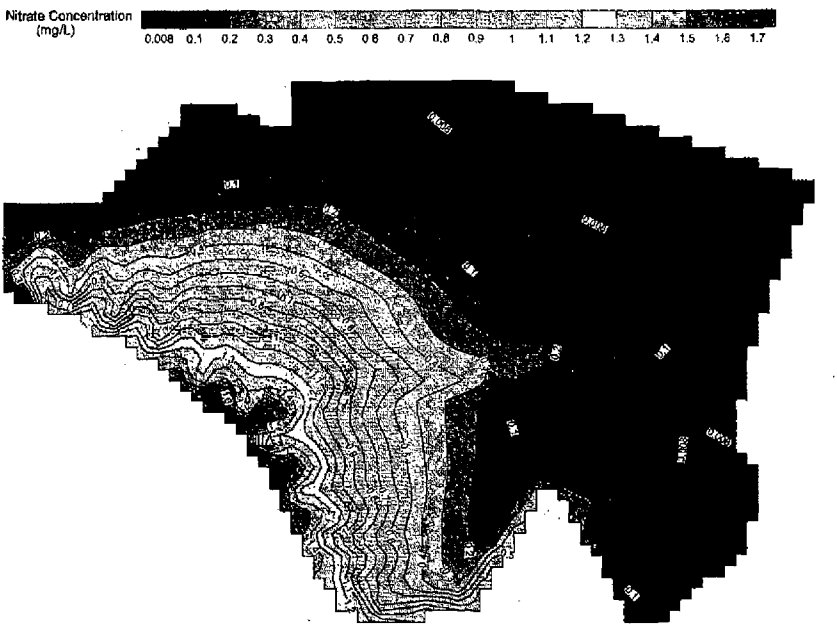


Figure L2.10.1-7 Spatial distribution of NO3 Concentration at Day 300 for Alternative 2

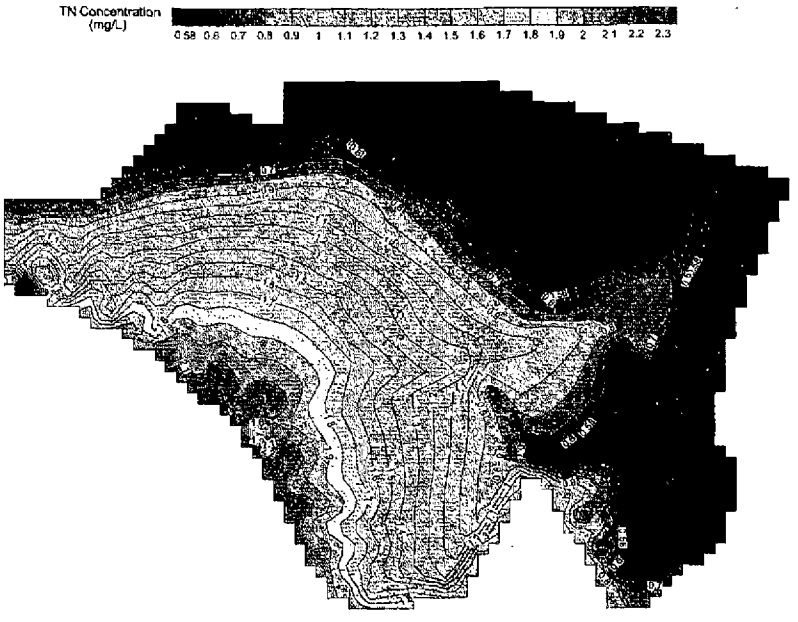


Figure L2.10.1-8 Spatial Distribution of TN Concentration at Day 300 for Alternative 2

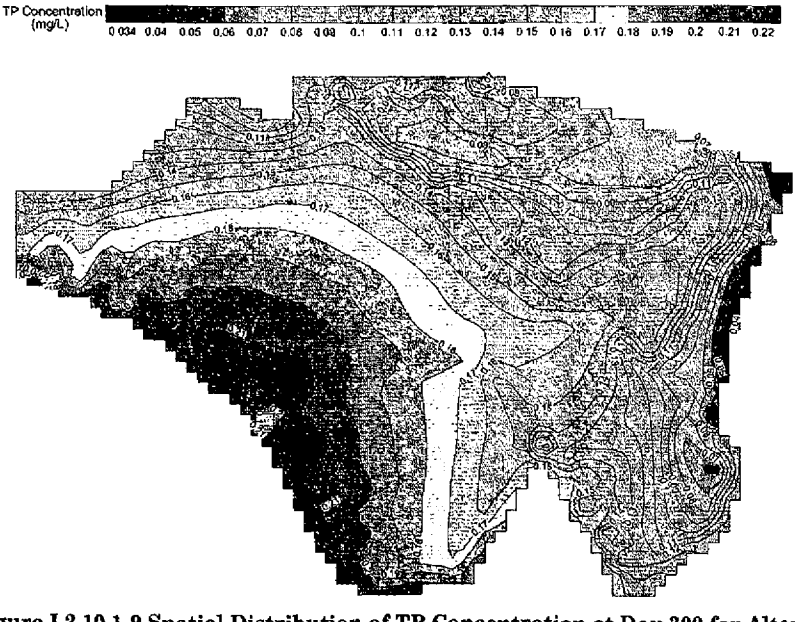


Figure L2.10.1-9 Spatial Distribution of TP Concentration at Day 300 for Alternative 2

Sea Level Rise

The average water depth and elevation increased as expected with increased sea level. Presented in **Table L2.10.1-5**, average velocity for each subbasin also decreased with sea level rise. Reduction of the average velocity in Alternative 2 resulted from a smaller head gradient due to the increased tail water from future sea levels. However, Alternative 2 did not experience the increases in reverse flow that were simulated for the future without project conditions as a result of higher tail water.

Table L2.10.1-5 Alternative 2 EFDC Flow Velocity with Sea Level Rise

Hydrologic Response Unit	Alternative 2				Existing Conditions - 2003			
	Current seal level	20-year sea level rise	30-year sea level rise	50-year sea level rise	Current seal level	20-year sea level rise	30-year sea level rise	50-year sea level rise
All	3,971	3,779	3,635	3,276	256	255	369	572
100	2,948	2,729	2,582	2,254	154	154	175	234
110	4,610	4,247	3,990	3,389	158	157	231	327
120	1,539	1,534	1,521	1,458	149	149	174	263
140	2,065	2,428	2,575	2,710	416	414	651	1,029
150	13,948	13,861	13,648	12,884	2,127	2,129	2,869	4,281
160	5,934	6,083	6,171	6,329	258	256	606	1,310
200	4,336	3,923	3,652	3,066	263	262	356	479
210	4,497	4,285	4,137	3,788	200	198	360	608
220	5,557	5,390	5,269	4,959	318	316	584	982
300	3,861	3,525	3,282	2,714	294	293	391	572
320	5,432	5,364	5,274	4,967	357	354	632	1,163
330	5,453	5,177	4,977	4,499	383	381	602	1,061

With the rise of sea level, thus the tail water, the HRT for each subbasin changed and responded differently in Alternative 2 than for the future without project conditions. **Table L2.10.1-6** summarizes the HRT simulated for both existing conditions and Alternative 2 for each subbasin with existing sea level and 50-year sea level. **Figure L2.10.1-10** indicates that the HRTs at the model cell scale.

As with HRT, sediment transport within of the project area also responded differently for Alternative 2 and existing conditions, which is shown in **Table L2.10.1-7**. For existing conditions some sediment deposition occurred in subbasins 140, 150, 300, 320, and 330 with increase of the tail water. Due to the reverse flow, the sediment of the Blind River attributed to the deposition inside of the subbasins near to the river exit at I-10 Bridge. For Alternative 2, the extent of sediment deposition generally reduced compared to existing sea level due to the reduced flow velocity that resulted from the higher tail water with future sea level rise. Alternative 2 still shows increased deposition compared to existing conditions with sea level rise, and does not display the reverse flow characteristics simulated

for existing conditions. **Figure L2.10.1-11** shows the extent of sediment deposition for Alternative 2 with 50-year sea level rise.

Table L2.10.1-6 Alternative 2 EFDC Hydraulic Residence Time with Sea Level Rise

Hydrologic Response Unit	Alternative 2		Existing Conditions - 2003	
	current sea level	50-year seal level rise	current sea level	50-year seal level rise
100	13.5	13.0	42.0	83.6
110	7.5	6.7	37.8	65.6
120	4.2	5.2	37.4	44.7
140	2.3	2.2	37.4	6.3
150	1.5	1.5	8.1	2.4
160	2.8	2.8	37.4	32.6
200	9.8	9.1	38.3	81.9
210	6.6	6.4	38.3	65.6
220	4.3	3.9	37.8	65.5
300	6.6	3.4	37.4	32.6
320	10.2	1.9	37.2	6.5
330	2.4	2.3	37.4	32.6

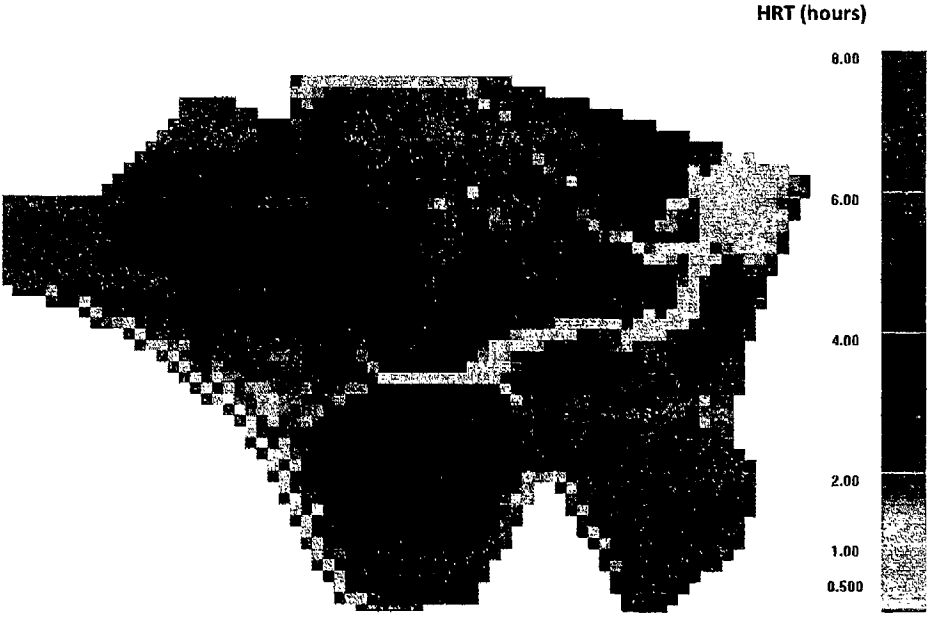


Figure L2.10.1-10 Alternative 2 EFDC Hydraulic Residence Time with Sea Level Rise (50 years)

Table L2.10.1-7 Alternative 2 EFDC Sediment Transport Summary with Sea Level Rise

Hydrologic Response Unit	Alternative 2				Existing Conditions - 2003			
	current seal level	20-year sea level rise	30-year sea level rise	50-year sea level rise	current seal level	20-year sea level rise	30-year sea level rise	50-year sea level rise
All	-9.24E+04	-7.79E+04	-5.55E+04	4.41E+03	-2.78E+04	-2.78E+04	-2.06E+04	-1.64E+04
100	5.54E+04	5.69E+04	5.88E+04	6.71E+04	-6.24E+00	-6.24E+00	-5.72E+00	0.00E+00
110	5.06E+04	5.27E+04	5.69E+04	6.71E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
120	3.01E+03	2.03E+03	1.32E+03	1.09E+02	-1.09E+01	-1.04E+01	-1.45E+01	-1.56E+00
140	-3.11E+00	-6.87E+03	-8.20E+03	-6.25E+03	-1.71E+02	-1.68E+02	-7.94E+01	5.49E+02
150	-2.12E+05	-1.94E+05	-1.76E+05	-1.36E+05	-2.76E+04	-2.77E+04	-2.04E+04	-1.69E+04
160	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
200	7.58E+02	5.04E+02	7.27E+01	0.00E+00	-1.66E+01	-1.61E+01	-3.01E+01	-8.83E+00
210	7.11E+03	8.39E+03	9.01E+03	8.83E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
220	2.46E+03	2.34E+03	2.44E+03	3.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
300	4.57E+02	1.61E+02	4.67E+01	2.60E+01	0.00E+00	0.00E+00	0.00E+00	2.08E+01
320	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.19E+00	1.56E+01
330	3.12E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.19E+00	5.19E+00

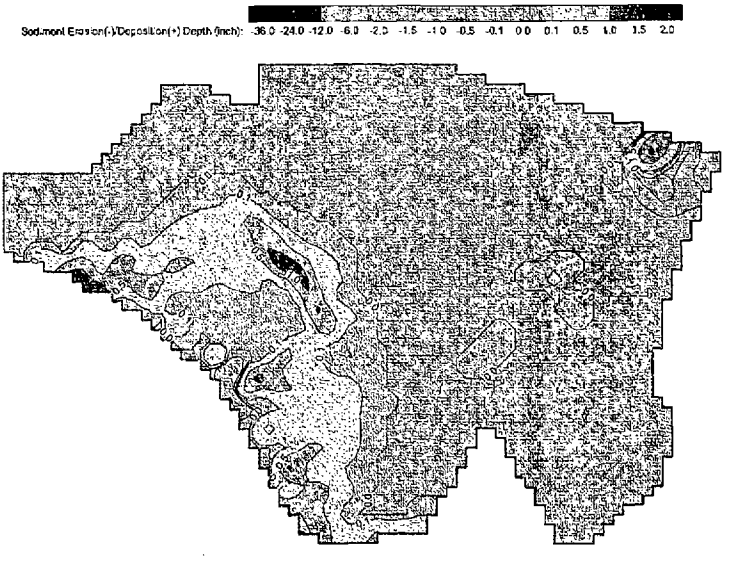


Figure L2.10.1-11 Alternative 2 EFDC Sediment Deposition and Erosion with Sea Level Rise (50 years)

L2.10.1.3 Engineering Calculations

Water Depth and Backflow Prevention

Existing conditions (no sea level rise) without berm gaps indicate an average long-term water depth ranging from 1.34 to 2.09 feet (**Figure L2.10.1-12** and **Table L2.10.1-8**) and a backflow prevention ranging from 73 to 91 percent (**Figure L2.10.1-13** and Table L2.10.1-8). By incorporating improved berm gaps in the existing condition scenario, hydraulic routing is improved and average water levels (0.55 to 0.82 feet) are reduced. The frequency of time during the 16-year period analysis that backflow is prevented (17 to 38 percent) is also reduced since the average water levels in the swamp are lower than the Lake Maurepas stage more often and, thus, the hydraulic gradient for backflow is more favorable.

For Alternative 2 (Romeville Diversion at 3,000 cfs), the average water depth ranges from 0.55 to 1.86 feet and backflow prevention ranges from 19 to 85 percent under no sea level rise conditions. This increase in water depths and backflow prevention when compared to the existing conditions with berm gaps is attributed to the additional diversion flow. The subbasins benefiting the most hydrologically from this alternative are 100 and 110 due to their adjacent location to the Romeville diversion point. Figure L2.10.1-12 further illustrates that as sea level rises, water depths increase throughout the swamp since more diversion flow is initiated and more water is routed through the system to attenuate backflow conditions. As sea level rises, backflow prevention generally decreases throughout the swamp (Figure L2.10.1-13) since the system is less effective at preventing backflow due to the increase in stages at the downstream boundary condition (Lake Maurepas).

Table L2.10.1-8 Summary of Average Water Depth and Backflow Prevention (No Sea Level Rise) for Existing Conditions and Alternative 2

Annual Average Water Depth (feet)							
Subbasin Number	**100**	**200**	**210, 220**	**110**	**120, 160**	**300, 320, 330**	**140, 150**
Hydrologic Unit Number	**HU 1**	**HU 2**	**HU 3**	**HU 4**	**HU 5**	**HU 6**	**HU 7**
Existing	1.91	1.86	1.85	2.09	1.34	1.53	1.61
Alternative 2	1.82	0.74	1.08	1.86	0.55	0.61	0.65
Annual Average Backflow Prevention (%)							
Existing	88	78	85	88	73	74	91
Alternative 2	85	20	48	79	25	19	38

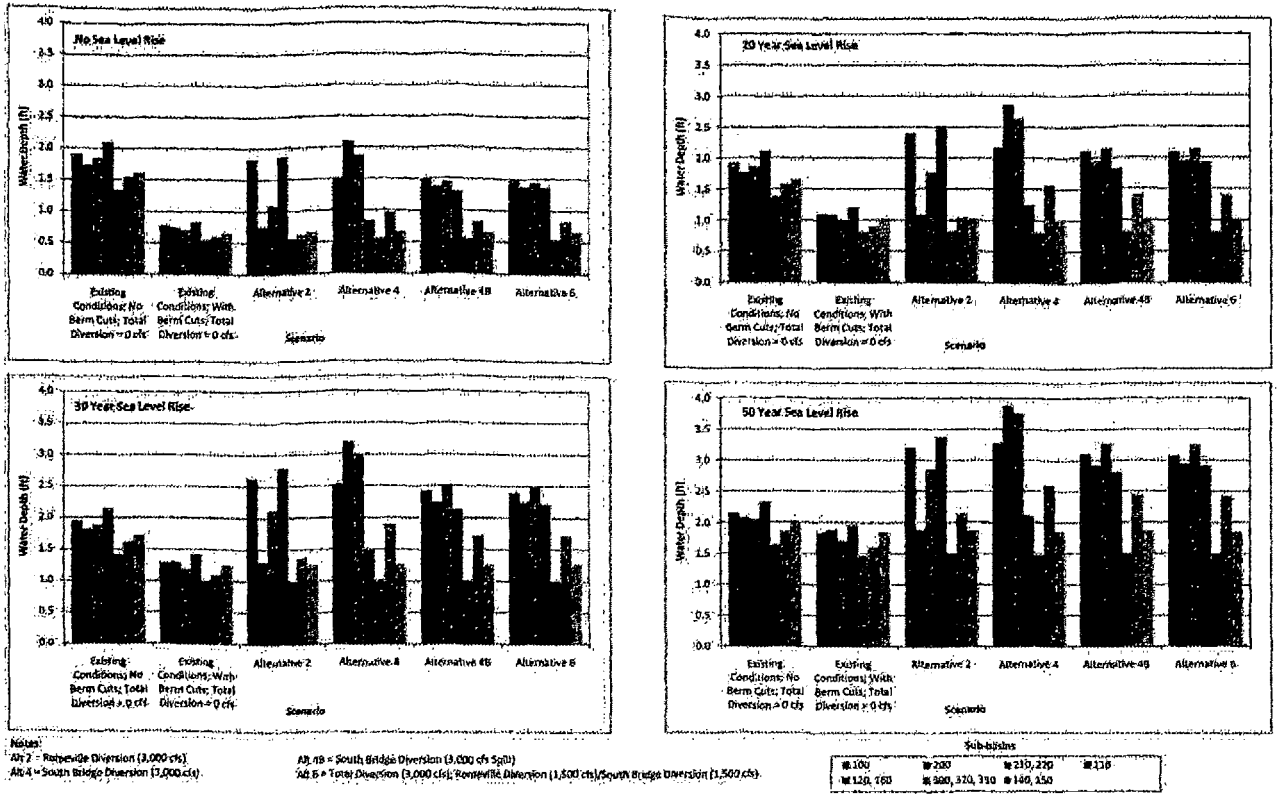


Figure L2.10.1-12 Average Water Depth for Final Array of Alternatives

1381

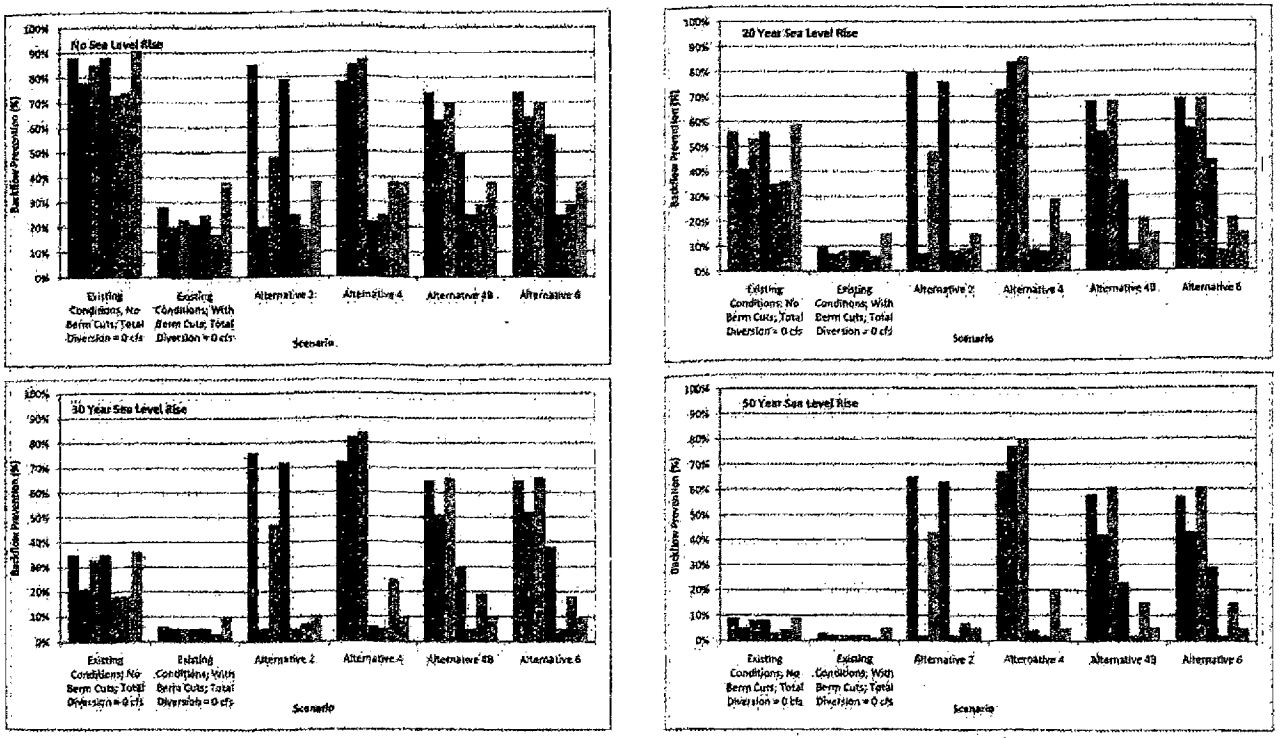


Figure L2.10.1-13 Backflow Prevention for Final Array of Alternatives

Frequency of Dry-Out Conditions

As shown on **Figure L2.10.1-14** and in **Table L2.10.1-9,** existing conditions (no sea level rise) without functional berm gaps indicate a long-term dry-out frequency (below 0.5 feet) from 0 to 3 percent. By incorporating additional wider berm gaps in the existing condition scenario, dry-out frequency (25 to 44 percent) increases since there is less opportunity for the water to remain stagnant in the swamp.

For Alternative 2, the average dry-out frequency ranges from 4 to 43 percent under no sea level rise conditions. There is a reduction in dry-out frequency when compared to the existing conditions with berm gaps mainly in the upstream subbasins (100, 110, 210, and 220), which are more directly impacted by the Romeville diversion due to their proximity. As sea level rises, dry-out frequency decreases throughout the swamp since more diversion flow is initiated to prevent backflow; therefore, reducing the occurrence of dry-out conditions.

Table L2.10.1-9 Summary of Average Dry-Out Frequency (No Sea Level Rise) for Existing Conditions and Alternative 2

Annual Average Dry-Out Frequency (%)							
Subbasin Number	**100**	**200**	**210, 220**	**110**	**120, 160**	**300, 320, 330**	**140, 150**
Hydrologic Unit Number	**HU 1**	**HU 2**	**HU 3**	**HU 4**	**HU 5**	**HU 6**	**HU 7**
Existing	1	1	2	1	3	2	0
Alternative 2	4	28	17	6	43	41	24

Note: Dry-out conditions defined as water depth less than 0.5 feet.

Frequency of Diversions and TSS Loading

As shown on **Figure L2.10.1-15**, the diversion is initiated under Alternative 2 (no sea level rise) an average 50 percent of the time. Also, approximately 1.5 mm/year of TSS loading from the Mississippi River (**Figure L2.10.1-16**) is introduced to the project area in this scenario. As sea level rises, additional diversion flow (up to 85 percent) is initiated and, hence, more TSS loading is introduced to the system (up to 2.7 mm/yr).

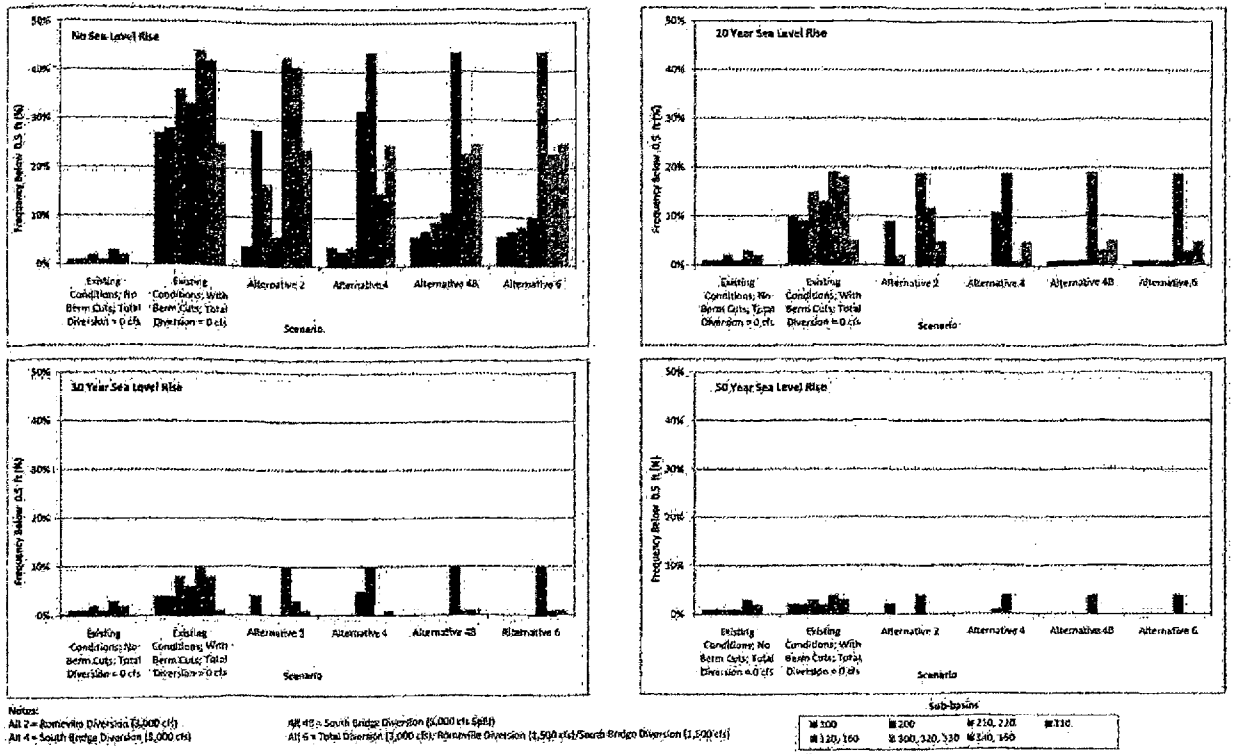


Figure L2.10.1-14 Average Dry-Out Frequency for Final Array of Alternatives

1384

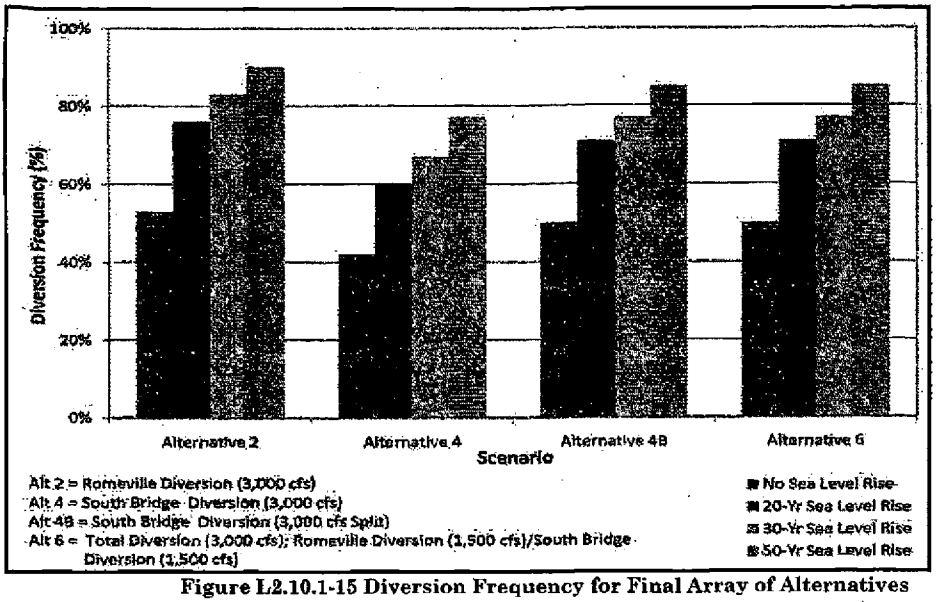


Figure L2.10.1-15 Diversion Frequency for Final Array of Alternatives

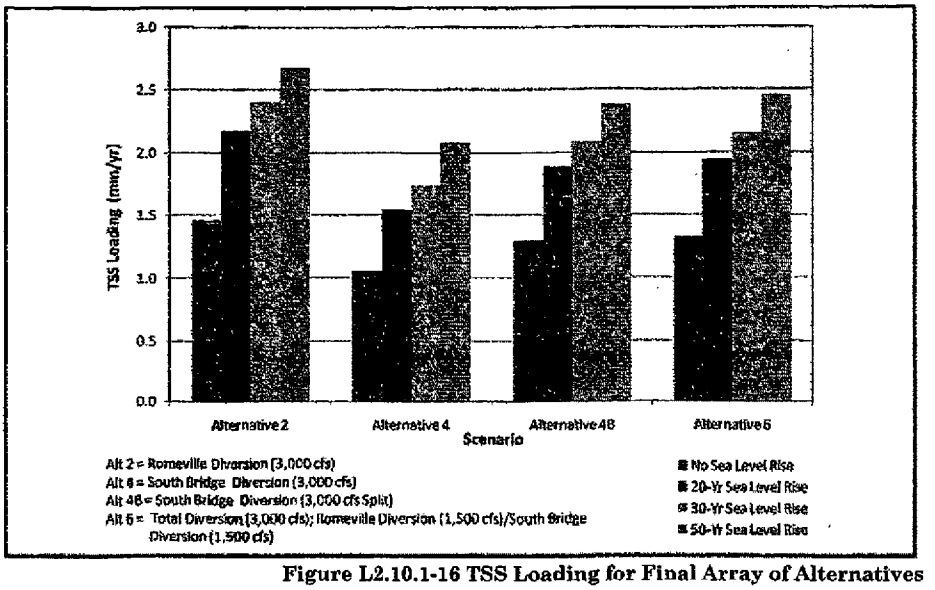


Figure L2.10.1-16 TSS Loading for Final Array of Alternatives

L2.10.2 Alternative 4

Alternative 4 includes a freshwater diversion of up to 3,000 cfs that follows the South Bridge alignment. A plan view of Alternative 4 is presented on **Figure L2.10.2-1**. This alternative has seven major components:

Diversion facility at the Mississippi River. The diversion culvert facility will divert fresh water from the Mississippi River, transfer it beyond the east levee and discharge to the transmission canal.

Transmission canal. The transmission canal will transfer the diverted water approximately four miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The project will use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp.

Distribution Canal. A distribution canal will be constructed across the swamp from the west edge of the project area to US 61. The distribution canal will be constructed with levees on each side to elevate the water surface above the swamp, similar to an irrigation canal, and allow for distribution of flow to adjacent areas of the swamp.

Control Structures. Approximately six control structures of various sizes with control gates will be installed at key locations in the existing channels to force water out of the drainage channels and into the swamp through the berm gaps. The proposed control gate is a specialty gate that rotates on a shaft at the bottom of the channel and is operated by large hydraulic cylinders. (One of the gate options, the Obermeyer gates, uses an air-inflated bladder to operate the gates.) The gate will be rotated up to the vertical position to increase the water surface elevation during the flow diversion and promote flow distribution to the swamp. The gate will be rotated down to the channel bottom into the open position when there is no diversion, to allow for normal drainage.

Berm Gaps. As identified in Alternative 2, new 500-foot wide berm gaps will be constructed to improve flow circulation in the swamp.

Highway 61 and KCS RR Culverts. As identified in Alternative 2, new culvert crossings will be added under the KCS RR and Hwy 61 at four locations.

Instrumentation. As identified in Alternative 2, instrumentation will be required to control the diversion flow rate and control structures.

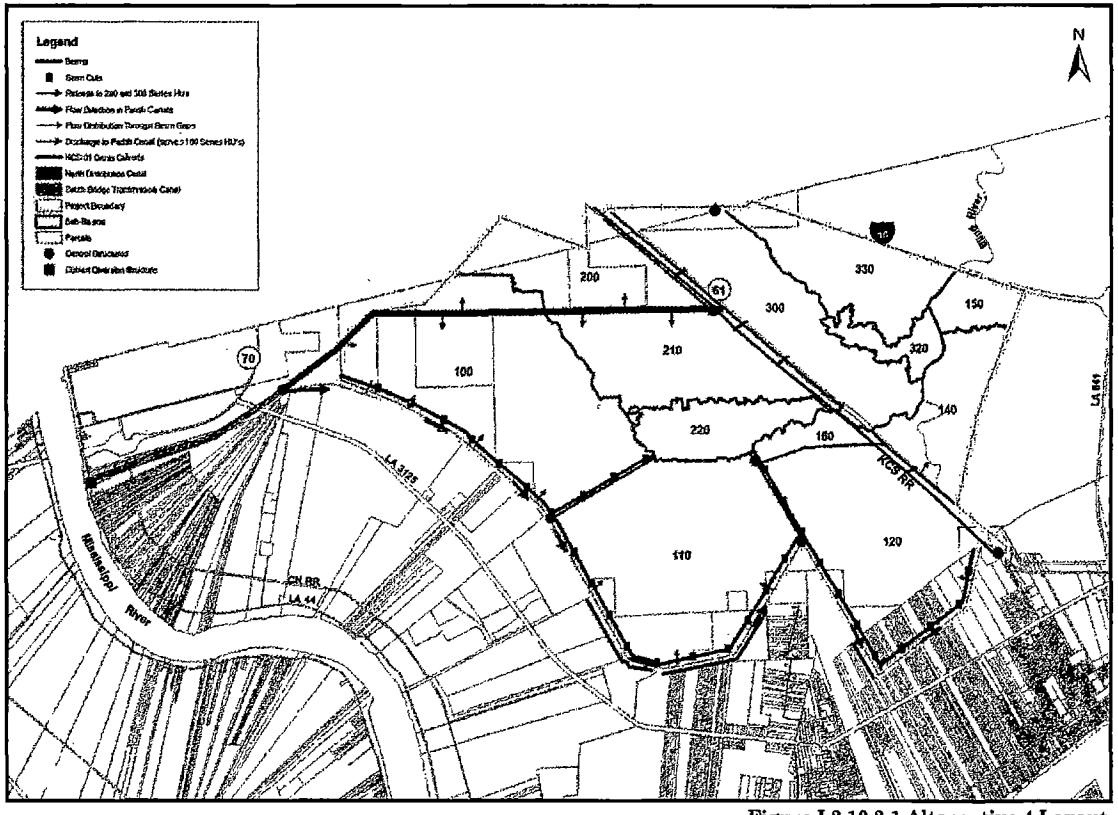


Figure L2.10.2-1 Alternative 4 Layout

L2.10.2.1 HEC-HMS and HEC-RAS

The following modifications to the existing conditions HEC-RAS model were incorporated to represent Alternative 4:

- HEC-RAS lateral structures that allow flow exchange between the drainage canals and the swamp were modified to reflect the berm gaps included in this alternative. The geometry of the lateral structures were modified to lower invert elevations to elevation 0 feet NAVD and widened to represent increased flow capacity compared to existing conditions.
- HEC-RAS culverts were added across US 61 to provide more conveyance capacity between swamp storage areas on both sides of the existing highway embankment.
- Fixed weirs were added in HEC-RAS at the locations of the control structures to simulate dry conditions when diversion flow will be distributed to the swamp. For simulations of wet weather conditions the weirs in HEC-RAS were modified to represent the control gates in the lowered position.

Alternative 4 also includes a diversion of 3,000 cfs along the South Bridge alignment and a distribution canal across the swamp to US 61. The distribution of diversion flows into the swamp for Alternative 4 was simulated in HEC-RAS with multiple boundary condition flow time series assigned to various swamp storage areas represented in the model. This conceptual modeling approach was used for the alternative analysis to simplify the detail that would have been needed to explicitly model the distribution canal and associated control structures in HEC-RAS. The flow split that was used consisted of 17% (500 cfs) assigned to the St. James Parish Canal, 17% (500 cfs) assigned to hydrologic unit 100, 33% (1,000 cfs) assigned to hydrologic unit 210, 17% (500 cfs) to hydrologic unit 220, and 17% (500 cfs) to hydrologic unit 300.

Review of the HEC-HMS and HEC-RAS results indicates that Alternative 4 increases net freshwater throughput compared to existing conditions. Backflow is also reduced, especially with projected increases in sea level. The throughput and backflow values for Alternative 4 are comparable to the other alternatives in the final array. Alternative 4 provides the most throughput volume to hydrologic units 100, 200, and 210, which are all located west and north of the Blind River. Alternative 4 also provides improved throughput to hydrologic units 300 and 220.

L2.10.2.2 Engineering Calculations

Water Depth and Backflow Prevention

For Alternative 4 (South Bridge Diversion at 3,000 cfs), the average water depth ranges from 0.54 to 2.09 feet (Figure L2.10.1-3 and **Table L2.10.2-1**) and backflow prevention ranges from 22 to 87 percent (Figure L2.10.1-4 and Table L2.10.2-1) under no sea level rise conditions. This increase in water depths and backflow prevention when compared to the existing conditions with berm gaps is attributed

to the additional diversion flow. The subbasins benefiting the most hydrologically from this alternative are 100, 200, 210, and 220 due to their adjacent location to the South Bridge diversion point, and the 300 series as a result of proposed improvements to routing flow through the Route 61 control structure. Figure L2.10.1-3 further illustrates that as sea level rises, water depths for this alternative increase throughout the swamp since more diversion flow is initiated and more water is routed through the system to attenuate backflow conditions. As sea level rises, backflow prevention (Figure L2.10.1-4) generally decreases throughout the swamp since the system is less effective at preventing backflow due to the increase in stages at the downstream boundary condition (Lake Maurepas). The reduction in backflow prevention for the subbasins listed above is less pronounced since these locations are more directly influenced by the South Bridge diversion due to their proximity.

Frequency of Dry-Out Conditions

As shown on Figure L2.10.1-5 and in Table L2.10.2-1, the average dry-out frequency for Alternative 4 ranges from 3 to 44 percent (no sea level rise). There is a reduction in dry-out frequency when compared to the existing conditions with berm gaps mainly in the upstream subbasins (100, 200, 210, and 220), which are more directly impacted by the South Bridge diversion due to their proximity to the entry point, and throughout the 300 series due to improved routing benefits. As sea level rises, dryout frequency decreases throughout the swamp since more diversion flow is initiated to prevent backflow; therefore, reducing the occurrence of dry-out conditions.

Frequency of Diversions and TSS Loading

As shown on Figure L2.10.1-6, the diversion is initiated under Alternative 4 (no sea level rise) an average 42 percent of the time. Also, approximately 1.1 mm/year of TSS loading from the Mississippi River (Figure L2.10.1-7) is introduced to the project area in this scenario. As sea level rises, additional diversion flow (up to 77 percent) is initiated and, hence, more TSS loading is introduced to the system (up to 2.1 mm/yr).

Table L2.10.2-1 Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 4

Subbasin Number	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
Hydrologic Unit Number	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Annual Average Water Depth (ft)	1.50	2.09	1.87	0.84	0.54	0.97	0.65
Annual Average Backflow Prevention (%)	78	85	87	22	25	38	38
Annual Average Dry-Out Frequency (%)	4	3	4	32	44	15	25

L2.10.3 Alternative 4B

Alternative 4B includes a freshwater diversion of up to 3,000 cfs that follows the South Bridge alignment in combination with control structures and channel improvements to promote distribution of flow to more of the swamp than Alternative 2 or 4. A plan view of Alternative 4B is presented on **Figure L2.10.3-1**. This alternative has eight major components:

Diversion facility at the Mississippi River. The diversion culvert facility will divert fresh water from the Mississippi River, transfer it beyond the east levee and discharge to the transmission canal.

Transmission canal. The transmission canal will transfer the diverted water approximately four miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp. The project will use the existing drainage channels at the perimeter of the swamp to distribute the diverted flow throughout and into the swamp.

Distribution Canal. A distribution canal will be constructed across the swamp from the west edge of the project area to US 61. The distribution canal will be constructed with levees on each side to elevate the water surface above the swamp, similar to an irrigation canal, and allow for distribution of flow to adjacent areas of the swamp.

Channel Improvements. Conveyance of 1,500 cfs in the St. James Parish Canal to areas south of the Blind River will require the existing drainage canal to be widened between the transmission canal and hydrologic unit 110, as shown in Figure L2.10.3-1.

Control Structures. Approximately six control structures of various sizes with control gates will be installed at key locations in the existing channels to force water out of the drainage channels and into the swamp through the berm gaps. The proposed control gate is a specialty gate that rotates on a shaft at the bottom of the channel and is operated by large hydraulic cylinders. (One of the gate options, the Obermeyer gates, uses an air-inflated bladder to operate the gates.) The gate will be rotated up to the vertical position to increase the water surface elevation during the flow diversion and promote flow distribution to the swamp. The gate will be rotated down to the channel bottom into the open position when there is no diversion, to allow for normal drainage.

Berm Gaps. As identified for the other alternatives, new 500-foot wide berm gaps will be constructed to improve flow circulation in the swamp.

Highway 61 and KCS RR Culverts. As identified for the other alternatives, new culvert crossings will be added under the KCS RR and Hwy 61 at four locations.

Instrumentation. As identified for the other alternatives, instrumentation will be required to control the diversion flow rate and control structures.

L2.10.3.1 HEC-HMS and HEC-RAS

The following modifications to the existing conditions HEC-RAS model were incorporated to represent Alternative 4B:

- HEC-RAS lateral structures that allow flow exchange between the drainage canals and the swamp were modified to reflect the berm gaps included in this alternative. The geometry of the lateral structures were modified to lower invert elevations to elevation 0 feet NAVD and widened to represent increased flow capacity compared to existing conditions.
- HEC-RAS culverts were added across US 61 to provide more conveyance capacity between swamp storage areas on both sides of the existing highway embankment.
- Fixed weirs were added in HEC-RAS at the locations of the control structures to simulate dry conditions when diversion flow will be distributed to the swamp. For simulations of wet weather conditions the weirs in HEC-RAS were modified to represent the control gates in the lowered position.
- Alternative 4B also includes a diversion of 3,000 cfs along the South Bridge alignment and a distribution canal across the swamp to US 61. Similar to Alternative 4, the distribution of diversion flows into the swamp for Alternative 4b was simulated with multiple boundary condition flow time series assigned to various swamp storage areas represented in HEC-RAS. The flow split that was used consisted of 50% (1,500 cfs) assigned to the St. James Parish Canal, 8.3% (250 cfs) assigned to hydrologic unit 100, 17% (500 cfs) assigned to hydrologic unit 210, 8.3% (250 cfs) to hydrologic unit 220, and 8.3% (250 cfs) to hydrologic unit 300.

Review of the HEC-HMS and HEC-RAS results indicates that Alternative 4B increases net freshwater throughput compared to existing conditions. Backflow is also reduced, especially with projected increases in sea level. The throughput and backflow values for Alternative 4B are comparable to the other alternatives in the final array, and provide distribution to more areas of the project area than either Alternative 2 or 4. Alternative 4 provides significant throughput volume to hydrologic units located both north and south of the Blind River, including hydrologic units 100, 110, 200, and 210. Alternative 4 also provides improved throughput to hydrologic unit 300, 220 and 140.

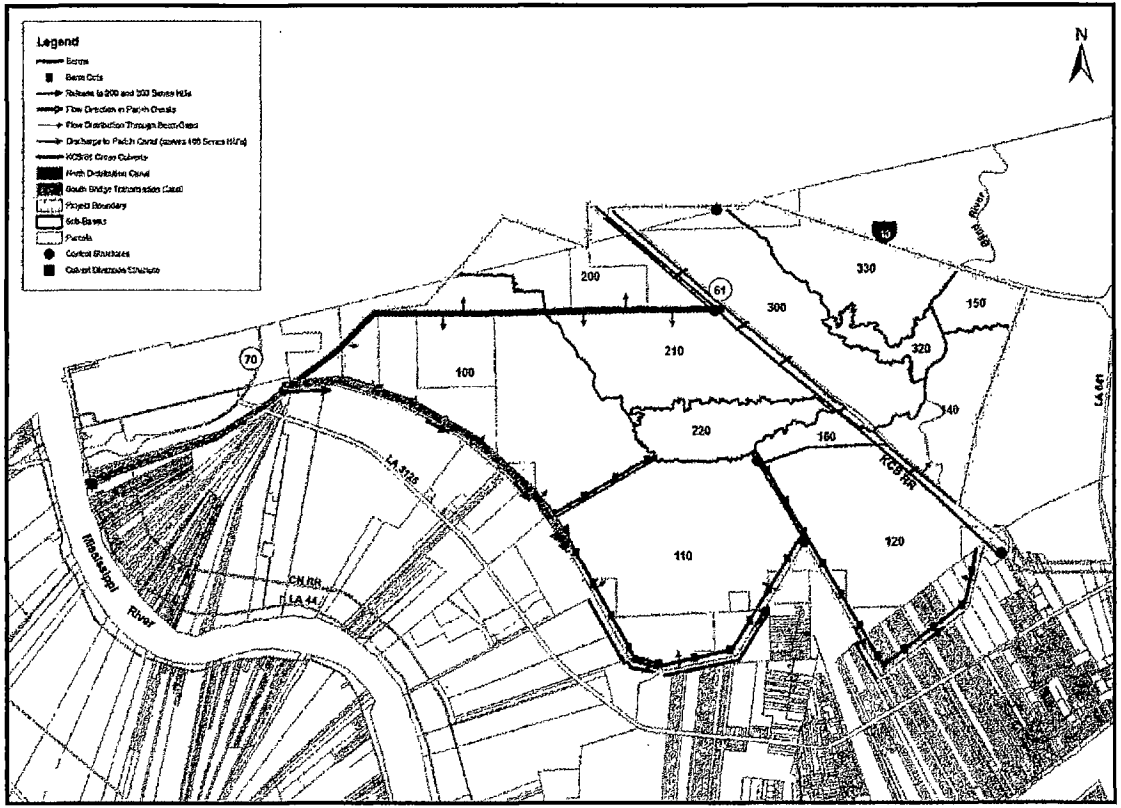


Figure L2.10.3-1 Alternative 4B Layout

1392

L2.10.3.2 Engineering Calculations

Water Depth and Backflow Prevention

For Alternative 4B (South Bridge Diversion split at 3,000 cfs), the average water depth ranges from 0.55 to 1.50 feet (Figure L2.10.1-3 and **Table L2.10.3-1**) and backflow prevention ranges from 25 to 74 percent (Figure L2.10.1-4 and Table L2.10.3-1) under no sea level rise conditions. This increase in water depths and backflow prevention when compared to the existing conditions with berm gaps is attributed to the additional diversion flow. The subbasins benefiting the most hydrologically from this alternative are 100, 110, 200, 210, and 220 due to their adjacent location to the South Bridge diversion point and St. James Parish Canal, and the 300 series as a result of proposed improvements to routing flow through the Route 61 control structure. Figure L2.10.1-3 further illustrates that as sea level rises, water depths for this alternative increase throughout the swamp since more diversion flow is initiated and more water is routed through the system to attenuate backflow conditions. As sea level rises, backflow prevention (Figure L2.10.1-4) generally decreases throughout the swamp since the system is less effective at preventing backflow due to the increase in stages at the downstream boundary condition (Lake Maurepas). The reduction in backflow prevention for the subbasins listed above is less pronounced since these locations are more directly influenced by the diversions due to their proximity to the South Bridge and St. James Parish Canals.

Frequency of Dry-Out Conditions

As shown on Figure L2.10.1-5 and in Table L2.10.3-1, the average dry-out frequency for Alternative 4B ranges from 6 to 44 percent (no sea level rise). There is a reduction in dry-out frequency when compared to the existing conditions with berm gaps mainly in the upstream subbasins (100, 110, 200, 210, and 220), which are more directly impacted by the South Bridge diversion due to their proximity to the entry point and to the St. James Parish Canal, and throughout the 300 series due to improved routing benefits. As sea level rises, dryout frequency decreases throughout the swamp since more diversion flow is initiated to prevent backflow; therefore, reducing the occurrence of dry-out conditions.

Frequency of Diversions and TSS Loading

As shown on Figure L2.10.1-6, the diversion is initiated under Alternative 4b (no sea level rise) an average 53 percent of the time. Also, approximately 1.3 mm/year of TSS loading from the Mississippi River (Figure L2.10.1-7) is introduced to the project area in this scenario. As sea level rises, additional diversion flow (up to 90 percent) is initiated and, hence, more TSS loading is introduced to the system (up to 2.4 mm/yr).

Table L2.10.3-1 Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 4B

Subbasin Number	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
Hydrologic Unit Number	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Annual Average Water Depth (ft)	1.50	1.37	1.44	1.29	0.55	0.83	0.65
Annual Average Backflow Prevention (%)	74	63	70	50	25	29	38
Annual Average Dry-Out Frequency (%)	6	7	9	11	44	23	25

L2.10.4 Alternative 6

Alternative 6 includes two freshwater diversions that each has a capacity of 1,500 cfs, for a total diversion capacity of 3,000 cfs. The alternative includes two transmission canals that follow the Romeville and South Bridge alignments in combination with control structures to maximize distribution of flow to the swamp. A plan view of Alternative 6 is presented on **Figure L2.10.4-1**. This alternative has nine major components:

Diversion facility at the Mississippi River (Romeville). The diversion culvert facility will divert fresh water from the Mississippi River, transfer it beyond the east levee and discharge to the Romeville transmission canal.

Diversion facility at the Mississippi River (South Bridge). The diversion culvert facility will divert fresh water from the Mississippi River, transfer it beyond the east levee and discharge to the South Bridge transmission canal.

Romeville Transmission canal. The transmission canal will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp.

South Bridge Transmission canal. The transmission canal will transfer the diverted water approximately four miles from the diversion culvert facility to an existing drainage channel at the perimeter of the swamp.

Distribution Canal. A distribution canal will be constructed across the swamp from the west edge of the project area to US 61. The distribution canal will be constructed with levees on each side to elevate the water surface above the swamp, similar to an irrigation canal, and allow for distribution of flow to adjacent areas of the swamp.

Control Structures. As identified for the other alternatives, approximately six control structures of various sizes with control gates will be installed at key locations in the existing channels to force water out of the drainage channels and into the swamp through the berm gaps.

Berm Gaps. As identified for the other alternatives, new 500-foot wide berm gaps will be constructed to improve flow circulation in the swamp.

Highway 61 and KCS RR Culverts. As identified for the other alternatives, new culvert crossings will be added under the KCS RR and Hwy 61 at four locations.

Instrumentation. As identified for the other alternatives, instrumentation will be required to control the diversion flow rate and control structures.

L2.10.4.1 HEC-HMS and HEC-RAS

The following modifications to the existing conditions HEC-RAS model were incorporated to represent Alternative 6:

- HEC-RAS lateral structures that allow flow exchange between the drainage canals and the swamp were modified to reflect the berm gaps included in this alternative. The geometry of the lateral structures were modified to lower invert elevations to elevation 0 feet NAVD and widened to represent increased flow capacity compared to existing conditions.
- HEC-RAS culverts were added across US 61 to provide more conveyance capacity between swamp storage areas on both sides of the existing highway embankment.
- Fixed weirs were added in HEC-RAS at the locations of the control structures to simulate dry conditions when diversion flow will be distributed to the swamp. For simulations of wet weather conditions the weirs in HEC-RAS were modified to represent the control gates in the lowered position.

Review of the HEC-HMS and HEC-RAS results indicates that Alternative 6 provides increases net freshwater throughput compared to existing conditions. Backflow is also reduced, especially with projected increases in sea level. The total throughput and backflow values for Alternative 6 are comparable to the other alternatives in the final array, and provide distribution to more areas of the project area than either Alternative 2 or 4. Alternative 6 provides significant throughput volume to hydrologic units located both north and south of the Blind River, including hydrologic units 100, 110, 200, and 210. Alternative 4 also provides improved throughput to hydrologic unit 300, 220, and 140.

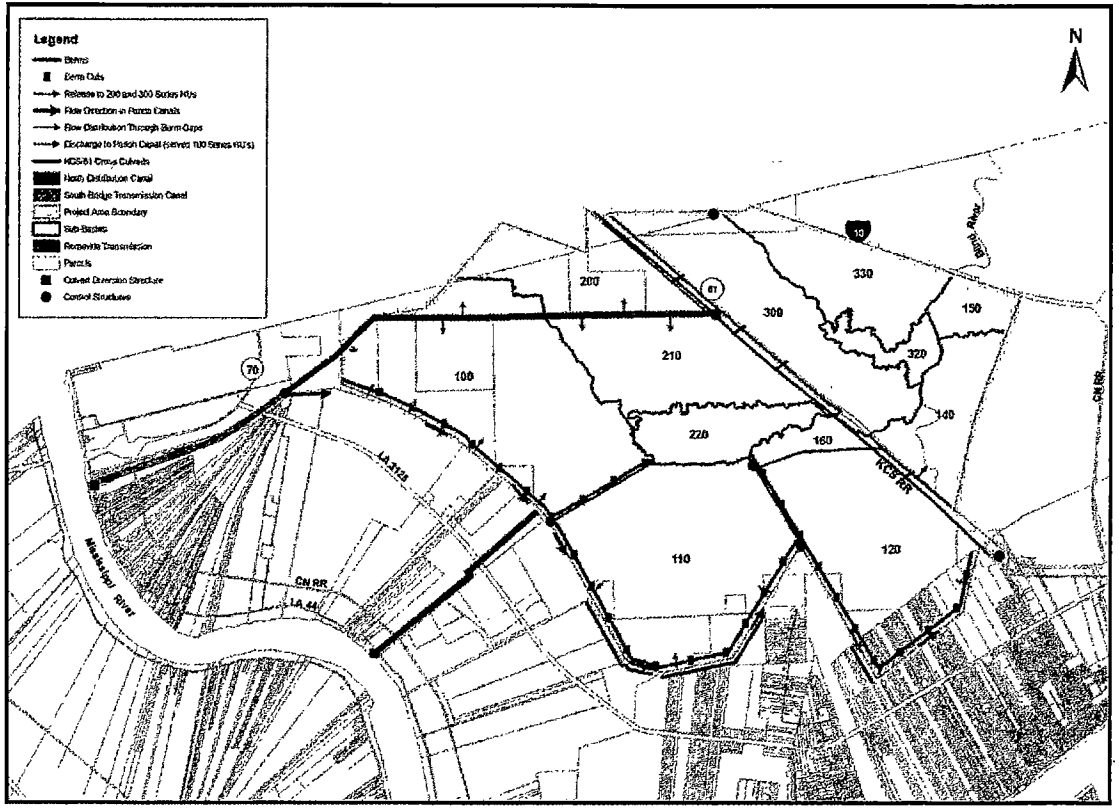


Figure L2.10.4-1 Alternative 6 Project Layout

1396

L2.10.4.2 Engineering Calculations

Water Depth and Backflow Prevention

For Alternative 6 (Romeville and South Bridge Diversions split at 1,500 cfs each), the average water depth ranges from 0.55 to 1.48 feet (Figure L2.10.1-3 and **Table L2.10.4-1**) and backflow prevention ranges from 25 to 74 percent (Figure L2.10.1-4 and Table L2.10.4-1) under no sea level rise conditions. This increase in water depths and backflow prevention when compared to the existing conditions with berm gaps is attributed to the additional diversion flow. The subbasins benefiting the most hydrologically from this alternative are 100, 110, 200, 210, and 220 due to their adjacent location to the Romeville and South Bridge diversion points, and the 300 series as a result of proposed improvements to routing flow through the Route 61 control structure. Figure L2.10.1-3 further illustrates that as sea level rises, water depths for this alternative increase throughout the swamp since more diversion flow is initiated and more water is routed through the system to attenuate backflow conditions. As sea level rises, backflow prevention generally decreases throughout the swamp (Figure L2.10.1-4) since the system is less effective at preventing backflow due to the increase in stages at the downstream boundary condition (Lake Maurepas). The reduction in backflow prevention for the subbasins listed above is less pronounced since these locations are more directly influenced by the diversions due to their proximity to the Romeville and South Bridge entry points.

Frequency of Dry-Out Conditions

As shown on Figure L2.10.1-5 and in Table L2.10.4-1, the average dry-out frequency for Alternative 6 ranges from 6 to 44 percent (no sea level rise). There is a reduction in dry-out frequency when compared to the existing conditions with berm gaps mainly in the upstream subbasins (100, 110, 200, 210, and 220), which are more directly impacted by the Romeville and South Bridge diversions due to their proximity to the entry points, and throughout the 300 series due to improved routing benefits. As sea level rises, dry-out frequency decreases throughout the swamp since more diversion flow is initiated to prevent backflow; therefore, reducing the occurrence of dry-out conditions.

Frequency of Diversions and TSS Loading

As shown on Figure L2.10.1-6, the diversion is initiated under Alternative 6 (no sea level rise) an average 50 percent of the time. Also, approximately 1.3 mm/year of TSS loading from the Mississippi River (Figure L2.10.1-7) is introduced to the project area in this scenario. As sea level rises, additional diversion flow (up to 85 percent) is initiated and, hence, more TSS loading is introduced to the system (up to 2.4 mm/yr).

Table L2.10.4-1 Summary of Average Water Depth, Backflow Prevention, and Dry-Out Frequency (No Sea Level Rise) for Alternative 6

Subbasin Number	100	200	210, 220	110	120, 160	300, 320, 330	140, 150
Hydrologic Unit Number	HU 1	HU 2	HU 3	HU 4	HU 5	HU 6	HU 7
Annual Average Water Depth (ft)	1.48	1.38	1.44	1.36	0.55	0.82	0.65
Annual Average Backflow Prevention (%)	74	64	70	57	25	29	38
Annual Average Dry-Out Frequency (%)	6	7	8	10	44	23	25

L2.10.5 Summary and Recommendations

Hydrologic Influence Areas

A primary output from the hydrologic and hydraulic analyses is the determination of the hydrologic influence on hydrologic units in the project area. All of the alternatives in the final array produced similar types of hydrologic influence that include improved throughput of freshwater, reduced backwater from Lake Maurepas, and improved frequency of dry-out. The differentiator between each alternative is the area of influence that receives hydrologic benefits. Results from each analysis method were used to characterize hydrologic influence into three categories:

- Areas that will benefit from the distribution of freshwater, nutrient, and sediment
- Areas that will benefit from the distribution of freshwater and nutrients
- Areas that will benefit from the distribution of freshwater

Figures L2.10.5-1 through **L2.10.5-4** present the allocation of hydrologic benefits to the study area according to the three categories listed above. In general, the Romeville diversion primarily benefits areas south of the Blind River, while the South Bridge diversion (no split) primarily benefits areas north of the Blind River. Sea level rise significantly increases backflow, water levels, and reduces dry-out frequency.

Consideration of Other Planned Projects

During completion of hydrologic and hydraulic analyses completed for the Blind River potential benefits from the Hope Canal project were also considered. Review of the Hope Canal report indicates that project diversions will be focused on areas north of I-10 (URS, 2007). Based on the provided hydraulic modeling results, the total recommended diversion flow can range from 1,500 cfs to 2,000 cfs. Approximately half of the diversion flow will be uniformly distributed along reaches of the Blind River and Amite River upstream of Lake Maurepas, and the remainder of the diversion will flow directly to Lake Maurepas. At times a small portion of flow, approximately 300 cfs, will be diverted to areas upstream of I-10 and will sheet flow to hydrologic units 140 and 150 in the Blind River project area.

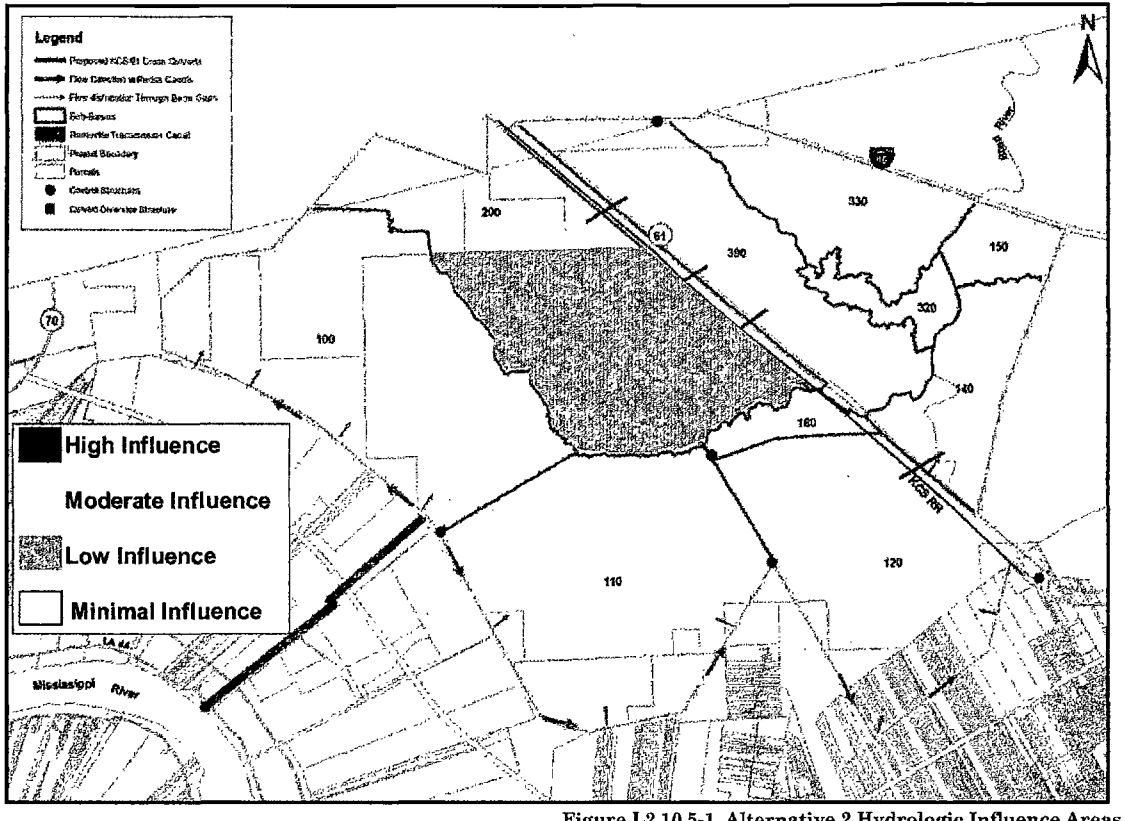


Figure L2.10.5-1 Alternative 2 Hydrologic Influence Areas

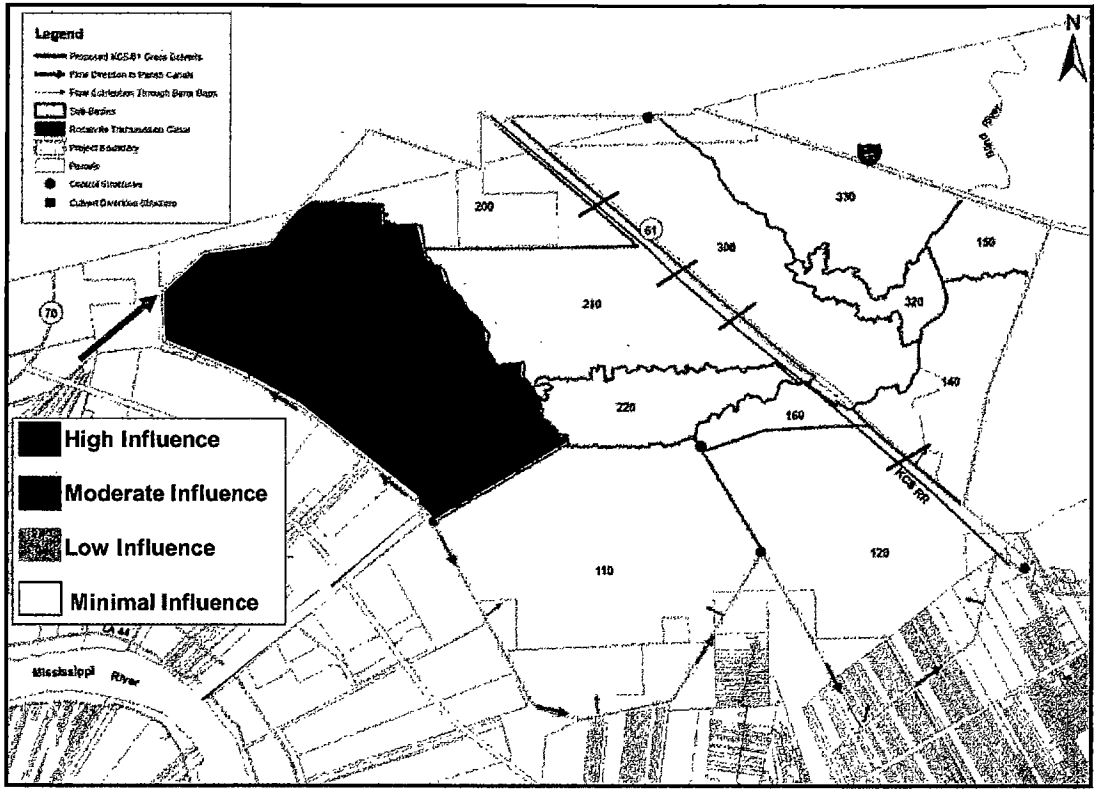


Figure L2.10.5-2 Alternative 4 Hydrologic Influence Areas

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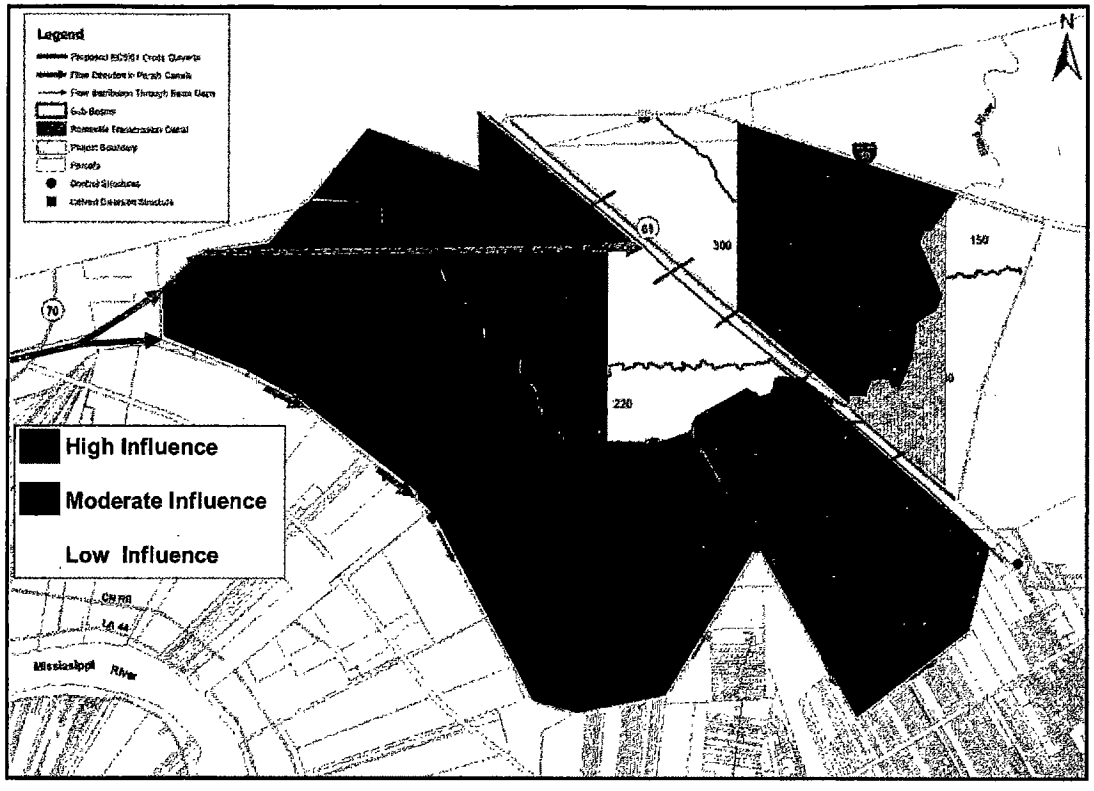


Figure L2.10.5-3 Alternative 4B Hydrologic Influence Areas

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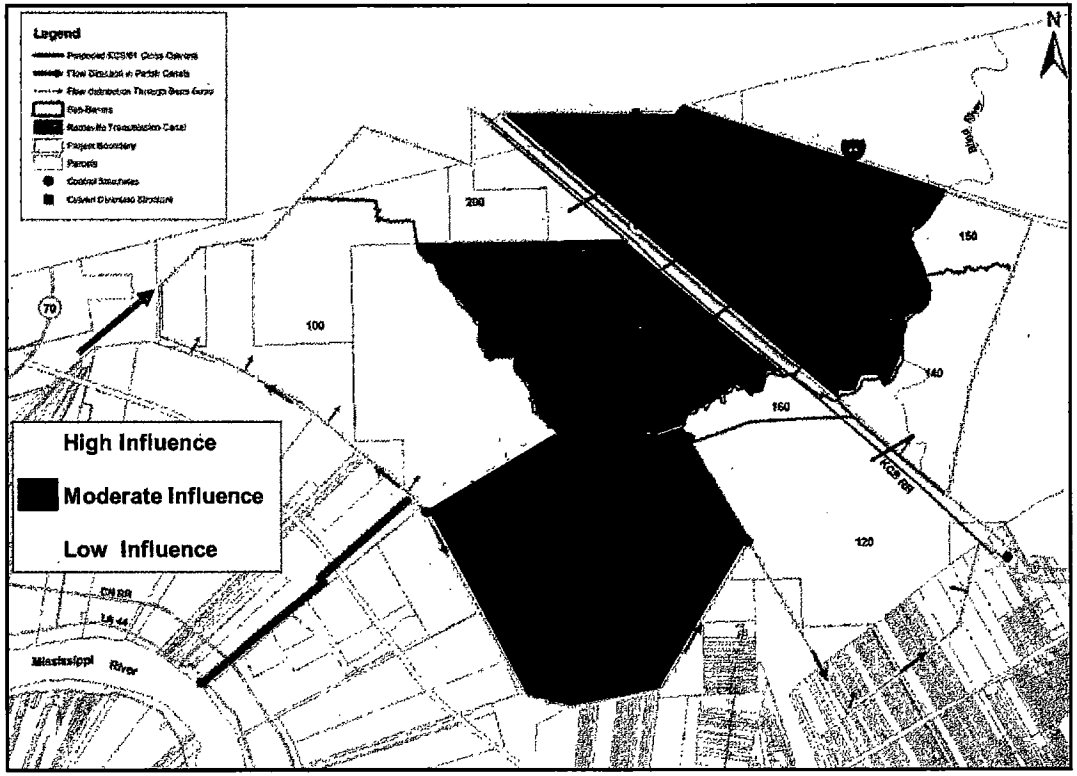


Figure L2.10.5-4 Alternative 6 Hydrologic Influence Areas

1402

HEC-RAS simulations were completed with 1,000 cfs allocated uniformly to reaches of the Blind River downstream of I-10 to represent diversion flows from the Hope Canal project. Model results indicated minimal increases in stage of 0.1 to 0.2 feet on the Blind River with the additional flow, which is consistent with findings presented in the Hope Canal project report. Because diversion flow from the Hope Canal project enters the Blind River downstream of I-10, it does not reduce backflow from Lake Maurepas, and most likely will comprise a portion of the backflow when the swamp water levels are low.

The small portion of flow that will be released intermittently upstream of I-10 provides some potential for benefit to hydrologic units 140 and 150. However, because the diversion flow from the Hope Canal project will sheet flow over a significant distance through portions of the Maurepas swamp before reaching the Blind River, it is unlikely that nutrients or sediment will be contributed to those hydrologic units.

Plan Selection

The hydrologic and hydraulic analyses contribute significantly to identification of viable alternatives and guiding the selection of the Tentatively Selected Plan. However, the hydrologic and hydraulic analyses are only informative, as the net benefits of each alternative for this project are to be determined by the WVA. The completed hydrologic and hydraulic analyses produced the following findings:

- All four alternatives in the final array were found to be feasible from the hydrologic and hydraulic perspective and provide similar types of benefits. The primary differentiator among the alternatives was the portion of the project area that receives hydrologic influence.
- By minimizing headloss and provision of controllable operations to both the diversion flow and control structures in the project area, the use of existing drainage canals to distribute diversion flow to the project area is feasible without adversely impacting the existing drainage functionality of the system.
- In order to provide hydrologic influence to areas north of the Blind River it was found necessary to include the construction of a distribution canal across the swamp as opposed to exclusive use of existing drainage canals for the distribution of the diversion flow.
- Alternatives 4B and 6 provide hydrologic influence to the most hydrologic units in the project area compared to Alternatives 2 and 4. The dual diversion component of Alternative 6 also appears to perform more efficiently from a hydraulic perspective than the other alternatives. However, this additional hydrologic influence is only attainable with substantial increases in the scope of the required conveyance improvements.
- Future conditions that include both mean sea level rise and continued subsidence will increase the magnitude of land area in the swamp that is

inundated during average hydrologic conditions, primarily because the average and peak water elevations in Lake Maurepas will increase relative to the ground elevation in the swamp.

- While sea level rise will deliver more water to the swamp, the frequency and duration of stagnant conditions will increase. The risks of potential impacts associated with inundation resulting from storm surge, such as salinity, will also increase.

Plan Refinement
As the selected plan proceeds through subsequent design phases, continued evaluation of the following hydrologic and hydraulic aspects of the project are recommended:

- Refine the operational logic for controlling diversion flows to allow for preemptive diversions and continuous seasonal diversions;
- Further evaluate the sensitivities and effects of sea level rise with explicit incorporation of accretion in the project area, including corresponding adaptations to system operations;
- Evaluate Blind River diversion, Amite River diversion, and Hope Canal diversion and effects on total ecosystem, in addition to each incremental project;
- Utilize monitoring data collected at the new Blind River stream gage and piezometers installed within the swamp to calibrate the developed HEC-HMS, HEC-RAS, and EFDC models;
- Refine the HEC-HMS, HEC-RAS and EFDC models using additional topographic and field survey data to support design and implementation of critical hydraulic features of the selected plan, including in-swamp control structures, proposed culverts, and berm gaps.

L2.11 Hydrologic Uncertainties

The results presented in the analysis to date have been developed with the best available information on historical hydrology, existing topography, and future conditions. However, each of these factors is subject to uncertainties, which could pose risks to the hydraulic and ecological functionality of the project. The uncertainties are discussed below:

- **Topography**: All modeling to date has been completed using best available topographic and bathymetric data, in combination with available engineering plans to define channel cross-sections, roadway culverts, and surface storage areas. The available topographic data coupled with field reconnaissance provided sound definition of major hydrologic and hydraulic features for use in the development models, but available data were not high resolution. LiDAR data collection was included in the scope of the

study, in parallel with modeling activities, with the intent of providing greater resolution for topography of the system. However, wet conditions in the swamp resulted in the LiDAR acquisition being completed while much of the swamp was inundated with water, and prevented the desired data resolution for swamp bottom surface topography. Due to limitations in the available data, the model calculations that rely on topographic input such as estimates of water depths, residence times, and propensity of water to flow in assumed directions are similarly limited in their resolution.

- **Future hydrology:** The period of record used for extended analysis covered the period from 1989 through 2004. During this period, it appears that extended dry conditions that would support cypress germination and sapling survival occurred only every 5 to 6 years. The frequency at which conditions in the future may support growth cannot be accurately forecasted based only on this available data record. Future tree growth will be a function of climate patterns, management of the diversion and control structures, and the factors listed below, each of which includes inherent uncertainty. What can be inferred from the analysis is that careful flow management within the system can facilitate periodic hydrologic conditions that would support tree re-growth, but favorable ecological factors will also need to be present for this desired outcome.
- **Relative Sea Level Rise:** The basis for estimating relative sea level rise and associated impacts to the project are based on multiple components that all contain elements of uncertainty:
    - **Sea level rise:** USACE estimates for 50-year eustatic sea level rise (without the relative impacts of subsidence or accretion) range from 0.28 feet to 2.00 feet. This is a very broad range, as it coincides generally with the magnitude of normal water level fluctuations in the swamp. Future conditions for this project used the intermediate eustatic sea level rise estimate of 0.67 feet (coupled with subsidence for a relative rise of 1.90 feet).
    - **Subsidence:** Future subsidence rates used in this project, per USACE guidance, were 7.5 mm per year. This corresponds to 1.23 feet over a 50-year period. This is based on the measured local increase in sea level over 50 years (9.20 mm/yr) – the global eustatic rate of sea level rise (1.7 mm/yr). Coupled with the intermediate value of sea level rise, this yields a relative sea level rise of 1.90 feet over a 50-year period. However, the range of 50-year relative sea level rise estimates when subsidence is included is still very broad: 1.51 – 3.23 feet. Further uncertainty is introduced when considering the subsidence value alone. For example, the Amite River Project used a subsidence estimate of 8.5 mm/year, selected from an estimate range of 4 mm/yr to 20 mm/year based on projects and limited

research available for the region. This range alone translates to 2.62 feet of uncertainty with respect to future subsidence.

- **Accretion:** Estimates of future accretion rates are not included in the projections of future relative sea level rise. The Amite River Project identified a range of 5 mm/year to 25 mm/year of accretion, with an intermediate estimate of 12 mm/year. Over a 50-year period, this range translates into 3.28 feet of uncertainty with respect to accretion alone. The intermediate rate of 12 mm/year translates into 1.97 feet over 50 years, which would roughly offset the relative sea level rise of 1.90 feet (eustatic rise plus subsidence).
- **Combined Effects:** Using ranges applied to the Blind River project and also developed for the Amite River project, the cumulative 50-year effects of uncertainty with respect to eustatic sea level rise, subsidence, and accretion are as follows, using combinations of extreme values:
  - **Highest Estimated Relative Sea Level Rise:**

    Maximum Eustatic Rise + Maximum Subsidence – Minimum Accretion

    2.00 ft + 3.28 ft – 0.82 ft = **4.46 feet**
  - **Lowest Estimated Relative Sea Level Rise:**

    Minimum Eustatic Rise + Minimum Subsidence – Maximum Accretion

    0.28 ft + 0.66 ft – 4.1 ft = **-3.16 feet**

  The total range, then, of cumulative effects of land and sea changes is approximately 7.62 feet, which represents a large range of potential future conditions, especially considering that the range spans almost equally in opposing directions. Relative sea rise conditions that result in a relative sea level reduction will not pose risk to the project, while increases in relative sea level could impact project performance. The use of intermediate values for all factors produces an estimated relative sea level rise is -0.07 feet, representing a condition in which accretion effectively offsets the combined effects of subsidence and eustatic sea level rise.

As discussed elsewhere in this Feasibility Study and Engineering Appendix report, there is considerable uncertainty in the future relative elevations of land and sea in the study area due to a combination of effects, including eustatic sea level rise, land subsidence, and accretion through swamp biological productivity (growth) and sedimentation. The potential projected ranges of these interacting effects are broad enough to cause uncertainty not only in the magnitude of potential changes, but also the direction. That is, the combined effects of these

phenomena could lead to future conditions characterized by sea levels that are either higher or lower than land elevations today.

As presented in Section L2.10, using intermediate values from available regional estimates of each contributing factor (eustatic sea level rise, subsidence, and accretion) suggest that relative sea level rise over 50 years will not produce the adverse hydrologic impacts to project performance that were analyzed. Analysis results developed for Alternative 2 are presented in this section utilized relative sea level rise for all three projections: low, medium and high.

The analyses in this Engineering Appendix have considered a portion of this range of combined effects, looking primarily at future estimates of relative sea level rise accounting for subsidence, but hydraulic modeling was not completed with explicit representation of accretion and sedimentation (in order to offer conservative "worst case" estimates). The relative rise has been applied in the modeling analysis at the downstream boundary condition, specifically the water level in Lake Maurepas, and the primary impact it has on model results is increased backflow of Lake water into the swamp, and a greater need for diverted water in future years to overcome the backflow.

However, it is conceivable that the water levels in the Mississippi River (upstream boundary condition and flow input for this project) could also be affected by combined effects of eustatic sea level rise and changes in sediment load. This is important because the flow rating curves developed for the gravity-based diversion structure are based on the differential head across the system, not just on the water level in the Mississippi River. If downstream water level rises in Lake Maurepas but Mississippi River water levels are largely unchanged, the physical ability to divert water could be diminished.

Specific forecasts of future water elevation trends in the Mississippi River near the study area are not readily available, so the analysis presented herein should be evaluated with the following considerations:

- If the Mississippi River water level does not change appreciably in the future, total diversion capacity could be diminished based on the assumptions guiding the application of sea level rise estimates to Lake Maurepas (less differential head across the system, and correspondingly lower diversion flows). As stated elsewhere, if intermediate projections for all contributing factors to relative sea level rise are applied together, the net effect could be almost negligible (counterbalancing effects). Hence, while there is the potential that rising relative sea level coupled with stationary river level could reduce diversion throughput, there is some uncertainty with these projections.
- If the Mississippi river water level rises in future decades, it should improve the ability to divert water to the Blind River system when compared to stationary water level in the river.

It is uncertain which of these scenarios is more likely to occur, and to what degree. Therefore, the project team has evaluated the effects of the different phenomena in sensitivity analyses. The worst case for diversion project performance would be higher levels in Lake Maurepas that do not appreciably affect the Mississippi River. This case would effectively reduce the gravity head gradient from the diversion to the Maurepas Swamp system and increase the need for more diverted flow to provide equal swamp restoration and flushing benefits.

The following two factors were used in deciding how to estimate the design level upstream boundary conditions in future decades:

- Intermediate (medium) projections of relative sea level rise, accounting for eustatic changes, subsidence, and accretion, suggest that the relative rise could be practically negligible.
- If relative sea level does change appreciably, it might be inferred that backwater elevations in the Mississippi River could also increase, if not in direct proportion, somewhat commensurately.

For these reasons, neither the historic water surface elevations in the Mississippi River (used in the hydrologic and hydraulic analysis) nor the flow rating curves for the diversion structure (in which the Mississippi River water level is the independent variable) were adjusted for the analysis of sea level rise in future decades.

Analysis results were developed for Alternative 2 with low, medium and high projections of sea level rise. The trends of the results for low and high relative sea level projections are consistent with the results for medium sea level rise presented in Section L2.10. **Figure L2.11-1** through **Figure L2.11-5** present analysis results developed for low, medium, and high sea level rise projections in combination with the approach and assumptions previously discussed.

- **Throughput and Backflow:** Figure L2.11-1 compares freshwater throughput experienced for existing conditions with increased throughput from the freshwater diversion. As shown, the increases in throughput as sea level rises results from increased diversion flows introduced to prevent backflow from Lake Maurepas. The analysis results indicated that the project can substantially increase throughput and prevent backflow over the range of potential relative sea rise conditions.
- **Average Water Depth:** Figure L2.11-2 illustrates that as sea level rises, water depths can be expected to increase accordingly throughout the swamp. The average water depth is a function of both the increased downstream water levels in Lake Maurepas as well as recommended increases in diversion flow that is initiated through the system to attenuate backflow conditions.

- **Backflow Prevention:** Figure L2.11-3 presents backflow prevention for all three sea level rise projections. The graphs indicate that subbasins receiving hydrologic influence from the freshwater diversion will be protected from frequent backflows originating from Lake Maurepas, and that backflow prevention will be marginally reduced with the high sea level rise projection compared to lower projections of sea level rise.
- **Dry-Out Frequency:** Presented on Figure L2.11-4 is the dry-out frequency that can be expected with and without the project. As presented, the project will increase the ability of subbasins within the project area to dry out and support the potential for bald cypress and tupelo germination and sapling survival. As sea level rises, this potential is expected to diminish over time and to different degrees within each subbasin.

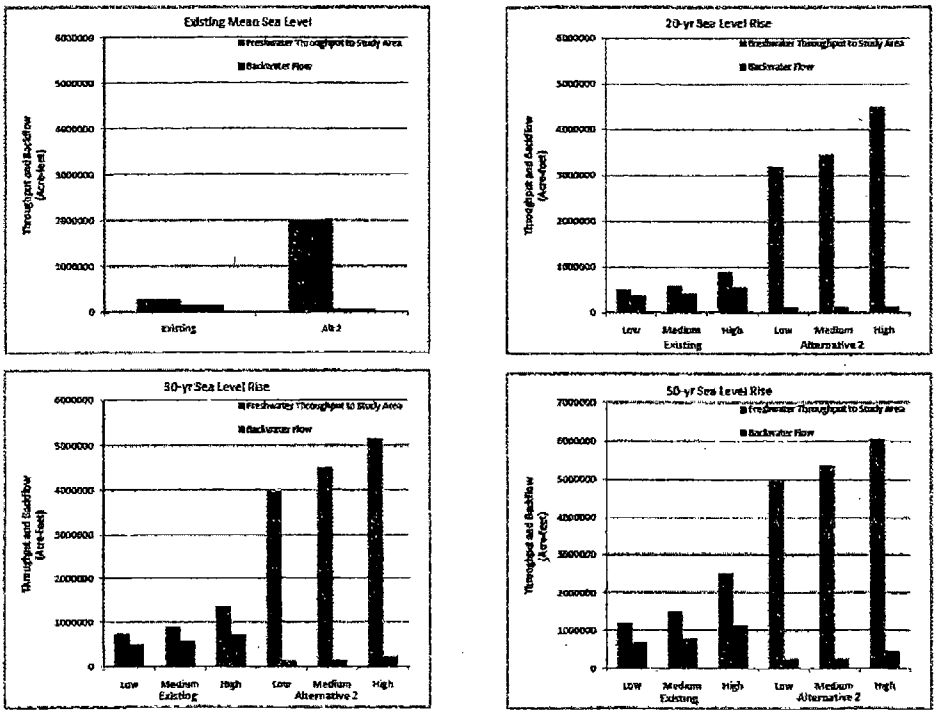


Figure L2.11-1 Throughput and Backflow with Projected Relative Sea Level Rise

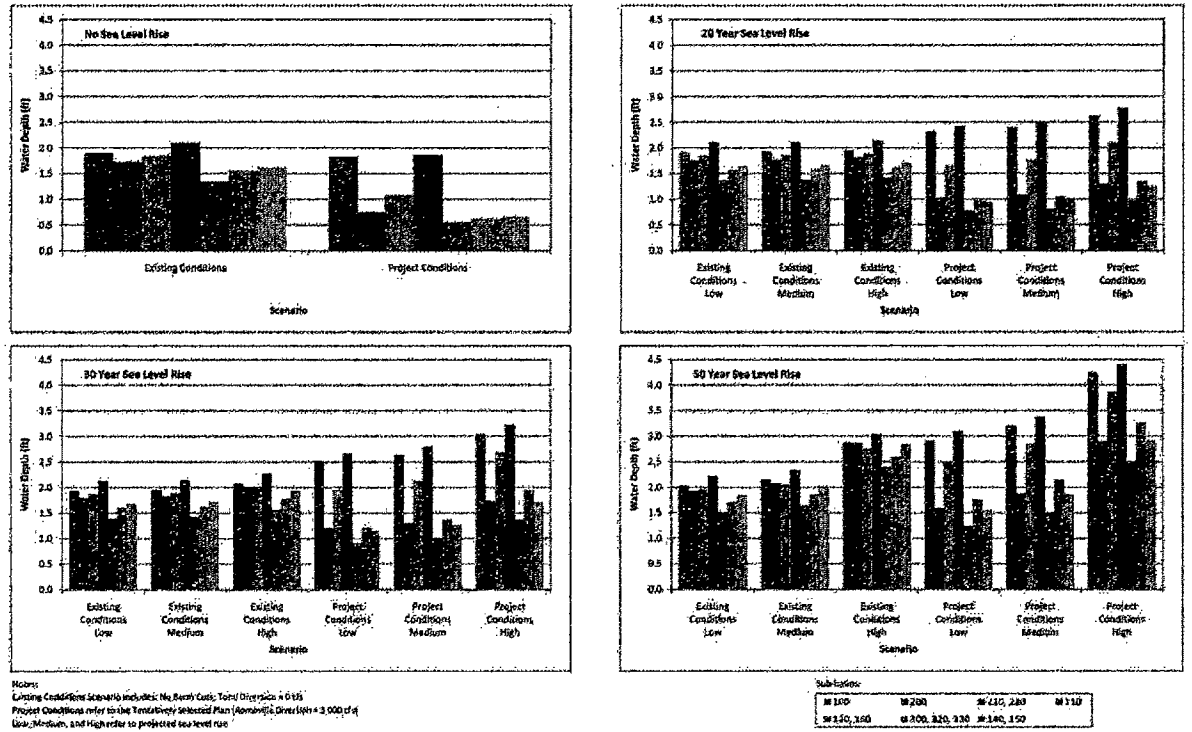


Figure L2.11-2 Average Water Depth with Projected Relative Sea Level Rise

1410

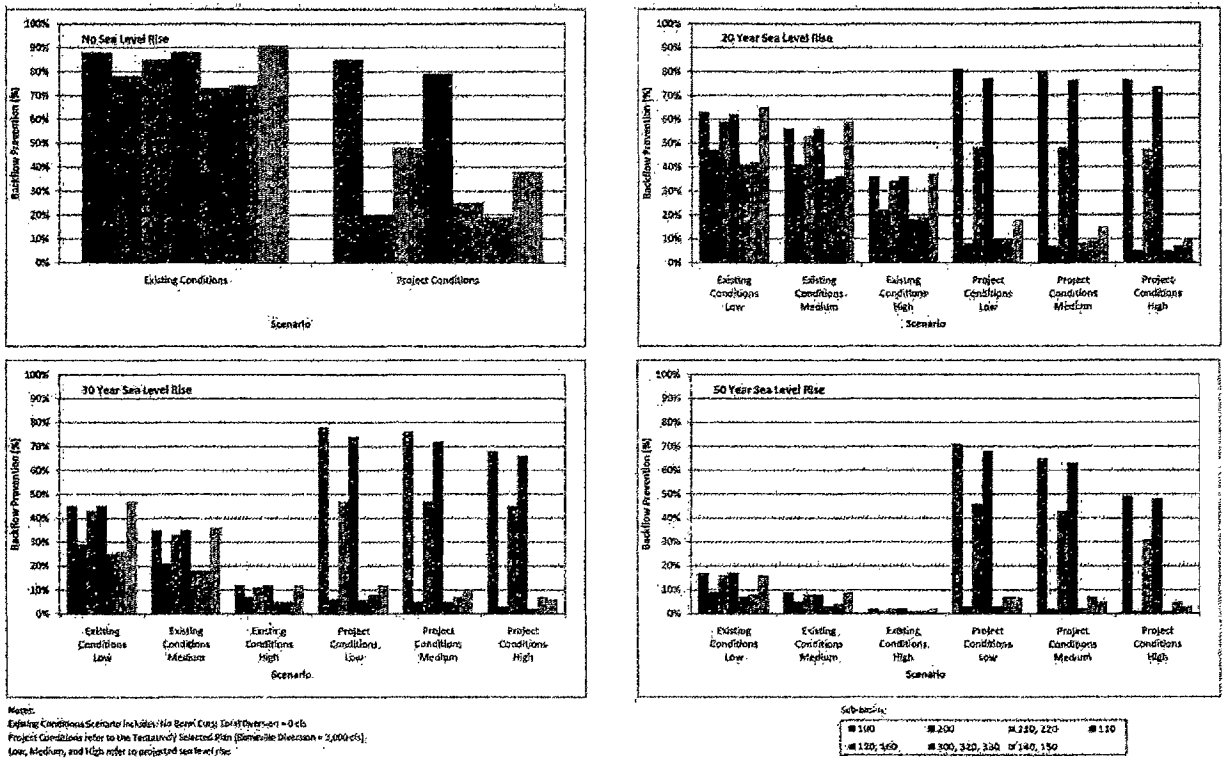


Figure L2.11-3 Backflow Prevention with Projected Relative Sea Level Rise

1411

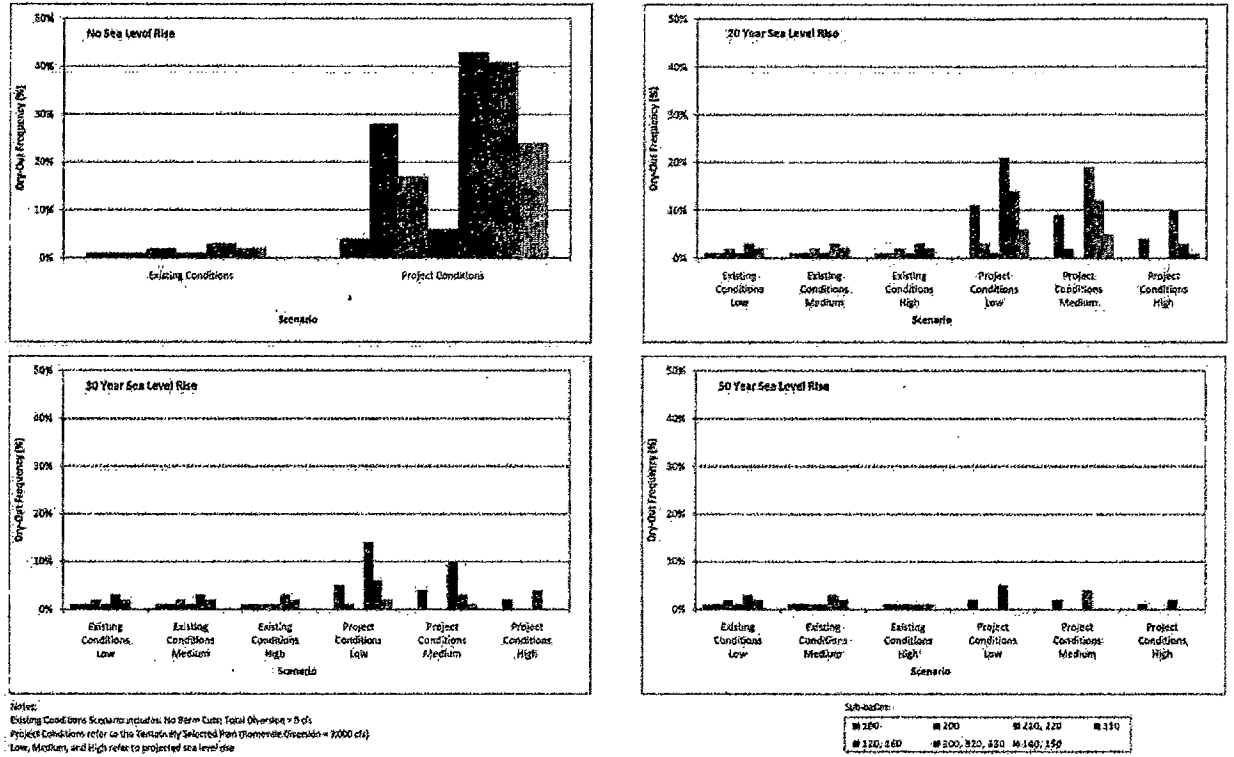


Figure L2.11-4 Dry-Out Frequency with Projected Relative Sea Level Rise

1412

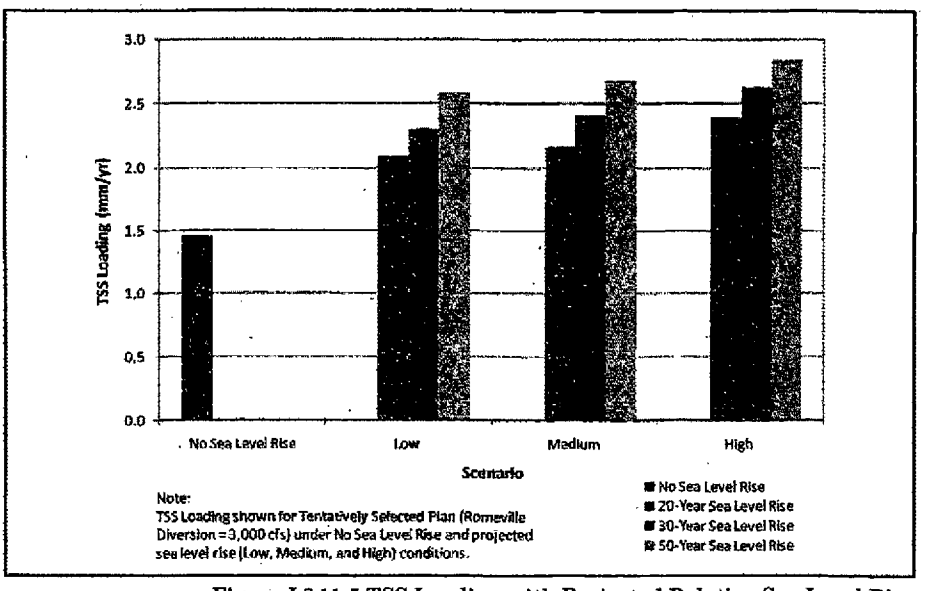


Figure L2.11-5 TSS Loading with Projected Relative Sea Level Rise

- **TSS Loading:** Figure L2.11-5 displays anticipated TSS loading to the project area for various sea level conditions. Since the delivery of TSS is closely correlated with the volume of freshwater diversion flow introduced to the project area, TSS loading is shown to increase as diversion flows are increased to maintain throughput and prevent backflow.

Significant uncertainty in each contributing factor provides the possibility for relative sea rise conditions that could affect the performance of the project. The sea level rise scenarios that were evaluated are considered to be conservative, since they account for eustatic rise and subsidence, but not for accretion. Uncertainty associated with relative sea level rise can be reduced with the collection and incorporation of additional information during subsequent project phases to better define local subsidence and probable accretion rates. In addition, adaptive management strategies should continue to be incorporated into the planned project in order to minimize potential impacts of relative sea and land elevations in the future. As additional information becomes available consideration of future conditions will continue to be refined during project design and to facilitate adaptive management after construction.

L3 SURVEYING, MAPPING AND GEOSPATIAL DATA REQUIREMENTS

L3.1 General

The feasibility study performed limited surveying and bathymetric surveys to identify key components of the project for the purpose of establishing correct costs for the various alternatives. the surveys were tied to existing benchmarks in or near the project area and adjusted to a NAVD 88 datum. The results of those surveys are in the following sections.

L3.2 Ground Topographic Surveys

SJB Group was selected to be the ground surveyors for this project. Their tasks, as stated in an August 12th contract, included: a Centerline Profile Survey of the transmission canal, a Partial Topographic Survey of US 61 (Airline Highway), establish six temporary benchmarks, and a Partial Topographic Survey of I-10 crossing at Blind River.

L3.2.1 Vertical and Horizontal Control Data

The Centerline Profile Survey was taken from the water's edge of the Mississippi River to the northeastern side of LA 3125 at a total distance of 10,150 feet. Data was collected at approximately every 500 feet or at sudden changes in elevation. Elevations were recorded at geographical features, drainage, and irrigation ditches encountered by the surveying team. Pipeline marker locations, culverts, and utility poles were identified by station number and distance from the channel centerline. Exact pipeline locations and cover were not included in the scope of work.

Horizontal and vertical control data were established for this project utilizing GPS Observations and made relative to NAD 83. Horizontal positions are expressed in Louisiana State Plane Coordinate System, Louisiana South Zone. Vertical datum is NAVD88 epoch 2006.81 GEIOD 03 updated.

L3.2.2 Cross Section Locations

A cross-section was taken of the canal bottom at bridge crossings along US 61. The cross-sections show piers, abutments, and the lowest horizontal members of the bridge structure perpendicular to water flow. A cross-section of the canal bottom was taken adjacent to and west of the south bound lane and adjacent to and east of the north bound lane.

L3.2.3 Profile Alignment and Orientation

The channel alignment survey was conducted from the riparian zone between the levee and Mississippi River to the northern side of LA 3125. The survey can be found as plan and profile sheets in Annexure 4.

L3.3 Bathymetric Survey

Coastal Engineering Consultants, Inc was selected to perform bathymetric surveys at specific locations for this project. Their surveying tasks, as stated in a June 29th contract, included: a survey of Blind River, a survey within the Mississippi River at the location of the proposed siphon, and processing and reviewing of all compiled data.

L3.3.1 Vertical and Horizontal Control Data

Tidal correction information was collected from CDM's survey control points to calibrate the collected bathymetric data to the project datum.

L3.3.2 Cross Section Locations

Cross-sections through the waterways were taken at 2000-foot intervals. If a branch channel length was shorter than 2000 feet, cross-sections were conducted at its intersection with Blind River, midway, and at the end of the navigable portion of the branch channel.

L3.3.3 Profile Alignment and Orientation

Bathymetric profiles were conducted in the Mississippi River at the location of the proposed siphon/culvert at the levee. Profiles began 500 feet from the river bank and proceeded landward to the shallowest possible water depth for the survey vessel and equipment. Survey transects were taken at 500-foot intervals beginning 2500 feet upstream and ending 2500 feet downstream of the proposed culvert/siphon location.

L4 GEOLOGY

L4.1 Geology of St James Parish

St James Parish lies on Alluvium and Natural Levees deposits. The Alluvium consists of gray to brownish to reddish brown or gray clay and silty clay with some sand and gravel locally. It includes all alluvial valley deposits except natural levees of major streams. Natural Levees are gray and brown or reddish brown silt, silty clay, with some very fine sand. The natural levees are near the Mississippi River, with point bars and backswamps further inland. In general, on the concave sides of the river are fine-grained natural levee deposits, undifferentiated deltaic plain swamp, and marsh materials. On the convex sides of the river bends are accretionary and point bar deposits. The alluvial deposits are fluvial sediments deposited by a rise in sea level in this region between 4000 and 6000 years ago.

Sediments underlying this region are of the Holocene Epoch, overlying Pleistocene formations. The Mississippi River valley had become deeply entrenched in the coastal plain sediments at the end of the Pleistocene Epoch when the sea level had been lowered 400 to 450 feet below its present level. About 3500 to 5000 years ago, as the sea approached its present levels, the entrenched valley gradually filled up with Holocene alluvial sediments, covering the exposed weathered and eroded

Pleistocene stratum. When the sea reached its present level, the Mississippi River migrated back and forth across the alluvial plain, building a series of delta complexes, while continually shifting the center of deposition to steeper areas. This shift displaced the Gulf waters with deposits of fine-grained material, and eventually formed the existing Mississippi River deltaic plain. The elevations of the top of the Pleistocene layer generally vary between -25 and -250 feet MSL. The Holocene sediments dip gently at about three feet per mile to the south to fill the Gulf of Mexico Basin. Local subsidence of the Holocene deltaic sediments due to compaction and consolidation contributes to loss of wetlands in the Mississippi River Delta plain.

The fine-grained natural levee and inland swamp deposits typically have lower moisture contents and higher shear strengths than similar fine-grained soils from shallow water settings. Late Pleistocene soils typically also have lower moisture contents and higher shear strengths than the younger Holocene soils.

The physical descriptions of the soils in the various geologic environments are as follows:

- Natural levee – Interfingering layers of fat and lean clays and layers of silt;
- Pointbar – Silts, silty sands, and sands with layers of clay;
- Backswamp – Homogeneous fat clays with wood, organic matter, and a few layers of silt;
- Undifferentiated deltaic plain – Fat and lean clays with lenses and layers of silt;
- Accretionary – Alternating layers of clay, silt, silty sands, and sands;
- Holocene – Fine-grained, usually clayey, and often organically rich soils;
- Pleistocene – Stiff to very stiff oxidized clays with lenses and layers of silt, silty sands, and sand.

L5 GEOTECHNICAL INVESTIGATIONS AND DESIGN

The State of Louisiana, together with the Louisiana Coastal Authority (LCA) and the United States Army Corps of Engineers (USACE) New Orleans District, is conducting a feasibility study to restore part of the Maurepas Swamp in St. James Parish, Louisiana. CDM was retained to conduct the feasibility study for the proposed project.

L5.1 Project Description

The Maurepas Swamp (Swamp) is one of the largest coastal fresh water swamps in the State of Louisiana, covering an area of approximately 233,000 acres. Since the construction of the Mississippi River flood control levees in the region, the swamp has been cut off from freshwater infusion, as well as sediments and nutrients hitherto provided by the Mississippi River. As a result, the swamp has

undergone considerable degradation of its ecosystem, together with continual local subsidence.

The proposed project involves designing and constructing a small freshwater diversion canal from the Mississippi River to the Swamp. The proposed flow rate in the diversion canal would be less than 5000 cubic feet per second, discharging into the Blind River, which is located within the Swamp.

L5.2 Purpose and Scope

This report presents geotechnical field investigations being undertaken at the project location.

The investigations consist of drilling and sampling 21 test borings, and installing seven (7) piezometers within the project area. **Figure L5.2-1** and **Figure 5.2-2** show the boring location plan.

Results of laboratory testing of the soil samples and water level readings from the piezometers will furnish information pertinent to the geotechnical design of the diversion canal.

L5.3 Existing Site Conditions

Terrain

The project area is relatively flat, with elevations within the Swamp ranging from 1 to 3 feet, gradually increasing to about 10 feet near the Mississippi River levees south of the Swamp. The Swamp is wooded with cypress trees and other vegetation. The Blind River runs through the Swamp along with connected canals. The Interstate 10 corridor and Airline Highway also cross the Swamp.

Existing soil survey information from the United States Department of Agriculture (USDA) indicates that soils in the area are predominantly clay with occasional layers of silt; the top six inches is mostly peat. Soil information was only available to approximately 6.5 feet below ground surface.

Geology

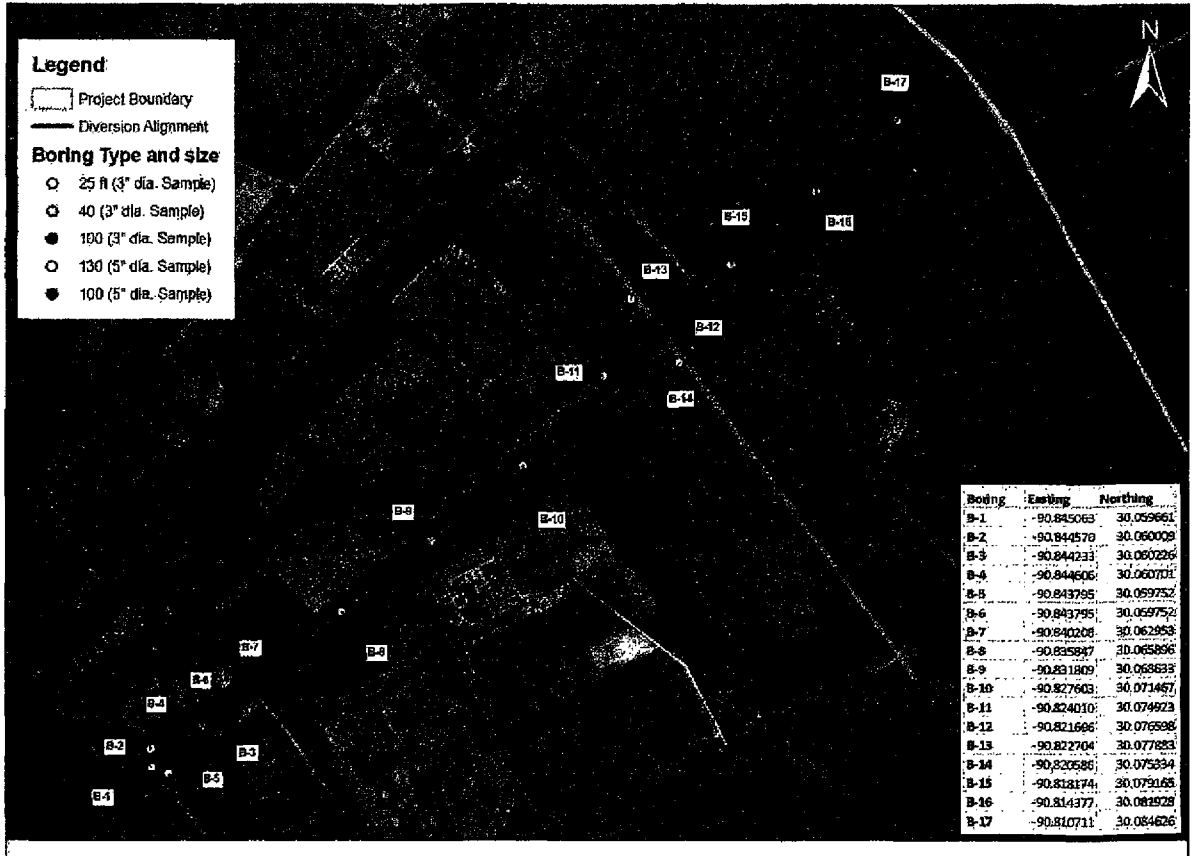
St James Parish lies on Alluvium and Natural Levees. Sediments underlying this region are of the Holocene Epoch, overlying Pleistocene formations. The Alluvium consists of gray to brownish gray clay and silty clay, reddish brown in the Red River Valley, with some sand and gravel. Natural Levees are gray and brown silt, and silty clay, with some very fine sand, reddish brown along the Red River. The natural levees lie near the Mississippi River, with point bars and backswamps further inland. In general, on the concave sides of the river are fine-grained natural levee deposits, undifferentiated deltaic plain swamp, and marsh materials. On the convex sides of the river bends are accretionary and point bar deposits. The alluvial deposits are fluvial sediments deposited by a rise in sea

level in this region between 4000 and 6000 years ago.

L5.4 Subsurface Investigations

Field Exploration

As mentioned earlier, the geotechnical field investigation consisted of drilling a total of 21 test borings and installing seven (7) piezometers. The test borings consisted of sixteen 3-inch diameter, and five 5-inch diameter borings. **Table 5.4-1** presents some information for the test borings.



Boring	Easting	Northing
B-1	-90.845063	30.059661
B-2	-90.844578	30.060029
B-3	-90.844233	30.060226
B-4	-90.844606	30.060701
B-5	-90.843795	30.059752
B-6	-90.843795	30.059752
B-7	-90.840208	30.062953
B-8	-90.835847	30.065896
B-9	-90.831809	30.068833
B-10	-90.827603	30.071467
B-11	-90.824010	30.074923
B-12	-90.821696	30.076598
B-13	-90.822704	30.077883
B-14	-90.820586	30.075834
B-15	-90.818174	30.079165
B-16	-90.814377	30.082928
B-17	-90.810711	30.084626

CDM

Figure L.5.2-1 Boring Location Plan Romeville Diversion – Blind River Fresh Water Diversion

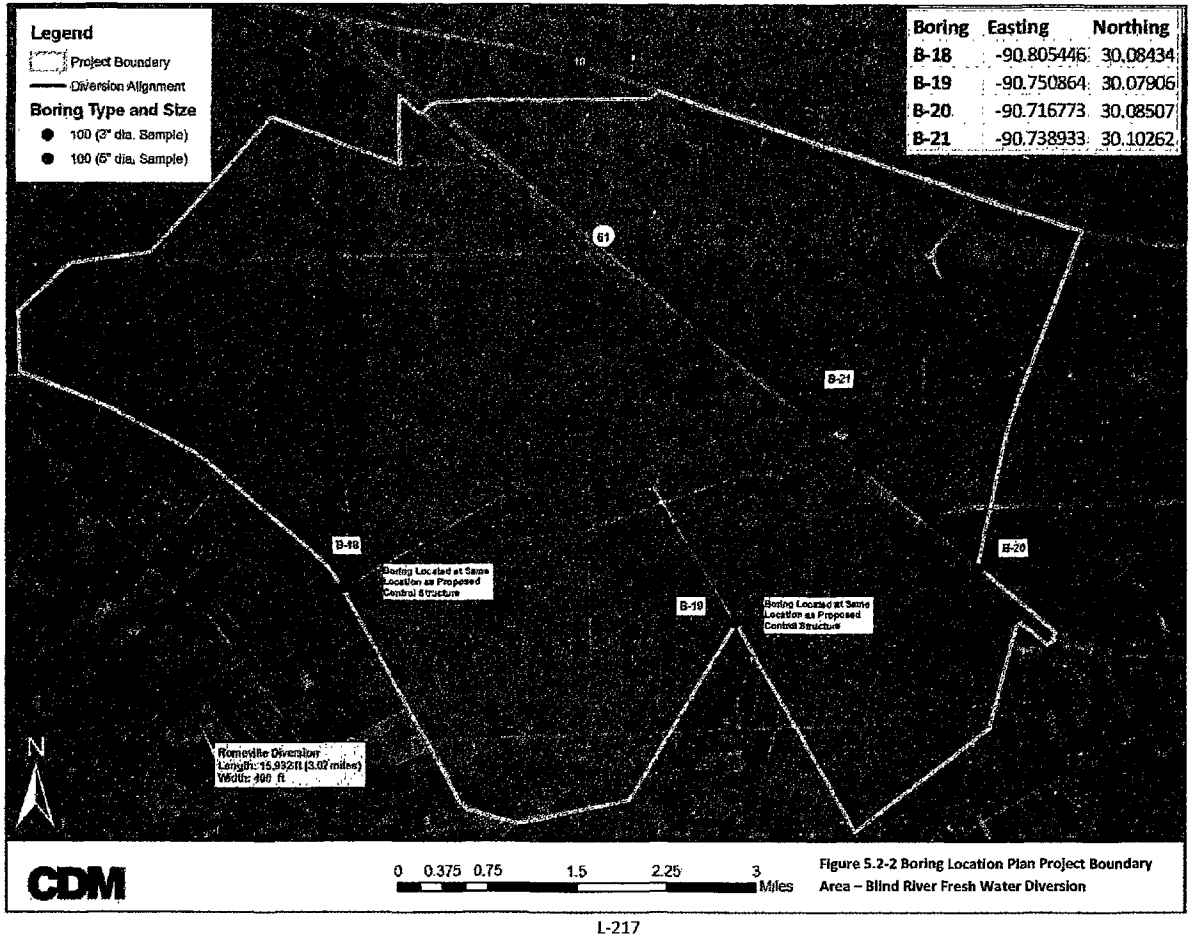


Figure 5.2-2 Boring Location Plan Project Boundary Area – Blind River Fresh Water Diversion

Borings B-7 through B-14 and B-18 through B-21 have been completed, with the samples at the laboratory testing stage. Borings B-1 through B-6, which are close to the Mississippi River levee, will be drilled once the Pontchartrain Levee District approves the drilling permit application. Borings B-15 through B-17 will be drilled upon permit approval by the Louisiana Office of Coastal Restoration and Management. The completed borings were drilled and sampled between January 18 and March 5, 2010.

Before drilling, the borings were located and staked in the field using a handheld GPS device. The boring locations are shown on Figures L5.2-1 and L5.2-2.

Table 5.4-1. Test Borings Information

Boring	Boring Depth (ft)	Boring Diameter (in.)	GPS Coordinates		Groundwater Depth (ft)
			Easting	Northing	
B1	100	5	-90.84506	30.05966	
B2	130	5	-90.84457	30.06000	
B3	100	5	-90.84423	30.06023	
B4	25	3	-90.84461	30.06070	
B5	25	3	-90.84380	30.05975	
B6	40	3	-90.84380	30.05975	
B7	100	3	-90.84021	30.06295	0.5
B8	40	3	-90.83585	30.06590	0.2
B9	40	3	-90.83181	30.06863	0.3
B10	40	3	-90.82760	30.07147	0.3
B11	40	3	-90.82401	30.07492	1.5
B12	100	3	-90.82170	30.07660	Not Recorded
B13	25	3	-90.82270	30.07788	1.0
B14	25	3	-90.82059	30.07533	3.0
B15	40	3	-90.81817	30.07917	
B16	40	3	-90.81438	30.08193	
B17	40	3	-90.81071	30.08463	
B18*	100	5	-90.80545	30.08434	3**
B19*	100	5	-90.75086	30.07906	8**
B20	100	3	-90.71677	30.08507	
B21	100	3	-90.73893	30.10262	

*Drilled in Blind River

**Depth to mudline

The borings were drilled using a track-mounted drilling rig, except borings B-18 and B-19 in the Blind River, which were drilled with a pontoon-mounted drilling rig. Each boring was sampled with the solid stem auger technique until groundwater was first encountered and recorded; the wet rotary sampling technique was used thereafter.

Split spoon samples, typically taken in cohesionless soils, and Shelby tube samples, typically taken in cohesive soils, were collected continuously to a depth of 10 feet below existing ground surface, and then at 5-foot intervals thereafter until boring termination. Shelby tube sampling was conducted in general accordance with ASTM D 1587, Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes. The Shelby tubes were extruded on-site for visual classification and storage. Split-spoon sampling was conducted in general accordance with ASTM D 1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. For the 24-inch split-spoon sampler used, the sampler was driven 18 inches into the ground at 6-inch increments. The number of blows required to drive the sampler each 6-inch increment was recorded, and the Standard Penetration Resistance (N-value) was determined as the sum of the blows over the 2nd and 3rd increments. Representative soil samples were taken from each split-spoon or Shelby tube sample, stored in moisture proof containers, and securely transported to the laboratory for later review and geotechnical laboratory testing. The borings were backfilled with cement-bentonite slurry after final groundwater readings were recorded. Borings drilled in the Blind River were backfilled immediately after drilling.

Field logs were prepared by a CDM geotechnical engineer, who also observed the test borings in the field. Final boring logs will be prepared upon receiving test results back from the laboratory. Drilling and laboratory testing are being performed by Professional Service Industries, Inc. (PSI). Completed boring logs are provided **Annex L-3.**

L5.5 Laboratory Testing Program

The laboratory testing program for undisturbed and disturbed samples obtained from the borings consisted of the following:

- Moisture Content
- Atterberg Limits
- Unit Weight
- Sieve Analysis (percent passing #200)
- Unconfined Compression Test
- Triaxial Test (UU test- 3 point)

The preceding laboratory tests, conducted according to ASTM standards, will provide the necessary geotechnical parameters for design and construction purposes. Available laboratory test results are shown on the completed boring logs in Annex L-3.

L5.6 Subsurface Conditions

Final boring logs from completed sample testing indicate that subsurface soils are mostly brown and gray stiff clay with occasional loose silt and fine sand lenses and layers. The silt and sand layers were usually encountered between 30 and 50 feet below ground surface.

Some soft clay was encountered in some of the borings, usually between 0 and 25 feet below ground surface. In boring B-18, the soft clay extended to 65 feet, and in B-21 soft clay was encountered at 73 to 78 feet.

In most of the borings, soil color changed to red-brown between 25 and 50 feet.

L5.7 Groundwater

Final groundwater levels were usually measured 24 hours after drilling. Groundwater generally varied between 0.2 and 3 feet below ground surface.

L5.8 Variation in Subsurface Conditions

The interpretation of general soil conditions is based on soil and groundwater conditions observed at the test boring locations. However, subsurface conditions may vary at locations other than the subsurface exploration locations.

Groundwater levels are expected to fluctuate with season, temperature, river stage, and other factors.

L5.9 Closure

This geotechnical field investigation report has been prepared for the proposed Blind River Freshwater Diversion canal in St. James Parish, Louisiana. This report presented geotechnical field investigations, including available results of laboratory testing on selected soil samples. The methods and procedures used in this report are in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

A final geotechnical report including recommendations for slope stability, foundation support for various diversion structures and other relevant design requirements for the proposed diversion project will be issued once the final alignment, depth, hydraulic modeling and other design features have been completed.

L6 ENVIRONMENTAL ENGINEERING

L6.1 Incorporation of Environmental Compliance Measures into Project Design

Environmental compliance measures are an integral component of all planning, construction and operation & maintenance activities associated with this project. These measures have been developed in full coordination with involved Federal and state agencies and made part of the public review process as required by regulations. The documentation and details of all environmental compliance is reported in the Integrated Feasibility Report. Environmental compliance measures are related solely to the timing and methods used for dredged material disposal during both project construction and project maintenance. The plan for dredged material disposal is contained in the project EIS. The EIS will be referred to during the Preconstruction Engineering and Design (PED) phases of this project. Additionally, a detailed description of the long-term dredge disposal plan will be included in the project OMRR&R Manual.

L6.2 Incorporation of Environmental Sensitivity

Environmental sensitivity has been incorporated into all aspects of project design, construction, and operation & maintenance activities associated with this project. The beneficial use of dredged material incorporates the recommendations of Federal and state resource agencies to the maximum extent practicable. This also includes their recommendations on the avoidance and minimization of adverse impacts which may occur during construction and operations & maintenance activities. Construction methods that will enhance environmental features to the maximum extent practicable will be incorporated into the designs of the various features of this Project.

L7 CIVIL DESIGN

This section presents the preliminary civil design for the components making up the Convent/Blind River Small Diversion project. Since the project is primarily civil works, this section also discusses the coordination needs for other design and engineering disciplines, as these typically have direct impacts on the civil design. These include hydraulics, transportation, geotechnical, mechanical, structural, electrical, and instrumentation.

The purpose of the Blind River diversion project is to divert fresh water into the Maurepas Swamp to freshen the Swamp, provide nutrients and sediment to enhance growth, and counter potential backflow of water from Lake Maurepas containing elevated levels of salinity. The hydraulic and the hydro-dynamic analyses identified means to divert the fresh water from the Mississippi River, deliver it to the Swamp, and distribute it within the Swamp to accomplish the environmental goals. The hydro-dynamic analysis also identified specific actions necessary to improve the distribution and circulation of the water into and within the Swamp. These included opening large gaps in the existing spoil banks along

the existing drainage channels and adding cross culverts at the KCS RR and Hwy 61 corridor to improve drainage and circulation between the hydrologic units in that area. The environmental and hydro-dynamic analyses identified 3,000 cfs as the appropriate design flow rate for the project.

The system components for the Romeville diversion were designed to address the hydro-dynamic and environmental concerns identified in the analyses, and to meet the project's environmental goals. The Romeville diversion alignment has six major components: a diversion culvert facility, a transmission canal, approximately six control structures of various sizes, approximately 30 berm gaps, cross culverts at four locations along the Highway 61 corridor, and instrumentation. The major project components are primarily hydraulic conveyance and hydraulic control structures designed to divert fresh water from the Mississippi River, transfer it to the Maurepas Swamp, and distribute and direct the diverted water into and through the Swamp. The preliminary hydraulic design is documented in Section L2.

L7.1 Diversion Culvert Facility

L7.1.1 Description – Diversion Culvert

The diversion culvert facility will divert fresh water from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal. The primary hydraulic elements of the diversion culvert facility are as follows:

- 3 – 10' x 10' multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44;
- 3 – 10'x10' Sluice gates with motor operators on the culvert inlets to control the diversion flow rate and, when required, to completely block the flow;
- Trash racks near the culvert inlet to keep large debris out of the diversion system; and
- Inlet canal across the batture from the Mississippi River to the culvert inlet.

LA 44 (River Road) is adjacent to the levee and the box culvert will be extended under the road and discharge into the transmission canal 100 feet east of the road. Erosion protection will be provided at locations with relatively high flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance and exit.

Ancillary elements at the diversion culvert facility include a gate, a cut-off wall in the levee for seepage control, and two sets of stop logs. The diversion site will include an access driveway, a site road for access to the top of the levee, fence (6' chain link fence with 3-strand barbed wire), drainage, lighting, a security system, and a control building. The major temporary construction facilities will include a

temporary earthen levee, a cofferdam on the east bank of the Mississippi River, and a temporary detour road for LA 44.

L7.1.2 Civil Design – Diversion Culvert

The box culvert will be installed through/under the existing east levee of the Mississippi River by open-cut methods. The facility design is focused on engineering and design, construction techniques, temporary construction facilities, and sequencing to maintain the flood protection integrity of the east levee to current levels.

The elements of the diversion facility were designed on the following basis:

- Temporary earthen levee – A temporary earthen levee will be constructed on the batture, on the river side of the existing levee, to allow open-cut construction of the box culverts through the levee. The temporary levee will have riprap lining on the river side to protect the more exposed levee from erosion during floods stages in the river. The temporary levee will be designed to the standards of the existing levee to maintain the full flood protection integrity of the existing levee system. The temporary levee may be in place for approximately two years.
- Cofferdam – A cofferdam will be installed on the east bank of the Mississippi River to make the tie-in of the inlet canal into the Mississippi River, including placing riprap on the river bank. The initial concept extended the cofferdam down to Elev. -10 on the river bank. The cofferdam protects only access to the final tie-in to the river, and will not be part of the overall levee flood protection system. Therefore, the top of the cofferdam will not protect from the higher Mississippi River flood elevations, but will match the batture, near Elev. 24.
- Erosion protection – Erosion protection consisting of riprap and concrete channel lining will be installed at areas with potential for destructive erosion, such as high velocities or turbulence. The upstream end of the inlet canal and the entrance and exit at the box culvert will also have erosion protection.
- Romeville revetment – the inlet canal will penetrate the Romeville revetment. Large riprap will be extended into the inlet canal to maintain the existing revetment erosion protection system.
- Inlet canal – The intake for diversion facility will need to cross the 200 to 300-foot-wide batture from the Mississippi River bank to the levee. Based on a cost comparison, an inlet canal will be less expensive than extending the box culverts across the batture. See the transmission canal for discussion of inlet canal design.
- Cut-off wall – A steel sheet pile cut-off wall will be incorporated into the box culvert and a gate tower wall to maintain levee stability and to reduce the

potential for seepage and piping (loss of fines) through the reconstructed levee and along the box culvert backfill.

- Box culverts – The box culverts will be large reinforced concrete structures designed to support the levee overburden. The culverts are designed as cast-in-place monolithic structures supported on a pre-cast concrete pile foundation.
- Sluice gates –Sluice gates with motor operators will be installed on the upstream end of the box. The sluice gate position is designed to have a positive seating head during Mississippi River flood stages.
- Stop logs – Stop logs will be provided on both sides of the sluice gates to fully isolate the sluice gates for maintenance. The upstream stop logs will be placed at the gate tower and will block the Mississippi River. In the event a sluice gate is out of service, the upstream stop logs will also provide redundant capabilities to fully block flow through the culverts during flood stages in the Mississippi River. The downstream stop logs will block backflow from the transmission canal. Both sets of stop logs will be positioned to have a positive seating heads.
- Trash racks – Trash racks with a coarse grid size will be place near the culvert inlet to reduce the potential for large debris from passing through the installation. At this point in the design, fine screens are not considered necessary to reduce the potential for fish passage.
- Gate tower – The sluice gates and one set of stop logs are on the inside, or river side, of the levee. A gate tower will be constructed over the box culverts to elevate the motor operators and provide access to the top of the levee, well above the Mississippi River flood stage
- Site facilities – The site facilities will be designed during the final design phase.

L7.1.3 Geotechnical Coordination

The following items will require geotechnical input for the design and layouts:

- Temporary earthen levee – Foundation preparation, material specifications, slope, placement and compaction, settlement potential, seepage control measures, tie-in to the existing levee, use of material from the transmission canal excavation.
- Cofferdam – Horizontal loadings, sheet pile length, sheet pile embedment, pile section.
- Riprap – Bedding or geotextile requirements.
- Dewatering – Existing groundwater conditions (batture, levee, and LA 44), dewatering methods.

- Cut-off wall at the levee – Location in relation to levee, width along levee, depth, seepage potential, cut-off wall material (i.e. – steel sheet piling), loading, pile section, length; other potential seepage control measures.
- Box culvert foundation – Foundation requirements, such as concrete piles (loading, size, length, loading/bearing capacity)
- Box culvert design – Vertical loading on box culvert at the levee and at LA 44, horizontal loading, bedding and backfill.
- Temporary shoring – Temporary shoring design for open-cut excavations.
- Headwall and retaining wall designs – Loads, backfill material specification
- Permanent levee reconstruction – Material specifications, verify removed material is suitable, placement and compaction, settlement potential, seepage control measures, tie-in to existing levee.
- LA 44 road crossing – Subgrade, base, and pavement recommendations for the detour, and for the reconstructed road.
- Control building – Foundation recommendations.
- Inlet canal – See the transmission canal paragraph.

L7.2 Transmission Canal

L7.2.1 Description – Transmission Canal

The transmission canal will transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the Swamp. The primary hydraulic elements of the transmission canal are as follows:

- Earthen trapezoidal channel Canadian National Railroad (CN RR) crossing; and
- LA 3125 crossing.

Other site improvements for the transmission canal include fences at each right-of-way line, access driveways, access roads on the berms, drainage, and vegetation cover. Site lighting and security cameras are not planned for the transmission canal. The only major temporary construction facilities are cofferdams.

L7.2.2 Civil Design – Transmission Canal

The civil design basis for the transmission canal elements is as follows:

- Earthen canal – The canal will be an earthen trapezoidal channel section, with a 155-foot-wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2-foot freeboard. The top width will be approximately 250 feet.
- Canal Side Slopes – The transmission canal is currently designed conservatively for 4:1 (H:V) side slopes. Steeper side slopes would be desirable

to increase the conveyance effectiveness of the section, and to reduce the canal width. The geotechnical report will provide the final value.

- Embankments/Berms – Embankments or berms will be constructed on both sides of the canal. The berms have a top width of 12 feet, for use as access for maintenance and operations. The exterior side slope will have a 4:1 or 5:1 (H:V) side slope to allow safe access by mowing equipment. These slopes will be determined during future geotechnical analyses.
- Freeboard – The diversion flow rate through the diversion structure is expected to vary due to changing stages in the Mississippi River, and changing sluice gate settings. Therefore, the transmission canal was designed for a 25% higher flow rate. Provide a freeboard of 2 feet above the design water surface elevation at the canal design flow rate.
- Right-of-Way Width – A minimum right-of-way width was estimated to allow space for the channel, the berms, drainage along the edge of the right-of-way, and fences. The space from the toe of the berm to the fence line is recommended to be 10 feet to provide for drainage and allow mower access. Without berms, provide a minimum of 30 feet each side for large maintenance equipment and drainage ditches. The actual right-of-way is anticipated to be wider than the minimum required, as the available tract is 400 feet wide.
- LA 3125 Road Crossing – Reinforced concrete box culverts will be used for the LA 3125 road crossing. The culvert will extend across the full right-of-way width. During final design, it will be investigated if a bridge is more cost effective.
- CN RR Crossing – Reinforced concrete box culverts will be used for the CN RR crossing. The culvert will extend across the full right-of-way width. During final design, it will be investigated if a bridge is more cost effective.
- Erosion Protection – Riprap and concrete channel lining will be installed at both sides of the culvert crossings. Riprap will be installed at the outfall into the existing drainage channel.
- Cofferdam – A cofferdam will be installed in the existing Parish drainage channel at the downstream (east) end of the transmission canal. This will allow excavation of the final segment of the canal at the drainage channel, which is nearly full with standing water.

L7.2.3 Geotechnical Coordination

The geotechnical investigation will address the following transmission canal design items:

- Channel side slopes – The preliminary hydraulic design is based on 4:1 side slopes. The geotechnical investigation will provide a slope recommendation based on long-term stability and on rapid drawdown conditions.

- Canal berms/embankments – Material, placement, and compaction requirements for the fill sections to create the berms.
- Liner - The HGL will be above natural ground. Determine if there will be a seepage concern through the berm and natural ground, and if a liner, such as clay, would be required to control seepage losses or if seepage-control drains are needed for stability.
- Excavated material suitability – Evaluate the properties of material to be excavated for the canal, and determine if it can be used for the berms and for the temporary earthen levee at the Mississippi River. The analysis will also indicate other beneficial uses for disposal of excess material on-site or off-site.
- Groundwater conditions and dewatering – Define existing groundwater conditions and expected conditions after construction. Also define dewatering methods for construction.
- Erosion protection – The canal will have relatively low velocities; however, the geotechnical investigation will need to identify soil layers that may be vulnerable to erosion, and if erosion protection is required.
- Culverts at railroad – Foundation, bedding, and backfill, temporary shoring, and loading recommendations for the box culverts and associated retaining walls and wingwalls.
- Culverts at road - foundation, bedding, and backfill, temporary shoring, and loading recommendations for the box culverts and associated retaining walls and wingwalls.
- Cofferdam – cofferdam design parameters for a cofferdam at the downstream of the channel, including loadings, sheet pile section, length, embedded length

L7.3 Control Structures

L7.3.1 Description – Control Structures

The project will use the existing drainage channels at the perimeter of the Swamp to distribute the diverted flow throughout and into the Swamp. The hydraulic grade line, or water surface elevation, will need to be raised above the existing levels and controlled to force the diverted water out of the drainage channels into the Swamp. Control structures with control gates will be installed at key locations in the existing channels to perform this function.

The proposed control gate is a specialty gate that rotates on a shaft at the bottom of the channel and is operated by large hydraulic cylinders. The gate will be rotated up to the vertical position to increase the water surface elevation during the flow diversion. The gate will be rotated down to the channel bottom into the open position when there is no diversion, to allow for normal drainage, and to allow the passage of boats and barges. The control gates will be installed in large concrete structures constructed in the existing drainage channel.

Instrumentation, controls, a hydraulic power unit, and a generator will be located in a precast concrete building at each control structure site.

L7.3.2 Civil Design – Control Structures

The control structure designs are based on establishing and maintaining a set water surface elevation to force flow through the proposed berm gaps into the Swamp and to allow flow over the control gate to downstream segments of the project. The control gates require power for the hydraulic power unit to operate the large gates.

The control structures are located in the Swamp, where the existing natural ground is approximately Elev. 2 and the static water surface is Elev. 1.5 to 2.0. The proposed operating water surface is approximately Elev. 4.0. The civil design items are:

- Control Gate – The control gates are designed to fully block flow in the existing channel and raise the upstream water surface to Elev. 4.0. The gates are not designed based on flow rate. However, the gate position will be based on allowing water flow over the gate.
- Control Structure - The size of the control structures will vary at each location, and are based on the width and depth of the existing drainage channels. The top of the side walls will be at Elev. 5.0, 1 foot above the operating water surface elevation.
- Berms/embankments – The existing berms typically have a top at Elev. 4 to 6. A berm will be extended from the control structure to the existing berm to prevent the diverted water from by-passing the control structure.
- Control Building – The HPU, controls, and generator will be housed in a pre-cast concrete building, which will be elevated above flood levels on concrete columns or piles. The existing 100-year flood level is approximately Elev. 5.0, and the finished floor will be placed at Elev. 7.0 so that the bottom is a minimum of 1 foot above the 100-year elevation.
- Power – The installations are in remote areas, and a generator will be required for power.
- Hydraulic Power Unit – A hydraulic power unit will be required to operate the large control gate hydraulic cylinders. Large gate installations may require cylinders on each side. If routing hydraulic lines through the concrete structure is not feasible, it may be necessary to have HPU's on each side of the channel, and an additional protective pre-cast concrete building.
- Site improvements – 6' chain link fence with 3-strand barbed wire, video camera. As the site is isolated in the Swamp, there are no drainage or access provisions.

L7.3.3 Geotechnical Coordination

Geotechnical recommendations will be for:

- Cofferdam – horizontal loadings, sheet pile length, sheet pile embedment, pile section.
- Foundation preparation – require removal of silt and unsuitable material in channel.
- Foundation requirements – Concrete piles – loads, size, length, loading/bearing capacity.
- Groundwater conditions and dewatering recommendations.
- Retaining wall designs – Loads, backfill material specification
- Foundation for pre-cast building – pre-cast concrete piles vs. drilled shaft piers, load, size, length, loading/bearing capacity.

L7.4 Berm Gaps

L7.4.1 Description – Berm Gaps

When the existing drainage channels were excavated in the Swamp, the excavated material was cast to one side of the channel forming spoil banks. The size of the spoil banks vary, with the top elevations ranging from Elev. 4 to Elev. 12. From field observations and the hydro-dynamic modeling, it has been determined that the spoil banks currently block flow circulation into and out of the swamp, resulting in stagnant areas and poor circulation of water through the hydrologic units. In the current configuration, the spoil banks would continue to prevent the diverted water from easily entering and flowing through the Swamp. Therefore, new 500-foot-wide berm gaps will be excavated in the spoil banks at an approximate spacing of 2,500 feet on center.

L7.4.2 Civil Design – Berm Gaps

The gaps will be excavated to the elevation of the adjacent Swamp natural ground elevations and the spoil will be disposed behind the existing spoil banks. The spoil will be piled up to Elev. 6 to provide additional refuge areas for wildlife during flood events in the Swamp.

The proposed berm gaps were sized to have low velocities through the opening, and to reduce the chance of complete blockage by debris. The hydro-dynamic modeling confirmed that the berm gap size and spacing provided adequate capacity for distribution from the channels into the Swamp.

The gap elevations, design WSEL in the channel, and downstream HGL conditions will vary, resulting in different flow rates through each gap. However, assuming uniform conditions, the gaps will have the flow characteristics presented below for a 3,000 cfs diversion. Note that not all diverted flow will go

through the berm gaps. Also, the berm gaps are excavated to the elevation of the Swamp, and a weir is not created.

No. of gaps:	30
Length of gap:	500 feet
Floor of gap:	Elev. 2.0
Operating WSEL:	Elev. 4.0
Flow rate each gap:	100 cfs
Approx. area:	1,000 SF
Velocity:	0.1 fps

Construction will consist of moving approximately 3,000 CY of material at each gap. The fill will be placed in an unconsolidated, uncontrolled compaction disposal area.

L7.4.3 Geotechnical Coordination

The following input will be from the geotechnical investigation:

- Reinforce the soil to support construction equipment – (i.e., geotextiles)

L7.5 Cross Culverts at the Highway 61 Corridor

L7.5.1 Description – Cross Culverts

The hydrodynamic modeling of the Swamp project area indicated that the KCS RR and the Highway 61 embankments disrupted the natural flow and circulation of water through the Swamp. This resulted in hydrologic units east and west of the KCS RR/Hwy 61 corridor having stagnant water, poor drainage, and lack of sources of fresh water input. New culvert crossings will be added under the KCS RR and Hwy 61 at four locations to re-establish circulation. Each installation will consist of 3 – 3' x 4' reinforced concrete box culverts. Note that there may be sufficient cross drainage openings at the KCS RR and additional culverts may not be required. Earthen channels (large ditches) will be excavated across the 500-foot space between the KCS RR and Hwy 61 to interconnect the drainage capacity at the railroad with the new culverts at Hwy 61.

L7.5.2 Civil Design – Cross Culverts

Civil design for the cross culverts include:

- Culvert cross sectional area - The combined cross sectional area of the culverts is 144 SF. At 0.5 fps, a velocity indicated by the hydro-dynamic modeling, the flow rate is 72 cfs, or a daily volume of 150 ac-ft. If the total Swamp has an average depth of 6", the total volume is 11,200 ac-ft. The cross culverts will allow approximately 1.5% of the Swamp volume to circulate per day, or ½ of the total Swamp volume each month.

- Cross culverts – Reinforced concrete box culverts. The culverts at Highway 61 will likely have minimal cover under the pavement and will be ASTM C-850 precast units. Cast-in-place construction will also be allowed.
- Interconnecting drainage channel – A small drainage channel will be extended across the 500-foot wide corridor between the railroad and the highway. The flow line profile will be set to match existing drainage flow lines at the upstream and downstream ends. The channel section will have a 6-foot-wide flat bottom and 3:1 side slopes (to be confirmed by the geotechnical investigation).
- Erosion protection – The channel will have low velocities, and no erosion protection will be required. However, the channel will have 10-foot segments of riprap-lined channel at the culvert entrances and exits. The channels will not have embankments/berms, as the HGL will be at or near natural ground.
- Access roads – There will be 12-foot wide access roads on each side of the interconnecting drainage channel for maintenance access, and for access to the crossings at the railroad.

L7.5.3 Geotechnical Coordination

Geotechnical input will be required for the following items.

- Interconnecting channel – see transmission canal
- Box culvert design – Vertical loading on box culvert, horizontal loading, bedding and backfill.
- Temporary shoring for open-cut excavations
- Highway 61 road crossing – Subgrade, base, and pavement recommendations for the detour and for the reconstructed road.
- Groundwater conditions and dewatering recommendations

L7.6 Instrumentation

L7.6.1 Description - Instrumentation

Instrumentation will be required to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the Swamp. Design of the instrumentation has been coordinated with the civil design, the hydraulic design, and the operation scheme.

Typically, flow rates and water levels will be measured and the feedback data will be used to adjust gate positions to control the desired parameters at the diversion culvert and the control structures. The monitoring and control data will be collected, analyzed, and transmitted to and from a control building on the diversion culvert site. Following are the main instrumentation for data collection and control at each component:

- Diversion Culvert – The flow control at the diversion culvert will establish the flow rate for the project. The diversion flow rate will likely be set manually by an operator, with adjustments as necessary. The diversion culvert will have instrumentation for water levels at the culvert entrance and exit, for flow measurement, and for sluice gate positions. The control system at the diversion structure will be designed to automatically adjust the sluice gate openings as the Mississippi River stage varies to maintain a constant flow rate.
- Control Structures – The control gates at the control structures will require water level measurement on both sides of the gates, and gate position measurement, to control gate position, water levels, and flow rates over the gates. The control gates will likely have manually set positions, with occasional adjustments based on feedback from system monitoring.
- Transmission Canal – There will be no instrumentation in the transmission canal to control flow rates or water surface elevations. However, the transmission canal will have level monitors at several locations to ensure that the berms are not overtopped.
- Water level monitors will be required in the Blind River at Highway 61, at I-10, and possibly additional locations on Blind River and on the existing drainage channel network within the Swamp. These monitors will provide feedback for the flow rate control and control gate settings.
- The environmental monitoring and hydrological monitoring and data collection within the Swamp have not yet been defined in detail.
- Communications to remote sites will be via satellite, with dishes installed on top of the control buildings at the control structure sites.

There will be no flow or water level control at the following components:

- Berm Gaps – there will be no flow measurement, level measurement, or controls at the individual berm gaps. All water level control will be at the control structures.
- Cross Culverts at the Hwy 61 Corridor – there will be no flow measurement, level measurement, or controls at the four cross culvert locations.

The data collected from the project will be used as input for adaptive management.

Real-time data are required from the system components to allow the operator to control and adjust the system flow rates.

Initial designs considered communications via radio towers at each control structure and in the Highway 61 corridor to communicate to the central control building via a radio tower at the diversion facility. The towers would be 150 to 200 feet tall to have clear line-of-sight communications above the mature Bald Cypress trees. The satellite system was selected as a more cost effective alternative, and to reduce the visual impacts to the natural setting in the Swamp.

L7.6.2 Civil Design – Instrumentation

None.

L7.6.3 Geotechnical Coordination

None.

L8 STRUCTURAL DESIGN

8.1 Codes and Standards

8.1.1 Governing Code.

The governing code for the project will be as follows. In no case will the strength, serviceability, or quality standards for materials and procedures be less than that required by the governing code.

- 2006 International Building Code

Where the provisions contained or referenced herein differ from those in the governing code, design will be performed in accordance with the most stringent.

8.1.2 Supplemental Codes and Standards.

The following codes and standards will be used for design when and as specifically referenced herein.

- USACE Engineering Manual 1110-2-1913 Design and Construction of Levees.
- National Flood Insurance Program - NFIP Regulations.
- American Concrete Institute - ACI 318

- American Concrete Institute - ACI 350R with recommendations
- American Association of State Highway and Transportation Officials - AASHTO Bridge Specification
- American Welding Society - AWS D1.4

8.2 Design Loads and Serviceability

8.2.1 Scope

All applicable loads and load combinations will be determined as required by the governing code, occupancy, site and environmental effects, equipment and processes. Appropriate load combinations will be established and as well as appropriate allowable stresses, load factors and safety factors (as applicable). These criteria will be established at the beginning of preliminary design and confirmed at the beginning of final design.

8.2.2 Dead Loads

Dead loads are those resulting from the weight of all fixed construction such as walls, partitions, floors, roofs, cladding, equipment bases and all permanent, nonremovable, stationary furnishings.

Numerical values for the dead load of well-defined components of a structure will be used as documented in the following publications:

- ASCE 7
- AISC Manual
- CRSI Handbook
- Manufacturer's catalogs for fabricated components

8.2.3 Live Loads

Live loads will consist of all loads due to occupancy, furnishings and equipment. Live load reduction will not be employed for members of large influence area in the design of environmental and industrial facilities, due to the relatively high probability of simultaneous loads on all areas. Live load reduction may be employed in general buildings that are not part of environmental or industrial facilities, with approval.

8.2.3.1 Uniform Live Loads

Uniform live loads will be established in accordance with the governing code. Values are listed below for purposes of preliminary design. Actual usage and equipment will be considered during final design and higher loadings used when appropriate.

Process Structures

▪ Roadways and slabs designated	AASHTO load or for vehicle traffic design vehicle
▪ Slabs on grade	300 psf

8.2.3.2 Equipment Loads

Loads from equipment will be considered live loads. The maximum loads and support details for each major piece of equipment will be provided by the discipline designing or specifying it. Final weights of process-mechanical equipment and gates will be established during preliminary design.

In addition to the mechanism's static dead load, design will be performed for other effects, such as those due to operation, maintenance and malfunction. Examples include, but are not limited to, the following.

- Sluice gates, non-self-contained: Design will be performed for a load equal to the breaking strength of the operating stem, or the stalling torque of the motorized operator, in the event the gate is frozen.
- All equipment: Design will be performed for required maintenance procedures, such as the removal of a large component and the placing of it temporarily on the adjacent structure.

8.2.3.3 Impact Loads

Static loads will be increased for the effects of impact by the following percentages.

- Vehicular loads: In accordance with the AASHTO Specification

8.2.3.4 Construction Live Loads

The contractor is normally responsible for maintaining loads on partially or fully complete structures at or below the design live loads noted on the drawings, or for providing supplemental support. However, in certain cases, if the service load on a structural element is negligible, a design load will be used which would accommodate reasonable construction activities.

When it is necessary to provide particular restrictions on construction sequencing, special loads conditions may result. This is particularly applicable to work involving the modification of existing structures. These cases will be evaluated and appropriate criteria established during final design. Such restrictions will be indicated in the drawings or specifications.

8.2.4 Environmental Loads

8.2.4.1 Wind Loads

Wind loads will be developed from the following criteria in accordance with the governing codes. Appropriate shape modification factors, uneven distributions, and orthogonal effects will be considered for each structure. Increased allowable stresses or reduced load factors will be used, as appropriate. Concrete mass foundations and/or guy-wire anchors will be used to resist wind loads on tower foundations.

8.2.4.2 Seismic Loads

Seismic loads will be developed from the following criteria in accordance with the governing codes. Increased allowable stresses or reduced load factors will be used, as appropriate.

8.2.5 Process Liquid Loads

Design will be performed for liquid loads assuming liquid surface at the maximum working level using normal allowable stresses, or the load factor for a live load, as appropriate. In addition, design will be performed assuming the liquid surface at the maximum possible level under surcharge conditions using an increase in allowable stresses, or the load factor for a dead load, as appropriate.

8.2.6 External Earth and Groundwater Loads and Freeboard

Earth and water loads will be developed in accordance with the project geotechnical report when complete and the governing codes. A minimum freeboard as required in coastal levees as required by NFIP Regulations but not less than 3.0 feet above the Base Flood Elevation (BFE) all along length, and an additional 0.5 foot at the upstream end of a levee.

Design will be performed for pressures generated by groundwater acting laterally, downward and upward, as appropriate. Loads factors appropriate for live loads will be used. Design will be performed for groundwater at the normal elevation for normal allowable stresses or load factors, as appropriate. Design will be performed for groundwater at the following flood elevation for increased allowable stresses or reduced load factors, as appropriate.

Lateral Soil and Groundwater Pressures

Hydrostatic

The following equivalent fluid pressures will be used in preliminary design for well-graded, granular, mineral soils with an estimated moist unit weight of 120 pcf. Soil pressures for final design will be developed in accordance with the geotechnical report. Design for cantilevered walls of environmental engineering structures will be performed for at-rest soil pressures.

Surcharge
Walls and structures to which vehicles can reasonably be expected to approach within a distance equal to half the wall height will be designed for a uniform surcharge equal to 2 feet of soil.

8.2.7 Combination of Loads

8.2.7.1 General

Design will be performed for combinations of loads, along with appropriate load factors or allowable stresses, in accordance with the governing code. In the absence of specific direction by the code, the most severe distribution, concentration and combination of design loads and forces will be used. These combinations may be limited by practical considerations, such as the following:

- Combination of certain loads will not be considered when the probability of their simultaneous occurrence is negligible. Such loads include wind and seismic on superstructures; and seismic, live load surcharge, and flood on substructures.
- An increase in allowable stress of 33 percent, or a reduced load factor of 0.75, will be applied to the entire load combination where such is permitted for any of the loads considered in the combination.
- The effects of any load type (other than dead load) will not be used to reduce the effects of another load type. A maximum of 90 percent of the dead load will be used in any combination where it reduces the effects of another load type.

8.2.7.2 Below Grade Structures including Box Culverts

Design will be performed for structures that contain liquids, extend below grade, or both, for the following load combinations.

- Liquid-containing compartments full, no backfill for liquid containing compartments. No reduction will be made for any counteracting soil pressure on the face remote from a contained liquid unless approved.
- Backfill and groundwater with liquid-containing compartments empty and full.
- Liquid containing compartments empty or full in any combination.

8.2.8 Serviceability

Additional requirements for serviceability will be considered as provided in subsequent sections and referenced standards for specific materials.

8.3 Foundation Design

8.3.1 Scope

Criteria will be established for the design of structure foundations in coordination with the geotechnical recommendations. Permanent structure foundation elements will be designed to distribute loads to the supporting soil, rock, or piling in accordance with their allowable loads, and to accommodate predicted deformations of the structure caused by settlement or movement of the supporting elements. Piling elements (piles and caissons) will be designed as structural elements to the accommodate stresses generated by the design loads. The design of the transmission of loads from the pilings to the supporting soil or rock will be performed by the geotechnical discipline. Structure foundation elements will be designed to resist effects of groundwater, including buoyancy.

8.3.2 Shallow Foundation Support

Design of shallow foundation elements (footings and mats), including excavation and backfill limits and details, will be performed in accordance with the recommendations of the geotechnical report.

To the extent possible, buried piping and ductbanks will be maintained outside the influence zone of the foundation elements. Limits of this zone will be established based on bearing materials' characteristics as documented in the geotechnical report. At a minimum, this zone will be defined by a line extended outward and downward from the bottom corners of a foundation element at a 1 vertical to 1 horizontal slope. A reinforced concrete encasement or other appropriate protection will be provided for any utilities extending into this zone.

8.3.3 Deep Foundation Support

Piling will be design in accordance with the recommendations of the final geotechnical report. Where a transition is required from pile supported to soil supported elements of a structure, design will be performed to accommodate the predicted deformation from such a transition.

Lateral loads to the structures will be resisted by the piling elements, the surrounding elements, or both. Where appropriate, the strain compatibility of the elements will be considered to determine the distribution of the lateral reactions.

8.3.4 Buoyancy

8.3.4.1 General Criteria

Buoyancy is defined as the condition of instability resulting when uplift forces due to groundwater exceed resisting forces due to dead load and anchorage systems. Design will be performed in accordance with the following.

Complete Structures
For groundwater at the design level, structures will be designed to resist buoyancy considering only the structure dead load, soil directly above the structure and footing extensions. The effects of live loads, liquid contents, vertical soil friction and soil cohesion will be neglected. When anchorage systems are used, they will be designed to resist the net uplift force transmitted to the components of the anchorage.

Partially Complete Structures
Since the contractor will normally be required to maintain a dewatered excavation, it will be considered that groundwater will be maintained, at any given time, at or below the surface of the backfill currently in place. If the completed portion of the structure has insufficient resistance against pressures generated in this condition, the groundwater elevations at which the structure is stable will be provided in the contract documents.

Anchorage Systems
Where appropriate geotechnical conditions exist, rock anchors or tension piles may be used to resist buoyancy. Design these elements will be performed considering recommendations from the geotechnical engineer.

L9 ELECTRICAL POWER SYSTEM DISTRIBUTION

L9.1 Codes, Standards and References

The Blind River Fresh Water Diversion Project electrical design concept will comply with all federal, state and local laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society Lighting Handbook
IPCEA	Insulated Power Cable Engineers Association
NFPA	Life Safety Code
NFPA 70	National Electrical Code
NFPA 70E	Electrical Safety in the Workplace
NEMA	National Electrical Manufacturers Association
UL	Underwriters Laboratories

L9.2 General Power Distribution

To the greatest extent possible and practicable, power for the new control structures, sluice gates, diversion structures and monitoring systems will be provided with permanent power utility service drops from Entergy. In remote locations where utility service drops are not available, standalone power will be needed.

Based on preliminary load information single phase power will be adequate for most control equipment locations for the project; however, preliminary load calculations indicate that power for the six control structures and Romeville diversion structure will require 3 phase electrical services. Typical three phase service voltages are rated 120/208 , 3 phase or 277/480 volt, 3 phase depending on the maximum power demand and control structure equipment motor sizes. For this project, new three phase power utility service drops will be provided at the control structures where reasonable access to permanent local power utility service can be obtained. At critical control structure and diversion structure locations where a normal utility service drop is provided, standby back-up emergency power will also be provided to provide power in the event there is loss of the normal utility feed.

For control structures located in remote locations where local power utility service is not available, standalone power systems will be provided. Depending on the location and requirements for power at the remote sites, stationary or portable generators will be utilized.

L9.3 Utility Power Services

New electrical services from Entergy will be provided at Romeville diversion structure and control structures No. 3-2 and 1-7. Based on preliminary load information the Romeville Diversion structure will be served at 120/208 volts, 3 phase, 4 wire from new Entergy Louisiana transformers. Service at control structure No. 3-2 and 1-7 will be obtained at 277/480 volts, 3 phase from Entergy. The electrical power system will employ single ended simple radial type distribution at all location. Based on preliminary load information, a 100 amp main service circuit breaker and transfer switches will be provided. Switchboards utilizing group mounted bolt-on circuit breakers will distribute the incoming power to the diversion and control structure equipment including the sluice gates, sump pumps, control gates and control systems. The power distribution equipment will be located an equipment building adjacent to the structure.

A diesel engine driven generator will be provided for standby emergency back-up power. The generators will be sized for all diversion and control structure operation and life safety loads including, lighting, ventilation, controls and required safety equipment. Generator controls will be provided to allow

automatic transfer to generator power when normal power is interrupted. Based on preliminary load data, the generator for the diversion structures will be sized at 25 kW. Back-up generators for the control structures will be sized at 60kW.

The generator will operate at 1800 rpm and provide back-up system power at 480 or 208 volts. Open transition will be utilized and the generator will not synchronize with the utility. A weather protected enclosure with sub-base mounted fuel tank will be provided.

L9.4 Standalone Power Services

At control structure No. 1-6A, 1-6B, 1-8A and 1-8B, standalone diesel (or LP gas) engine driven generators are proposed for gate hydraulic motor power, lighting, security systems, monitoring instruments and controls. In addition, solar photo voltaic (PV) panels would be installed at these remote sites to provide power during times when control structure gates are not being operated and generator power is not needed. Power from the PV panels would be stored in battery racks to power security systems, monitoring instruments and SCADA system equipment at these locations when power from the generator is not available. Generator controls will be provided to allow manual or automatic starting of the generator when needed to control the position of the control structure gate system. For control structure 1-6A and 1-6B, a single generator and power distribution system sized to power both control structures will likely be used. The standalone power generator and control building housing for the power distribution equipment would be located on the north side of the canals to simplify cable routing and access to the control structure equipment. A similar concept would be employed for control structure 1-8A and 1-8B. The proposed location for the standalone power generator and control building at 1-8A and 1-8B is housing location for 1-building at Based on preliminary load data, the generator would be sized at 100kW.

Operation at remote locations would be as follows:

When called to run by the SCADA system or control structure PLC, the generator would start and operate at 1800 rpm and provide system power at 277/480 or 120/208 volts. Generator system power would be stepped down as needed to 120 volt levels for powering lights, instruments, battery chargers and other miscellaneous equipment at the control structure location. When operating, the generator would feed power through a transfer switch that would transfer power to the control structure electrical distribution system when the generator has reached proper operating speed. All power requirements at the control structure would be met with the use of the generator system including charging systems for the PV panels. During times of inclement weather or cloudy days when available solar power is not sufficient to power the SCADA and instrument monitoring systems, the generator can be operated as a back-up to charge batteries and power the system.

The generator would be located within a weather protected enclosure at the control structure location. A self contained base mounted diesel fuel tank (or separate LP gas tank) sized to run the generator continuously for 12 hours will be provided.

L9.5 Exterior Lighting

Exterior lighting needs at the Blind River Diversion and Control Structures will be evaluated to limit light pollution falling on neighboring property. Fixtures with sharp cutoff type III lenses or back reflectors to control the direction of light will be provided. Individual fixture control will also be provided to switch off light if distribution control measures are not effective enough. At remote locations where normal utility power is not available, solar powered fixture will be considered.

L9.6 Transient Voltage Surge Suppressors (TVSS)

Transient Voltage Surge Suppression will be provided for the electrical distribution system equipment to reduce the destructive effects of electrical transients and temporary excess voltage and/or current in the electrical circuits. The TVSS devices will be incorporated to limit short duration events, typically lasting from a few thousandths of a second (milliseconds) to billionths of a second (nanoseconds).

The electrical system equipment will be protected by transient voltage surge suppressors (TVSS) on the 480-volt line entering the Switchboards, lighting and power panelboards and control panels. UL1449 standard will be specified.

L9.7 Wire and Conduit

All wire and cables will be run in galvanized rigid steel (GRS) conduit or PVC coated GRS conduit. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper. All conductors shall be stranded, except that lighting and receptacle wiring may be solid. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used. Minimum conduit size will be ¾". Boxes for terminations etc. will be 316 stainless steel or FRP to resist the corrosive environment depending on availability. Conduit in hazardous locations will be galvanized rigid steel.

L10 OPERATION, CONTROL, AND INSTRUMENTATION

This section presents the current planning on the operation, control, and instrumentation needs for the diversion project.

L10.1 Diversion System Operation

The Blind River diversion project is a hydraulic system that will divert fresh water from the Mississippi River, transfer it to the fringes of the Maurepas Swamp, distribute it into the Swamp, and then drain the water into the Blind River. The principle hydraulic elements and functions of the overall system are:

- Mississippi River stage – the upstream boundary condition for the hydraulic grade line and the hydraulic driving force for the entire system.
- Diversion Structure – diverts the flow through/under the east levee of the Mississippi River via a culvert.
- Transmission Canal – transfers the flow from the diversion structure to the edge of the Swamp.
- Distribution System – distributes the flow into the Swamp.
- The existing drainage channels in the Swamp will serve as the distribution system.
- Control structures will be installed in the existing channels to control the water surface elevations (WSELs) and the hydraulic grade line to force the water into the Swamp.
- The proposed berm gaps will open up the existing spoil banks, allowing the higher water surface to force flow from the existing drainage channels through the gaps into the Swamp.
- Overland Flow and Drainage System – after flowing through the proposed berm gaps and other routes, the diverted water will flow through the Swamp via overland flow, and then to drain from the Swamp and discharge into the Blind River.
- The proposed cross culverts and interconnecting channels at Highway 61 will improve overland flow and circulation within the Swamp
- Blind River stage – the downstream boundary condition for the hydraulic grade line. The stage is influenced by runoff from rainfall in the watershed and back-flow from Lake Maurepas due to:
- Tidal effects
- Tropical storm surges
- High water levels due to flood events in other drainage systems discharging into Lake Maurepas

The diversion system will typically operate long-term at steady-state flow conditions. The primary flow control at the diversion structure will likely be manually set to a given flow rate, then the sluice gate openings will automatically vary based on feedback from the flow meters, to maintain the set flow rate. The flow rate may be changed manually from time to time. The Mississippi River stage varies widely, from Elev. 0.5 to Elev. 29, although the day-to-day variation is very low. As the Mississippi River stage varies, it is anticipated that the automatic flow rate feedback will result in gradual automatic adjustments to the sluice gate positions to maintain the set flow rate.

During diversion periods, regional hydrologic events may dictate changes in the flow rate, or a decision to completely stop the diversion flow. These include:

- More intense local rainfall events which may cause local flooding and require a decision to discontinue the diversion to avoid increasing the flood levels.
- Tropical storm surges through Lake Maurepas and up the Blind River may cause flooding. A decision may be required to discontinue the diversion flow to avoid increasing the flood levels.

These events should be monitored by the operating staff, which would then make the decisions to manually shut down the system. A backup/fail-safe system needs to be in place to reduce flood risk in case the staff fails to manually shut down the system. The Blind River water levels will be monitored at Highway 61 and at IH-10 to indicate rising water and probable back-flow from Lake Maurepas. Flow and velocity meters could also be included to better define that back-flow is occurring. The WSEL's at the control structures should also be monitored for high water conditions. At certain high WSEL's, the diversion system would then be automatically shut down.

L10.2 Diversion System Control

The diversion system operation and control is centered on hydraulic elements. Other parameters will be monitored. Categories of operation/control/monitoring data include:

- Primary hydraulic system control – control the diversion flow rate and key WSEL's in the Swamp
- Secondary hydraulic system monitoring and controls – WSEL and limited flow
- Others – security, motors, mechanical, electrical systems, etc.

Other data will be collected and monitored, but will not be used directly to control diversion flow rate or water levels. The additional data can be used to refine control parameters and settings, monitoring system performance, and provide a basis to for adaptive management changes. These items are not yet defined at the conceptual stage. These include the following:

- Hydrologic data collection – additional WSEL data can be collected inside the Swamp. At this point in the design, these data sets are not expected to be used for real-time monitoring and control of WSEL's and diversion flow rates.
- Environmental data – water quality, etc.

L10.2.1 Primary Hydraulic System Control

The three main hydraulic controls on the overall system are:

- Control of the diversion flow rate at the diversion culvert – The diversion flow rate will be controlled by a sluice gate on the inlet to each box culvert cell (barrel). The sluice gate will have a motor operator and the flow rate will be controlled by varying the sluice gate position. Flow meters in each culvert cell will provide real-time feedback to reposition the sluice gates, thereby adjusting the flow rate.
- Control of water surface elevations at each control structure – In the Swamp, the control structures with the control gates will control the WSEL in the existing drainage channels on the upstream side of the control gate to force the diverted water through the proposed berm gaps into the Swamp. The WSEL will be measured on the upstream side of the gate, and the gate height will be adjusted to maintain a set WSEL.
- Control of the flow rate at each control structure – Part of the diverted water will be required to pass over the control gate to continue downstream in the existing drainage channel. At each control structure, the same WSEL measurement on the upstream side of the gate will be used to set the gate height to serve as a weir, allowing a set flow rate to pass over the control gate.

L10.2.2 Secondary Controls and Monitoring

A secondary set of instrumentation will monitor hydraulic parameters at multiple locations for the purpose of protecting the system, safety, avoiding overflows, and avoiding flood conditions due to too high of water surface elevations. This monitoring effort will mainly consist of measuring the WSEL at various locations throughout the system, and collecting limited flow rate data at several locations. These monitoring points will trigger alarms and some will trigger system shut-down. Some of the monitoring involves comparative WSEL across structures to indicate blockages, or other problems.

Diversion Culvert

The WSEL will be monitored at three locations at the diversion culvert structure:

- Inlet canal WSEL – this indicates the WSEL in the Mississippi River and provides the upstream WSEL for the system
- Sluice Gates WSEL – the WSEL on the upstream side of each sluice gate

- Culvert Outlet WSEL – the WSEL at the diversion culvert outlet, in the upstream end of the transmission canal

The data will be used as follows:

- The inlet WSEL will be used to monitor the Mississippi River WSEL. At low WSEL's in the river, the diversion may have to be discontinued to avoid conflicts with other water users.
- WSEL differential at the trash racks – a high differential in WSEL from the inlet canal to the sluice gates indicates clogging by debris. This will trigger an alarm. The individual sluice gate will be shut down at an extreme differential to avoid damage to the trash rack.
- The WSEL differential between the sluice gate and culvert outlet could be used as an input to verify flow meter calibration.

Transmission canal
The WSEL in the transmission canal will be monitored to avoid the canal berm being overtopped, resulting in damage to the canal and potential local flooding. The design freeboard is 2 feet. The system will provide an alarm when the freeboard is reduced to 1 foot due to a rising water surface. Above that WSEL, the feedback to the sluice gates could gradually close the gates if the WSEL continues to rise, and shut down the diversion flow at approximately 0.5 feet of freeboard. The WSEL monitoring will be at:

- CN RR – upstream side of the culverts at the railroad
- LA 3125 – upstream side of the culverts at the road

Control Structures
The WSEL will be monitored on the upstream and downstream sides of the control gates. Alarms will be tripped by excessive WSELs. Extreme WSELs would indicate flooding conditions, and should initial system shut-down.

Blind River
Monitor the Blind River stage at IH-10 and Highway 61. High stages will trip alarms, and then shut down of the diversion system. Monitor the velocity and direction of flow, to indicate back-flow into the project area.

Berm Gaps
There will be no flow control at the individual berm gaps. All control will be by the control gates in the control structures.

Cross Culverts at Highway 61
There will be no level or flow control capabilities at the Highway 61 crossings.

L10.2.3 Hydrologic Data Collection

Hydrologic – rainfall and additional WSELs in downstream system

L10.2.4 Environmental

Environmental and water quality monitoring – not yet defined, and not addressed any further in this section.

L10.2.5 Others - Security, Motors, Mechanical, Electrical Systems, etc.

L10.3 Instrumentation and Control

This section provides the conceptual instrumentation and control design for the project. Each area to be controlled will be equipped with an independent Programmable Logic Controller (PLC) that will monitor process values and statuses and perform control of the local equipment. These PLCs will be linked by a satellite communication system that will allow data to be shared from site to site in order for the system to operate as a whole. The system will be able to be monitored from a single location by an operator. See **Annex L-5** for instrumentation drawings and schematics.

The current design layout provides a control building on the site of the diversion culvert. Provisions will be made to monitor the system from other locations via the internet or other means. All required real-time control and monitoring data will be supplied to the operator to be used for operational decision making. All sites will be monitored by video security with local digital video recorders (DVR) to record video. The sites will also be equipped with intrusion switches on the gates and doors to monitor entry to the sites and notify the on-call operator.

L10.4 Instrumentation and Control Requirements for Power Supply Systems

For this system, the primary source of power for the diversion facility and the transmission system will be grid power. The grid power will be backed up with a standby generator to keep the system operational during a grid power outage. The control system will monitor the availability of grid power, the generator status, and whether the systems are operating on grid power or generator power.

The control structures are located at remote sites and will have one generator at each site as the primary power supply to operate the control gates. Solar power and a battery pack will be used as back-up power for all needs except control gate operations. The control system will monitor the generator status.

L10.5 Instrumentation and Control Design for Romeville Diversion Facility

The proposed Instrumentation and Control design for the Romeville diversion facility is shown on the engineering panels in **Annex L-5**. The levels in each of the primary areas will be monitored and logged for trending purposes. The three diversion culvert gates will be controlled by the local PLC and any problems will be alarmed at the central control site. The flows in the three culverts will be monitored and logged for trending and reporting purposes.

L10.6 Instrumentation and Control Design for Romeville Transmission System

The water level will be monitored at the upstream side of the CN RR culvert and the upstream side of the LA 3125 culvert. High water levels within 1 foot of the top of berm will trigger an alarm and higher levels will initiate sluice gate closures at the diversion culvert.

L10.7 Instrumentation and Control Design for Swamp Control Structures

The proposed Instrumentation and Control design for the control structures in the Swamp is shown on the engineering panels in **Annex L-5**. At each structure, the water level on each side of the gate will be monitored and recorded. The gate will be controlled by the local PLC and any problems will be alarmed at the central control site. The number of times that this information is passed each day will be reviewed in order to keep the total amount of data passed to a minimum while ensuring that sufficient data is communicated for monitoring.

L11 CONSTRUCTION PROCEDURES

This section describes construction procedures, requirements, and special considerations necessary to construct the proposed facilities. The discussions include existing site conditions, access, construction techniques, temporary construction facilities, detours for transportation facilities, construction sequences, dewatering, and special items. The permanent project components are described in detail in Section L7.

The discussions in this section describe conditions impacting the construction effort, as these influence design, opinion of estimated costs, scheduling, permitting, and other project factors. The construction contractor will be fully responsible for selecting and implementing the construction means and methods.

Material Availability

The project is near industrial facilities along the Mississippi River. Construction materials, such as steel sheet piling, ready-mix concrete, stone and gravel, drainage pipe, and road materials should be readily available. Highway, rail, and river transportation facilities are in the immediate area, for delivery of items that need to be shipped to the area. Imported fill material may be in short supply, or expensive, due to high demands on reconstruction projects after Hurricane Katrina.

Upland Construction Sites

The diversion culvert facility and the transmission canal will be constructed outside of the Swamp in upland areas. Conventional land-based heavy civil construction equipment and procedures will typically be used for these two components. Probable equipment to be used include bulldozers, track-hoes, earthmovers, cranes, pile drivers, concrete pumps, dewatering equipment (well points), and other items.

Swamp Construction Sites

The control structures, berm gaps, cross culverts, and radio towers will be constructed in the Maurepas Swamp, in potential conditions of saturated soils, weak/soft soils, standing water, and flooded sites. Special equipment and procedures will be required for these heavy civil construction project components. Equipment will likely require wider tracks for work on soft ground. Specialized equipment for soft/marshy/swampy areas, such as Rolligons, might also be used in the Swamp.

Natural ground in the Swamp is typically near Elev. 1.5 to 2.0, the static water surface between storm events is approximately Elev. 1.5 to 2.0, and flood levels can approach Elev. 5. The ground conditions in the Swamp are typically described as saturated and soft, consisting of organic material, silts, and clays. The water table will vary from slightly below ground surface to standing water on the sites, to flooded conditions. The sites typically have heavy brush and trees, especially at the fringes of the Swamp along the existing drainage channels.

There are no existing roads into the Swamp to the project component sites. No access roads are included in the current plans, and temporary access roads will likely not be allowed. The conceptual designs and costs estimates consider that access is to be via barges and crew boats. These will be used to transport all construction equipment, materials, and crews to the control structure sites. An existing access point with a boat ramp is north of Grand Point. Construction of the transmission canal to the existing Parish drainage channel will provide an additional access point.

The control structures use control gates that rotate down to the channel bottom in the open position, thereby allowing boat and barge access past the control structure. Construction of a control structure, with the control gate in place, will not hinder construction access to the other construction sites.

SWPPP
Storm water pollution prevention plan (SWPPP) will be prepared for each construction site to meet the requirements of the EPA and State NPDES. The SWPPP will include provisions to control erosion and minimize sedimentation of streams during construction, using such measures as filter fabric fences, rock filter dams, stabilized construction exits, inspection and good housekeeping practices, and vegetation. The SWPPP is not included in the current preliminary plans, but will be developed during final design. (Erosion protection for the permanent facilities is discussed in Section L7, civil design section).

L11.1 Diversion Culvert Facility

Construction of the diversion culvert will require specific construction techniques, sequencing, and temporary facilities for the following three major portions of the facility:

- Connection of the inlet canal to the Mississippi River
- Construction of the culverts through the Mississippi River East Levee
- Construction of the culverts under LA 44

Existing Site Conditions
The diversion facility site is located adjacent to the Mississippi River and includes the batture inside the levee (river side of levee), the levee, and the area outside of the levee (land side of levee) to 100 feet east of LA 44. The site has no existing development, such as residential, commercial, or industrial facilities. The batture appears to be in original natural conditions, and is covered with trees and brush, and is considered to be poorly drained. The area adjacent to LA 44 is clear, being agriculture land, or fallow. LA 44 and the fields in the area have existing drainage infrastructure. The LA 44 right-of-way has utility lines, including overhead electric distribution, and underground communication lines, which will have to be adjusted for construction of the diversion culvert. There are no known water or sanitary sewer lines in the road right-of-way.

Access
Access to the diversion facility will be from the local paved road, LA 44 (River Road). Access is also available from the Mississippi River for delivery of large items or large volume items to the site via barges, such as the sluice gates, steel sheet piling, and riprap.

Construction Techniques
Installation of the diversion facility involves heavy civil construction and anticipated equipment includes large track-hoes, earthmovers, cranes, pile drivers, concrete pumps, and bulldozers. The site is outside of the Swamp, and normal land-based construction techniques apply. The diversion culvert is a large hydraulic structure, and will have to be constructed by open-cut techniques across the batture, through the Mississippi River levee, and under LA 44. The culvert is designed as a cast-in-place reinforced concrete structure and will likely be on a prestressed concrete piling foundation.

Temporary Construction Facilities
The current level of flood protection provided by the East Levee of the Mississippi River must be maintained at all times during the construction phase. A temporary earthen levee will be placed on the batture, inside of the existing levee, to allow open-cut construction of the culvert through the existing levee. The temporary levee will be designed and constructed to standards matching the permanent levee. The inside face of the levee will be lined with riprap for erosion protection, as the temporary levee could be exposed to flowing water during flood stages. During final design, an alternate steel sheet pile cofferdam will be considered at the levee to avoid a need for the temporary levee.

A steel sheet pile cofferdam will be installed on the east bank of the Mississippi River to allow excavation of the inlet canal and placement of the riprap in dry conditions. The work should be done during the summer months, when the Mississippi River normally has the lowest stages. The cofferdam protects only the inlet canal earthwork, and is not part of the overall levee flood protection system, and as such, the enclosure could be considered a non-critical enclosure. Therefore, the top of the cofferdam was initially designed to Elev. 24, the approximate elevation of the batture. It is considered that the cofferdam on the Mississippi River bank will be installed and removed from a barge in the River.

Detours
The diversion culvert will be constructed across LA 44 in an open-cut excavation, requiring the existing LA 44 pavement to be removed for construction. Re-routing traffic from LA 44 to LA 3125 will result in an unacceptably long detour route. Therefore, local traffic will be maintained through the construction area at all times by providing a temporary detour road. The detour road will be an asphalt road approximately 1,000 feet long with 2 – 12' lanes (one each direction).

Construction Sequences

The construction will be phased and sequenced at the levee to ensure that the east levee flood protection integrity is maintained at all times, in the following sequence:

- Construct temporary levee – the temporary levee must be in place on the batture before any excavation or disturbances to the existing levee. The temporary levee is to remain in place until the diversion culvert is constructed through the levee and the sluice gates are installed and operable, ensuring full blockage of flow through the culverts.
- Remove the existing concrete liner on the inside face of the levee
- Excavate the existing levee
- Install the cut-off wall in the levee
- Construct the box culverts through/under the levee, including the trash racks, gate tower, and installation of the sluice gates
- Reconstruct the main levee
- Reconstruct the concrete liner on the inside levee face
- Remove the temporary levee

The inlet canal should be constructed after the removal of the temporary levee, as part of the inlet canal is under the footprint of the temporary levee, using the following sequence:

- Install the cofferdam on the east bank of the Mississippi River
- Excavate the inlet canal and place the riprap
- Remove the cofferdam

The construction sequence for the culvert east of the levee under LA 44 is noncritical for levee integrity, and can be done at any time, either before, during, or after construction through the levee. The following sequence is required to maintain local mobility and traffic:

- Construct the LA 44 temporary detour
- Remove the existing pavement at the culvert crossing
- Construct the culvert
- Reconstruct LA 44 in the existing location
- Remove the temporary detour

The culvert under LA 44 should be completed before the downstream segment of the transmission canal is completely excavated and connected to the existing drainage channel in the Swamp to avoid flooding the culvert construction site. If this isn't possible, an earthen plug should be left in the transmission canal to

protect the culvert work site from flooding by backflow from the Swamp. The existing water surface at in the parish perimeter drainage channels is Elev. 1.5 and the proposed culvert flow line is Elev. -3.0 at LA 44.

Dewatering and Surface Water Management
Ground water conditions are currently unknown; however, it is considered that water tables are high and that dewatering, such as well points, will be required. Outside of the levee, surface water can be directed to the local drainage infrastructure. The batture may be poorly drained, but drainage could be redirected away from work sites to the Mississippi River.

Net Earthwork Quantities
No attempts were made to balance cut and fill quantities on the diversion culvert site. It is anticipated that excess spoil from the transmission canal excavation will be used for the temporary levee. The material from the removal of the existing levee will be stockpiled and reused for the reconstructed levee. Excess material from removal of the temporary levee, excess material from the original levee, material from the box culvert excavation, and material from the inlet canal will be removed from the site.

Example Diversion Culvert
The construction requirements for the Romeville diversion culvert are similar to those used on the Davis Pond diversion culvert. See the following photograph of Davis Pond (**Figure L11.1-1**), in which the following construction items are visible and applicable to the Romeville diversion location:

- Temporary earthen levee on the batture
- Riprap on temporary levee
- Open-cut excavation through the existing levee
- Pipes for a dewatering system in the excavation
- Concrete piling foundation
- Barge access from the Mississippi River
- Detour for local road
- Shoofly to temporarily relocate the railroad (see railroad discussions under the transmission canal paragraph)

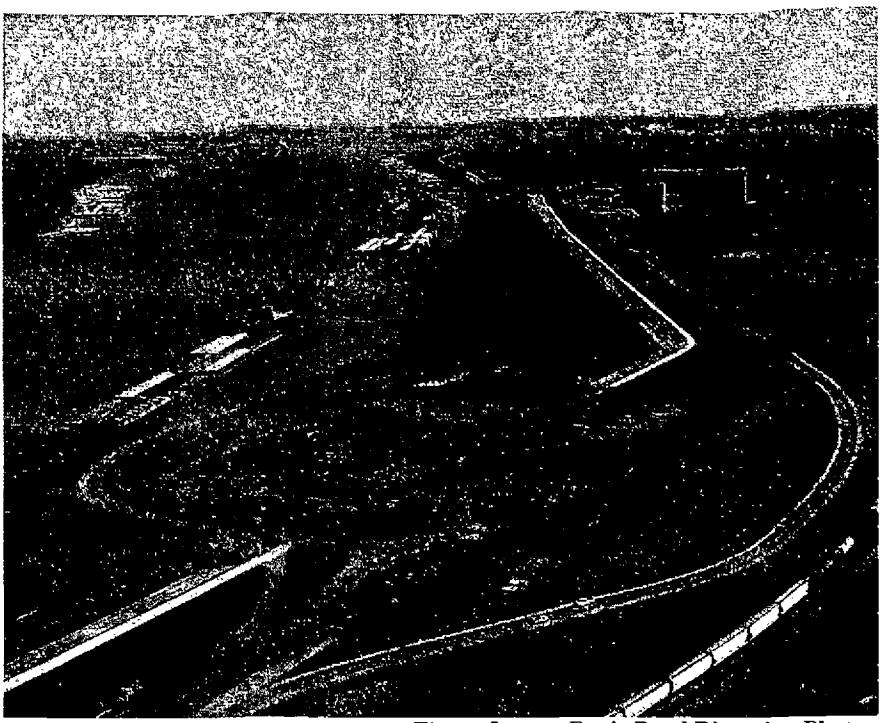


Figure L11.1-1 Davis Pond Diversion Photo

L11.2 Transmission Canal

The proposed transmission canal is primarily an earthwork project with culvert crossings at LA 3125 and the CN RR.

Existing Site Conditions

Most of the transmission canal alignment is located on agricultural or fallow land at elevations above the Maurepas Swamp. Routes considered are typically clear of residential, commercial, and industrial development. The area has existing drainage infrastructure, and surface water from rainfall is expected to drain off of the site in reasonable times. The downstream (east) end of the transmission canal is in the Swamp and likely has nearly permanent standing water and saturated conditions.

Access

The entire transmission canal alignment is readily accessible from the two roads it crosses – LA 44 and LA 3125. During construction, the right-of-way can be graded, and the berms can be constructed, providing good construction access along the entire alignment to each work site.

Construction Techniques
Installation of the transmission canal involves heavy civil construction. The majority of the transmission canal is in the upland areas and can be constructed using conventional equipment, such as track-hoes, bulldozers, and earth movers.

At the downstream end of the canal, the earthwork will be in wet conditions at the fringes of the Swamp. The berms will be extended along both sides of the canal to the existing drainage channel, providing access to the area. A temporary berm could be constructed across the work site at the downstream end, fully isolating the excavation area from the Swamp. This would allow conventional earthwork equipment to be used. Special construction approaches will be required to remove the final plug of earth to daylight the canal into the existing drainage channel. The soil could be excavated in the wet, a practice that results in sedimentation in the downstream channel. The tie-in area should be isolated with a cofferdam, allowing excavation and placement of the riprap in protected and dry conditions.

The culverts at the road and railroad are large hydraulic structures, and will have to be constructed by open-cut techniques. The reinforced concrete box culverts can be either pre-cast or cast-in-place, if allowed by permits from the owners. It is anticipated that cranes and concrete pumps will be required, in addition to the equipment listed above. The conceptual estimate is based on cast-in-place.

During final design, alternate construction techniques should be investigated for the railroad crossing, to determine if the shoofly can be avoided.

Temporary Construction Facilities
The only major temporary facility required will be a steel sheet pile cofferdam at the downstream end of the transmission canal to allow excavation of most of the east end in dry conditions.

Detours
The CN RR is an active rail line serving the mid-west and the south Louisiana port area. Based on informal discussions with railroad representatives, rail service must be maintained at all times, and speed reductions will likely not be allowed. The design assumes a 2,000-foot long shoofly (temporary track) to allow open-cut construction of the box culverts across the existing CN RR tracks. The shoofly will include turnouts at each end to expedite final switch-over to the shoofly. The railroad will likely discourage a temporary rail crossing at the work site. Such a crossing is not necessary, as access is available to both sides of the railroad from the existing public roads.

The proposed construction sequence at the CN RR is as follows:

- Construct the shoofly and re-route rail traffic
- Remove the existing tracks at the culvert crossing

- Construct the culvert
- Reconstruct the railroad tracks in the existing location and place rail traffic back on the original alignment
- Remove the shoofly track

A nearby, temporary detour will be required for construction of the LA 3125 crossing, due to the unacceptable length of potential detour routes if the road were closed. The detour was not designed in the conceptual phase, but was considered to be 1,000 feet long, consisting of a 2-lane asphalt road (1 – 12' lane each direction) with shoulders. LA 3125 has a 300-foot wide right-of-way, and the work should be done in one detour phase. The following sequence will be required:

- Construct the LA 3125 temporary detour road
- Remove the existing pavement at the culvert crossing
- Construct the culvert
- Reconstruct LA 3125 in the existing location
- Remove the temporary detour road

LA 3125 and the CN RR are to remain open to traffic at all times, except for brief periods to switch over traffic, as allowed by the permits.

Construction Sequences
Construction of the transmission canal does not impact the integrity of major flood protection facilities. However, specific sequences are necessary to avoid negative impacts to local drainage and transportation facilities. Following is the recommended construction sequence:

- Local drainage – the project will disrupt the local drainage patterns and revised drainage facilities are included in the design. These new drainage facilities need to be constructed first.
- Pipeline and utility adjustments need to be completed prior to the canal excavation.
- The road detour and railroad shoofly are to be constructed prior the canal excavation in the area of these crossings
- The isolation plug and temporary berm at the downstream end of the transmission canal are to be the last construction items

After the above items are done, sequencing of the overall transmission canal is non-critical.

Dewatering and Surface Water Management
Ground water conditions are currently unknown, although it is considered the groundwater levels are high. Dewatering, such as well points, is considered to be

required for the entire transmission canal length. The groundwater is likely at or near ground surface downstream (east) of LA 3125 and additional dewatering capacity may be required.

The design includes drainage ditches along both right-of-way lines to direct surface drainage to the local drainage infrastructure. These ditches should be excavated early in the construction process to direct surface drainage away from the work areas.

The segment of the transmission canal in the Swamp will require additional water management tasks. It is considered that the work area can be isolated from the Swamp surface with earthen berms, and that more extensive dewatering will be required.

Net Earthwork Quantities
The initial design for the transmission canal does not have the cut and fill quantities balanced. It is anticipated that there is a market for the excess spoil, and that the contractor will be able to readily sell or dispose of the spoils. If the material is to be disposed on site, the berms along the canal could be widened and raised to absorb the excess earthwork volumes. Or adjacent lands could be acquired as part of the project, and the excess spoil could be disposed on them.

The current design assumes that the excavated soil is suitable for the embankments creating the berms.

Based on the current ground profile and transmission canal design, there will be no need for imported fill.

L11.3 Control Structures

The control structures are large concrete structures with control gates to control the water surface elevations, as described in Section L7.

Existing Site Conditions
The control structures will be located in existing drainage channels with permanent standing water within the Swamp. Most of the control structure sites have an existing spoil bank on at least one side of the channel. Existing conditions in the Swamp are described in the introduction to this section.

Access
Access to the sites will be via barges, as described in the introduction to this section.

Construction Techniques
Installation of the control structures involves heavy civil construction and at a minimum, cranes, track-hoes, pile driving equipment, and bulldozers will be

required at the sites. The control structures will require structural excavation in the existing drainage channels, fill behind the retaining walls, and re-grading the berms on the site to control the flow of the diverted water, requiring land-based construction operations. Some construction operations can be performed from barges. However, some construction contractors may prefer to have a land-based operation. Work areas can be built up above the standing water levels and stabilized to allow the soil to support the construction equipment. This could be accomplished by using a soil reinforcement such as a geotextile and placing fill to the desired elevation. Excavated material from structural excavation could be used for the fill.

Concrete will have to be delivered to the site by barge.

Major Temporary Construction Facilities
The control gate structure will be constructed in the existing drainage channels, which have permanent standing water. Temporary steel sheet pile cofferdams will be installed in the channels to isolate the work area and allow them to be dewatered. The control structures will have to be phased and sequenced to maintain the drainage and flood control capacity of the existing drainage channels. For the preliminary design, it was considered that half of the channel can be blocked at each location. The final design will address specific allowable extents of channel blockage.

As an alternate, a by-pass channel could be excavated around the control structure site, allowing the entire control structure to be installed in one phase. This approach will be investigated during final design.

Construction Sequences
The work sites in the Swamp for the berm gaps and the control structures are independent and can be constructed in any sequence. The approximate construction sequence far an individual control structure will be as follows:

- Clear the site
- Establish work pads (build up the ground elevation) for land-based construction operations
- Phase 1
- Install a cofferdam on half of the channel
- Excavate half of the channel
- Construct half of the concrete structure
- Install half of the channel transition sections and erosion protection
- Backfill at the walls on one side

- Remove the end sections of the cofferdam and flood Phase 1, opening it to flow in the channel
- Phase 2
- Install a cofferdam on the second half of the channel
- Excavate half of the channel
- Construct half of the concrete structure
- Install half of the channel transition sections and erosion protection
- Backfill at the walls on one side
- Isolate the entire gate area
- Install the control gate
- Complete area grading
- Remove the cofferdam
- Install the control building and all remaining appurtenances

Dewatering and Surface Water Management
The site is in the Swamp, and will have a high ground water table, possible standing water, and potentially flooded conditions. The construction contractor will have to use construction methods to deal with these conditions. Deep sheet piling may be required to cut off deeper sand layers to control water from flowing into the cofferdam enclosures. Well points and deep wells may also be required. Surface water control can include building earthen berms around the work site and building up earthen work pads.

Net Earthwork Quantities
Earthwork quantities will be balanced on each site. Due to the isolated locations, no soil will be imported into, or exported from the work sites. Excess spoil will be disposed near the existing berms, as discussed under the Berm Gaps. If additional soil is required, the existing channels will be widened.

L11.4 Berm Gaps

Large gaps will be excavated in the existing spoil banks along the drainage channels in the Swamp. These new gaps will provide open and free flow between the existing perimeter drainage channels and the Swamp.

Existing Site Conditions
See the introduction to this section for a description of existing conditions in the Swamp.

The spoil banks were created or added to in the 1970's during the last known construction effort to deepen and widen the existing drainage channels. The size of the spoil banks vary widely, with the top ranging from Elev. 4 to Elev. 12. The spoil banks are covered by moderate to dense brush and trees approximately 30 years old. The general area in the Swamp also has moderate to dense trees and brush.

Access
See the introduction to this section for comments on access to the work sites.

Construction Techniques
Track-hoes, bulldozers and earth moving equipment will be moved to the site via barge. The existing spoil banks are considered to be stable and capable of supporting construction equipment.

The spoil will be disposed on site. The soil will be moved from the proposed gaps to areas behind the existing spoil banks that are to be left in place. Disposal areas could be built up above the 100-year flood level to provide additional wildlife refuge areas during floods. Alternatively, the spoil could be spread out in a 1 to 2 foot layer, to allow Bald Cypress seedlings a better chance of survival.

The construction contractor will have to use equipment and techniques adapted for swamp/marsh/soft ground conditions. These can include Rolligons and wide tracks on the track-hoes and bulldozers.

Major Temporary Construction Facilities
None.

Construction Sequences
None required.

Dewatering and Surface water Control
The contractor will need to have techniques to manage the high water levels in the swamp. These could include constructing low berms (1' – 2' high) around work sites, and pumping out the interior.

Net Earthwork Quantities
All excavated soil will be disposed on site. There will be no imported fill or exported spoil.

L11.5 Cross Culverts

Cross culverts will be constructed under Hwy 61 at four locations to improve water circulation. The cross drainage capacity at the Kansas City Southern railroad appears to be adequate, however, additional analysis to verify the quantities of flow will be completed during the PER phase of the project.

Existing Site Conditions
The proposed culvert locations are within the Maurepas Swamp where Highway 61 crosses the Swamp. Existing conditions in the Swamp are described previously.

The Hwy 61 crossing has two lanes each direction on an embankment at Elev. 6. The road has a large barrow ditch parallel on the east side, with standing water. The road and KCS railroad are approximately 500 feet apart. Pipelines and overhead power transmission lines are in the corridor between the road and railroad and the area appears to be highly disturbed by construction and maintenance activities for these facilities.

Access
The four culvert crossings are readily accessible from Hwy 61, including the work sites on both sides of Hwy 61, the area between the road and railroad, and the east side of the railroad. There are no known or apparent access points to the west side of the railroad. The corridor is largely disturbed by previous construction and maintenance activities. Access roads, either temporary, but preferably permanent, along the cross connect routes should be acceptable.

Construction Techniques
The work sites are within the Swamp, and specialized construction equipment will likely be required. If the access roads are allowed, stabilized work areas can be constructed consisting of geotextile and fill. This will allow use of more conventional equipment and techniques.

The cross culverts at the road are large hydraulic structures, based on the current designs, and will be constructed by open-cut techniques. The box culverts are reinforced concrete structures, and can be either cast-in-place or precast units, if allowed by the permits. As access is readily available, the ready-mix concrete, or pre-cast units, can be delivered to the site. It is anticipated that cranes and concrete pumps will be required, in addition to the equipment listed above.

If smaller culverts are used, the culverts could be installed by micro-tunneling or augering and jacking under the road and railroad.

Major Temporary Construction Facilities
Small cofferdams may be required to control local drainage ditches and surface runoff, especially in the barrow ditch on the east side of Hwy 61.

Detours
A detour will be required for construction of the Hwy 61 crossing, due to the unacceptable length of potential detours if the road were closed. Also, Highway 61 is an evacuation route, and full traffic capacity must be maintained at all times. The detour was not designed in the conceptual phase, but was considered to be 1,000 feet long, consisting of a 4-lane asphalt road (2 – 12' lanes each direction)

with shoulders. The following sequence will be required:

- Phase 1
- Construct the Hwy 61 temporary detour road in the east side of the right-of-way
- Remove the existing pavement at the culvert crossing
- Construct half of the culvert
- Reconstruct Hwy 61 in the existing location
- Remove the temporary detour road
- Phase 2
- Construct the Hwy 61 temporary detour road in the west side of the right-of-way
- Remove the existing pavement at the culvert crossing
- Construct the second half of the culvert
- Reconstruct Hwy 61 in the existing location
- Remove the temporary detour road

Hwy 61 is to remain open to traffic at all times, except for brief periods to switch over traffic, as allowed by the permits.

Construction Sequences
Specific sequences are necessary to avoid negative impacts to local drainage and transportation facilities. Following is the recommended construction sequence:

- Local drainage – the project will disrupt the local drainage patterns and revised drainage facilities are included in the design. These facilities need to be constructed first.

Construction sequences are not critical for the other elements of the cross culverts.

Dewatering and Surface Water Control
The sites are in the Swamp, and will have a high ground water table, possible standing water, and potentially flooded conditions. The construction contractor will have to use construction methods to deal with these conditions. Deep sheet piling may be required to cut off deeper sand layers to control water from flowing into the cofferdam enclosures. Well points and deep wells may also be required. Surface water control can include building earthen berms around the work site and building up earthen work pads.

Net Earthwork Quantities
The cut and fill will be balanced at each site, and no soil will be imported into, or

exported out of the individual sites. If there is excess spoil, it will be disposed in the corridor between the road and railroad.

L11.6 Instrumentation and Communication

Local instrumentation, controls, and control panels will be included in the designs of each project component. This paragraph addresses communication facilities, which tentatively consisted of radio towers for the conceptual design and construction cost estimating. The towers will be 150 to 200 feet high to be above mature Bald Cypress trees, and to provide clear line-of-sights for radio signal transmission. Radio towers will be located at the diversion culvert facility, at each control structure, and in the Hwy 61 corridor.

See the above discussions of project components for existing site conditions, access, major temporary construction facilities, and dewatering and surface water control.

Construction Techniques
The radio tower subcontractor will determine the appropriate construction method.

Construction Sequences
Construction sequences are not critical for the radio towers, in relation to other facilities.

L12 OPERATION AND MAINTENANCE

L12.1 Maintenance Dredging

The following text describes operation and maintenance activities, including maintenance dredging, associated with operation of the 3000 cfs Small Diversion at Convent/Blind River. The selected alternative is located at Romeville.

Operation and maintenance activities will also include (but are not limited to) starting and stopping the diversion(s), routine equipment and instrument maintenance, corrective equipment and instrument maintenance, and berm gap and culvert cleaning.

L12.1.1 Regular Maintenance Dredging

Maintenance dredging or de-silting is anticipated to remove sediments deposited in the Transmission Canal and drainage channels during operation of the diversion system. The Mississippi River carries a significant suspended solids load and it is expected that the flow diverted into the diversion operation will have the same characteristics. The velocities in the Transmission Canal and the drainage channels are relatively low, and sediment accumulation is anticipated in the system. The opinion of estimated cost assumes that this accumulated sediment volume is removed annually.

The Mississippi River sediment data is based on the two following sources, both of which provide similar coarse suspended solids characteristics:

- **Mississippi River Sediment, Nutrients, and Freshwater Redistribution Study, dated July 2000 (2000 MRSNFRS)** – The suspended solids load in the spring (high flow periods) is approximately 300 PPM and the fall (low flow periods) load is 200 PPM. The sand portion varies from 20 to 30% of the total suspended solids load. This results in loads of 60 to 90 PPM in the spring.
- **Sediment Flux and Fate in the Mississippi River Diversion at West Bay: Observation Study (a thesis at LSU)** – The coarse suspended sediment (0.0625 mm diameter and greater) has a typical value of 70 PPM in the spring and 20 PPM in the fall.

L12.1.2 Costs for Regular Maintenance Dredging

To be conservative, we made the following assumptions regarding maintenance dredging to establish sediment volumes and cost for sediment removal:

- The coarse suspended solids load will average 75 PPM during the entire diversion season
- 100% of the coarse sediments will be deposited in the transmission canal and the existing drainage channels
- The deposits will consolidate to 80 PCF
- The annual diversion period is eight to nine months

With these assumptions, 150,000 CY of settled sediment is expected to accumulate in the system annually.

The transmission canal and the drainage channels are wide channels and have permanent standing water; therefore, the estimate assumes hydraulic dredging. The spoil will be reused beneficially and discharged into the Swamp in a controlled manner that will supplement the land-building processes. At 2004 hydraulic dredging costs, which include reuse of the sediment at $12.00 per CY, we estimate that a 3,000 cfs diversion operation producing 150,000 CY will cost $1,800,000 in 2004 dollars, and with 20 percent added for contingencies will cost approximately $2,200,000.

L12.1.3 Single 3000 cfs Culvert Diversion O&M at Romeville or South Bridge

During operation of the single 3000 cfs culvert diversion, the following O&M activities (costs are provided later in this subsection) can be expected during diversion operation:

- Startup and shutdown
- Pre-startup, routine, and post shutdown O&M
- Preventive maintenance in accordance with manufacturer's recommendations
- Instrument maintenance and preventive maintenance

- Alarm response
- Vehicle operation and maintenance
- Electrical costs
- Mowing
- Gap clearing
- Materials and supplies
- Spare parts
- Miscellaneous activities (contingencies)

L12.2 Facilities Operations Plan

L12.2.1 Operating Assumptions

Once the diversion system(s) is operating, operating staff will enact regular operational changes in response to the hydrologic situation in the target area(s). The following text summarizes expected operation for the diversion.

We can expect to follow the following basic operating strategy:

- Diversion operations will begin whenever the average swamp level is less than the level in Lake Maurepas based on datum from strategically located level gauges and sensors.
- Diversion operation will be stopped whenever Lake Maurepas is at 0.5 NAVD or lower.
- Target is 3000 cfs.

Modeling indicates the diversions will operate for several months, followed by extended periods of no or reduced diversion.

Based on river level data, diversion could start in late winter and continue through late spring (May) and on into summer as river levels allow. Late summer and early fall river levels are typically low, and will yield lower rate diversions which will allow for a draining of the swamp during fall and winter when seed germination can occur.

L12.2.2 Anticipated Operational Sequencing

The operation of the diversion will be driven by a number of factors, including:

- Diversion Flow Rate
- Blind River System Discharge Flow Rate into Lake Maurepas
- Blind River System Swamp Water Level
- Amount of Freeboard in the Transmission Channel

- Lake Maurepas Level

These factors are discussed below:

L12.2.2.1 Diversion Flow Rate

The diversion flow rate will be dependent on the level in the Transmission Channel and the respective flow rate through the Transmission Channel. This flow will be controlled by manually initiated set points at the remotely located Operations Building from the Operator Control Panel (OCP). Operating staff will adjust the diversion flow rate weekly during normal operation by adjusting a flow set point. This flow set point will allow a range of operation between 0 - 4000 cfs through a real-time feedback loop controlling the Diversion Structure culvert gates. The flow set points will be remotely adjustable through input at the Operations Control Panel (OCP). Level and flow instrumentation will measure the flow rate and channel level, and transmit signals to the OCP to allow these parameters to be monitored.

L12.2.2.2 Blind River System Discharge Flow Rate into Lake Maurepas

The outflow rate from Blind River (with the exception of naturally induced outflow from precipitation events) will be controlled by the diversion flow rate. Strategically positioned level and flow instrumentation will transmit signals to the OCP to allow operators to monitor the Blind River flow rate and level. If the flow rate is too high or too low, the operating staff will then adjust the Diversion Structure culvert gates accordingly.

L12.2.2.3 Blind River System Swamp Water Level

The swamp water level in the Blind River System will be controlled from the diversion gates and the gates at the control structures. Staff will set the desired flow into the Transmission Channel using the gates at the Diversion Structure and then perform more finite adjustment of the control structure gates to keep the swamp water level elevation between 0 - 2 feet. These adjustments will be manually input by adjusting the set points through the OCP.

L12.2.2.4 Amount of Freeboard in the Transmission Channel

Transmission channel freeboard will be dependent on the operation of the gates at the Diversion Structure and the control structures. Operators will adjust the operating set points for the diversion flow rate and the flow rates through the control structures to maintain a freeboard at approximately 3 feet in the Transmission Channel.

L12.2.2.5 Lake Maurepas Level

While the level in Lake Maurepas is not actually controlled by operation of this diversion, it will influence operation of the diversion. When the lake level is higher than 0.5 NAVD (the lake is higher than the swamp), this will allow

operation of the diversion system to flood the swamp. When the lake level gets below 0.5 NAVD, the diversion operation will be stopped or reduced to allow the swamp to drain, providing an artificial dry period.

L12.2.3 Expected Operating Setpoints

The following table (Table L12.2.3-1) will provide the expected operating setpoints and range of measurement provided for each of the control parameters.

Table L12.2.3-1 - Expected Blind River Diversion Operating Setpoints

Operating Parameter	Set Point	Range of Measurement
Transmission Channel Level	1.5 to 3.0 foot freeboard	(-3.0) - (0) feet
Transmission Channel Flow Rate	0 - 4000 cfs	0 - 4000 cfs
Blind River System Outflow Rate	Monitoring only	(- 2000) - (6000) cfs
Blind River System Swamp Elevation	Varies	0 – 2.5 feet
Lake Maurepas Level	Monitoring only	(-2.0) - (10) feet

L12.3 Long-Term Monitoring Plan

Long term monitoring by O&M personnel includes:

- Maintenance of operation and maintenance logs for the structures and equipment.
- Monitoring of any of the alternatives daily by a technician
- Monitoring/inspecting all gates and structures (including testing generator operation) once a month in the distribution system
- Inspection and calibration of instrumentation weekly at six sites (control structures)
- Recording and documenting levels, flow and level daily for the Mississippi River, diversion structure(s) and distribution flow control structure
- Recording and documenting readings from water level gauges and indicators throughout the system.
- Using depth profiles to determine the degree of siltation in the sedimentation trap areas, transfer canal(s), distribution canal(s), and berm gaps annually to determine the amount of sedimentation that has occurred
- Regular monitoring of the culverts under roads and railroads and berm gaps to make sure they are clean and flow freely.
- Assessment of vegetation types at inception of project with follow-up assessments annually to determine the impact the project is having on the wetland system. (Not included in O&M costs)

L12.4 Operation and Maintenance Costs

Excluding annual labor, cyclical costs, equipment costs, electrical costs, and mowing costs, the estimated O&M cost per annum for the Blind River Diversion Project alternatives are as follows:

L12.4.1 3000 cfs Culvert Diversion O&M Costs

Expected annual culvert diversion O&M costs for the diversion structure are:

- Labor - $40,000
- Equipment - $15,000
- Annual Costs including electrical, mowing, etc. - $8,300

Total Diversion Structure O&M costs with 20 percent contingency allowance - $76,000

L12.4.2 3000 cfs Transfer Canal O&M Costs

Expected annual Transfer Canal O&M costs are:

- Labor - $42,000
- Equipment - $12,000
- Annual Costs including electrical, mowing, etc. - $12,000

Total Transfer Canal O&M costs with 20 percent contingency allowance - $79,000

L12.4.3 Distribution Canal O&M Costs

Expected annual Distribution Canal O&M costs are:

- Labor - $42,000
- Equipment - $10,000
- Annual Costs including electrical, mowing, etc. - $11,000

Total Transfer Canal O&M costs with 20 percent contingency allowance - $76,000

L12.4.4 Control Structure O&M Costs

Expected annual Distribution Canal O&M costs are:

- Labor - $134,000
- Equipment - $23,000
- Annual Costs including electrical, mowing, etc. - $12,000

Total control structure O&M costs with 20 percent contingency allowance - $203,000

L12.4.5 Gap and Culvert O&M Costs

Expected annual Gap and Culvert O&M costs are:

- Labor - $15,000
- Equipment - $7,000
- Annual Costs including, etc. - $2,000

Total Gap and Culvert O&M costs with 20 percent contingency allowance - $29,000

L12.4.6 Total O&M Cost for 3000 cfs Diversion

The total operation and maintenance cost (excluding dredging) for the 3000 cfs Romeville Diversion is expected to be $463,000 including contingencies.

L12.5 Repair, Rehabilitation and Replacement

Excluding annual labor, equipment costs electrical costs, and mowing costs, the estimated cyclical repair, rehabilitation, and replacement costs for the Blind River Diversion Project alternatives are as follows.

L12.5.1 3000 cfs Culvert Diversion RR&R Costs

Expected annual culvert diversion RR&R costs for the diversion structure are:

- Labor -- $12,000
- Materials -- $10,000

Total Diversion Structure RR&R costs with 20 percent contingency allowance - $27,000

L12.5.2 3000 cfs Transfer Canal RR&R Costs

Expected annual Transfer Canal RR&R costs are:

- Labor -- $5,000
- Materials -- $4,000

Total Transfer Canal RR&R costs with 20 percent contingency allowance - $11,000

L12.5.3 Distribution Canal RR&R Costs

Expected annual Distribution Canal RR&R costs are:

Total Distribution Canal RR&R costs with 20 percent contingency allowance - $0

L12.5.4 Control Structure RR&R Costs

Expected annual Control Structure RR&R costs are:

- Labor -- $20,000
- Materials -- $18,000

Total control structure RR&R costs with 20 percent contingency allowance - $46,000

L12.5.5 Gap and Culvert RR&R Costs

Expected annual Gap and Culvert RR&R costs are:

- Labor -- $5,000
- Materials -- $3,000

Total Gap and Culvert RR&R costs with 20 percent contingency allowance - $9,600

L12.5.6 Total RR&R Cost for 3000 cfs Diversion

The total repair, rehabilitation, and replacement costs (excluding dredging) for the 3000 cfs Romeville Diversion are expected to be $93,600 including contingencies.

L13 PRELIMINARY OPINION OF ESTIMATED COSTS

Preliminary opinion of estimated costs were used to assist in the evaluation and screening of the array of management measures (components) and the alternative plans considered for the diversion project. This section presents these preliminary opinion of estimated costs and the procedures used to develop them. The estimates are presented in the standard cost categories used by the USACE, as follows:

- Construction costs
- Engineering and design (E&D) costs
- Supervision and administration (S&A) costs
- Costs for lands, easements, rights-of-way, relocations, and disposal areas (LERRD)
- Contingencies
- Total first costs (capital costs)
- Operation and maintenance (O&M) costs
- Total project costs

Conceptual-level Design

The preliminary estimates described in this report are based on conceptual-level

design analyses, topographic data, and schematics. These estimates are intended as comparative estimates to assist in the screening steps, and to indicate relative total project costs. These estimates should not be used to establish final budgets or funding for the project.

Opinion of Probable Project Costs
The opinion of estimated costs developed for the project are the engineer's opinion of probable project costs, and should not be considered as construction quotes, estimates, or bids. See Para. L13.8 for a discussion of risks and uncertainties that could impact the construction costs.

L13.1 Background Information

Detailed Estimate for the Tentatively Selected Plan
A more detailed opinion of estimated cost will be prepared separately for the tentatively selected plan (TSP), as described in **Annex L-7**. The TSP opinion of estimated cost will include a construction opinion of estimated cost using the USACE MCACES-II cost estimating program. The TSP estimate will be prepared as the preliminary design progresses on the TSP.

Design Flow Rates
The initial array of alternatives considered diversion flow rates from 500 cfs to 20,000 cfs, and the preliminary opinion of estimated costs covered this full range of flows. The specific flow rates being used in the initial alternative arrays are in 500 cfs increments up to 5,000 cfs, then in 5,000 cfs increments to 20,000 cfs.

System Components
The diversion project requires several different types of management measures, or components, serving different functions, which will be combined to form the alternative plans. Separate opinion of estimated costs were prepared for each component and for each design flow rate. These estimates were then combined to develop the overall opinion of estimated cost for each alternative plan for each design flow rate. The components are:

- Diversion facility
- Transmission canal
- Control structures
- Berm gaps
- Cross culverts at the Highway 61corridor
- Instrumentation

Diversion Alignments
The array of alternative plans considered three diversion alignment options. In the final array of alternative plans, these were identified as follows:

- Alternative 2 – Romeville Alignment near Mississippi River Mile 162.0
- Alternative 4 – South Bridge Alignment near Mississippi River Mile 167.0
- Alt. 4A – 500 cfs to the existing Parish drainage channel and 2,500 cfs to the North Distribution Canal
- Alt. 4B – 1,500 cfs to the existing Parish drainage channel and 1,500 cfs to the North Distribution Canal
- Alternative 6 – Dual Alignment, using a 50/50 flow split between the Romeville Alignment and the South Bridge Alignment

Topographic Data

Most of the construction quantities and estimates were based on the 2001 LiDAR-based topographic data obtained from the Louisiana State University. Both a digital elevation model (DEM) and a set of 2-foot contours were available and used. This LiDAR dataset is the best available topographic data, but may not accurately represent the topographic features and trends in the Swamp, and must be used with the following cautions:

- The LiDAR pulses have difficulty in penetrating dense vegetative cover, as is typical in the Swamp
- The LiDAR pulses are absorbed by water, and topography at water bodies may not be well-represented
- The DEM did not appear to be thoroughly processed and cleaned up, as the data coverage has gaps and apparent errors

The LiDAR-based contours appear to reasonably represent the topographic trends outside of the Swamp, and were used with more confidence for the diversion structure and the transmission canal. Also, the contours appear to accurately represent the embankments for Highway 61 and Kansas City Southern Railroad (KCS RR) where they cross the Swamp.

A bathymetric survey was obtained in 2009 for the Blind River upstream of IH-10 and for much of the existing perimeter drainage channels. These elevations were used to establish the downstream flow line elevations for the transmission canal options, and for the designs and sizes of the control structures.

Limited on-the-ground surveys became available late in the screening process; however, these surveys were not used for the preliminary construction opinion of estimated costs. Also, a new LiDAR-based topographic dataset was obtained in the summer of 2009, but was not processed in time for use in the preliminary construction opinion of estimated costs.

Schematics, Exhibits, and Drawings

The preliminary opinion of estimated costs for the various components were developed from conceptual exhibits, schematics, sketches, and in limited cases,

from drawings for the components. Many of the exhibits were GIS-based, and should be considered less accurate than construction plans would be.

L13.2 Preliminary Construction Opinion of estimated costs

The estimating basis for each component included the permanent and temporary facilities and considered existing conditions that would have significant impacts on construction pricing. These items included:

- Permanent constructed facility
- Ancillary site improvements, such as driveway, drainage, fence, security, lighting, etc.
- Existing site conditions
- Access
- Construction techniques
- Major temporary construction facilities, such as coffer dams and temporary levees
- Temporary road relocations and detours
- Temporary railroad relocations
- Pipeline adjustments
- Utility adjustments
- Construction sequences
- Storm water pollution prevention plan (SWPPP)
- Dewatering and management of surface water
- Net earthwork quantities – need for importing fill or exporting excess excavated material

Cost Data Sources

Multiple sources of construction cost and pricing information were used to develop the construction costs estimates for the management measures.

- The primary source of construction pricing was from a nationwide database developed and maintained by CDM Constructors, Inc. (CCI) using the Timberline cost estimating software. The data includes material and equipment costs, labor costs, and construction equipment costs (i.e. hourly costs).
- The costs of various equipment and specialty items were based on quotes from vendors and manufacturers. Examples include sluice gates, control gates, valves, vacuum pumps, and rip rap. The quotes provided costs for the equipment or material delivered to the site. The installation costs (labor and construction equipment) were developed in the Timberline program.

- Published construction cost information from R.S. Means Company, Inc. was used to supplement the cost data from the CCI database and the vendor quotes.
- CDM engineers and CCI construction professionals provided input on construction costs, techniques, and expected production rates.
- Several construction contractors and construction equipment vendors were contacted for input on construction techniques, construction equipment, and productivity, especially for work within the Maurepas Swamp.

Construction Opinion of estimated costs

The construction opinion of estimated costs were prepared in an Excel spreadsheets. The estimates developed an expected direct construction cost, and then a 30% markup was added to account for subcontractor markups, insurance, overhead, profit, and other such costs. As the design is still at the conceptual level, a 15% contingency was also added to the construction opinion of estimated cost. A 10% contingency was used for the canals, which consisted primarily of large quantities of earthwork. These construction cost contingencies are separate, and in addition to, the contingency factor applied to the overall project costs, as described in Paragraph L13.4.

A broad range of flow rates were being evaluated for the diversion and it was impractical to prepare opinion of estimated costs for each reasonable flow rate with the limited schedule and budget available for the feasibility study. Therefore, a limited number of estimates were used to identify cost trends, and these trends were then used to project costs for other flow rates. **Table L13.2-1** and **Table L13.2-2** show which estimates were prepared for each component and design flow rate. The detailed construction opinion of estimated costs are in **Annex L-1**.

Table L13.2-1 Estimates for Components Sized for the Diversion Flow Rate

	Diversion Flow Rate, x1,000 cfs												
Item	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**10.0**	**15.0**	**20.0**
Romeville - Base Design													
Diversion Culvert (Elev. 11)	X	X		X		X		X		X	X	X	X
Transmission Canal - earthen	X	X		X		X		X		X	X	X	X
Romeville - Alternative Designs													
Diversion Siphon	X	X		X		X		X		X			
Batture Crossing - Siphon Pipe	X	X		X		X		X		X			
Batture Crossing - Inlet Canal	X	X		X		X		X		X			
Diversion Culvert (Elev. 5)	X	X	X	X	X	X	X	X	X	X	X		
Trans. Canal - earthen, deep	X	X		X		X		X		X	X	X	X
Trans. Canal - concrete-lined	X	X		X		X		X		X	X	X	X
South Bridge													
Diversion Culvert	X	X		X		X		X		X	X	X	X
Diversion Siphon													
Trans. Canal - earthen	X	X		X		X		X		X	X	X	X
North Distribution Canal			X		X								
Parish Ditch Widening			X										

Item	Diversion Flow Rate, x1,000 cfs												
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	10.0	15.0	20.0

Table L13.2-2 Estimates for Water Distribution and Water Management Elements

Item	Description
Control Gates	Based on existing drainage channel dimensions
Berm Gaps	Gap widths - 20', 100', 250', and 500'
Circulation Improvements KCS RR and Hwy 61 Corridor	
Small capacity culvert	1 - 4' x 4' box culvert
Large capacity culvert	4 - 5' x 5' box culverts
Bridge	50' span
Improve Existing Drainage Channels	2' deep and 20' wide
Diversions from Conway Canal	
Berm Gaps	
Diversion Ditch to HU 200's	
Instrumentation	Radio towers, gage stations, monitoring stations, control room
Romeville Alignment	
South Bridge Alignment	
Dual Alignment	

Projected Construction Costs

The detailed construction opinion of estimated costs were used to project the costs for the various flow rates. The detailed estimates were plotted, demonstrating that all elements have a near linear trend of cost versus flow rate. The unit costs versus flow rate were also plotted to verify uniform trends. As shown on the plots, the costs are not completely linear, due to approximations in quantities and design features made at the conceptual design level. The linear trends were calculated, and the projected costs were then used for the construction opinion of estimated costs for the management measures and alternative plans. The plots and projected cost calculations are in **Annex L-1.**

Annex L-1 has the following construction cost estimating items:

- Summary tables of the detailed estimates
- Summary table of the project estimates
- Tables with calculations to project the costs
- Figures of the construction costs versus flow rates

- Figures of the unit construction costs versus the flow rate
- Detailed construction opinion of estimated cost for each element

Construction Opinion of estimated cost Summary

Table L13.2-3 has a summary of the construction opinion of estimated costs for the final array of alternative plans, using the projected construction costs. Paragraph L13.7 provides a comparison and evaluation of the various components and elements, and selection of specific elements. In **Table L13.2-3**, the diversion structure cost is for a diversion culvert, as the siphons are more expensive at the designated flow rates.

Table L13.2-3 Construction Costs for Final Array of Alternative Plans

Item	Alt.2 Romeville 3,000 cfs	Alt. 4A South Bridge 3,000 cfs	Alt. 4B South Bridge 3,000 cfs	Alt. 6 Dual/Split 3,000 cfs
Diversion Structure				
Romeville	12,600,000			10,800,000
South Bridge		13,900,000	13,900,000	11,900,000
Transmission Canal				
Romeville	23,600,000			15,300,000
South Bridge		29,800,000	29,800,000	19,800,000
North Distribution Canal		29,300,000	15,500,000	15,500,000
Parish Drainage Channel			9,900,000	
Control Structures (6)	24,000,000	24,000,000	24,000,000	24,000,000
Berm Gaps (30)	4,000,000	4,000,000	4,000,000	4,000,000
Hwy 61 Crossings (4)	8,400,000	8,400,000	8,400,000	8,400,000
Instrumentation	900,000	1,300,000	1,300,000	1,500,000
Totals	73,500,000	110,700,000	106,800,000	111,200,000

L13.3 Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas

Costs for lands, easements, rights-of-way, relocations, and disposal areas (LERRD) were developed based on current real estate costs and utility relocation costs. CDM obtained the services of a real estate services firm, with local experience, to evaluate and recommend current acquisition costs for the various tracts of land. Specific real estate acquisition needs are described in Section L15.

The project will cross existing pipelines and utility lines, which will have to be adjusted or relocated to accommodate the diversion project. Preliminary costs were based on budgetary estimates because specific pipeline and utility conflicts are still under evaluation. Final opinion of estimated costs will be based on quotes from the owners to adjust their facilities.

The project will also cross several roads and railroads. The costs for culverts under the transportation facility are included in the preliminary construction opinion of estimated costs. Likewise, temporary detour roads and temporary railroad relocations (shoofly tracks) are included in the preliminary construction opinion of estimated costs.

L13.4 First Costs (Capital Costs)

The first costs, or capital costs, of the alternative plan is the sum of the construction costs, engineering and design, supervision and administration, LERRD, and a contingency. These cost categories were estimated as follows:

- Construction Costs – see Para. L13.1 and L13.2
- E&D Costs – 5% of the construction costs
- S&A Costs – 3% of the construction costs
- LERRD Costs – see Para. L13.3
- Contingencies – 25% of the subtotal of construction, E&D, S&A, and LERRD costs

The first costs for the initial array of alternatives are on **Table L13.4-1**.

Table L13.4-1 Project First Costs

Item	Alt.2 Romeville 3,000 cfs	Alt. 4A South Bridge 3,000 cfs	Alt. 4B South Bridge 3,000 cfs	Alt. 6 Dual/Split 3,000 cfs
Construction	73,500,000	110,700,000	106,800,000	111,200,000
Real Estate	2,200,000	2,200,000	2,200,000	4,400,000
Engineering & Design (E&D)	3,700,000	5,500,000	5,300,000	5,600,000
Supervision & Administration (S&A)	2,200,000	3,300,000	3,200,000	3,300,000
Contingencies (25%)	20,400,000	30,400,000	29,400,000	31,100,000
Total First Costs	**102,000,000**	**152,100,000**	**146,900,000**	**155,600,000**

[1] All costs are in October 2009 prices

L13.5 O&M Opinion of estimated costs

Operation and maintenance opinion of estimated costs were based on optional diversion arrangements as outlined in the alternatives to help in determining approximate cost of the single and dual diversion alternatives. These options had differing operation and maintenance requirements affecting operating cost. Operation and maintenance costs were based on estimations of the amount of labor to operate and maintain the equipment and structures with each option, materials, spare parts and supplies, electrical power, and other related costs. This cost estimation provided a basis for selection of the final alternatives based on operating cost added to the other costs on an annualized basis.

A final O&M opinion of estimated cost needs to be prepared after all engineering and electrical/instrumentation components have been selected.

Conceptual O&M costs were prepared for both single and dual siphon diversion structures and culvert diversion structures. Both single and dual diversions can result in meeting project goals, but operating costs are higher for the dual diversion alternative. (See discussions elsewhere on considerations of other performance and operational factors). Single or dual siphons will require higher O&M costs, which when combined with construction costs, make the single diversion culvert system more attractive. The following table (**Table L13.5-1**) provides the O&M opinion of estimated cost for each alternative.

Table L13.5-1 Diversion Alternative O&M Opinion of estimated costs

Diversion Alternative	Estimated O&M Costs Annually
1500 cfs Siphon System	$564,000
1500 cfs Culvert System	$525,000
3000 cfs Siphon System	$640,000
3000 cfs Culvert System	$590,000
Dual 750 cfs Siphon System	$689,000
Dual 1500 cfs Siphon System	$740,000

L13.6 Total Project Costs

The total project costs are shown on Table L13.6-1, and consist of the first costs on an annualized basis and the O&M costs. The annual costs for the capital costs were developed using an interest rate of 4-3/8% over a 50-year period, the USACE rate for 2011.

Table L13.6-1 Total Project Costs

Item	Alt.2 Romeville 3,000 cfs	Alt. 4A South Bridge 3,000 cfs	Alt. 4B South Bridge 3,000 cfs	Alt. 6 Dual/Split 3,000 cfs
First Costs	5,060,000	7,540,000	7,280,000	7,710,000
Operation & Maintenance Costs	590,000	590,000	670,000	740,000
Total Project Costs	**5,650,000**	**8,130,000**	**7,950,000**	**8,450,000**

[1] All costs are in October 2009 prices

[2] First costs were annualized using a discount rate of 4-3/8% over a 50-year period

L13.7 Cost Comparisons and Evaluations

Opinion of estimated costs were prepared for optional components and for optional elements of the components to help in refining the design and selecting

components. These options typically had similar hydraulic or other performance characteristics. Therefore, the selection of elements could be based primarily on cost considerations. These comparisons were a refinement to the designs and opinion of estimated costs. Similar cost comparisons need to be prepared as the preliminary and final design progresses to develop a more cost effective project.

Siphon vs. Culvert

Hydraulic designs and layouts were prepared for both a siphon diversion structure and for a culvert diversion structure. Theoretically, both methods can provide similar hydraulic performance. (See discussions elsewhere on considerations of other performance and operational factors). As shown on the **Figure L13.7-1**, siphons are the more cost effective low flow rates and culverts for higher flow rates. The cross-over is near 1,000 cfs. Siphons will require higher O&M costs; however, including the O&M costs will adjust the cross-over point only slightly.

Siphon Pipe vs. Inlet Canal

At the diversion points, the east levee of the Mississippi River is typically 200 to 300 feet from the river bank and the diversion structure needs to be extended across the batture to the river bank. With the siphon pipe in the river, the pipes need to be protected with bollards, as on the West Pointe a la Hache and Naomi siphons. Also, providing a trash rack on the inlet end of each pipe could introduce a maintenance problem. With an inlet canal, there would be no facilities projecting into the river. The trash racks could be installed in the inlet canal, providing better access for cleaning and maintenance. The cost comparison is in **Annex L-1**.

Based on this comparison, and the trash rack considerations, the recommended design is to use an inlet canal.

Diversion Culvert vs. Inlet Canal

As with the siphon installation, the diversion culverts could be extended across the batture, or an inlet canal could be extended from the River to near the base of the levee.

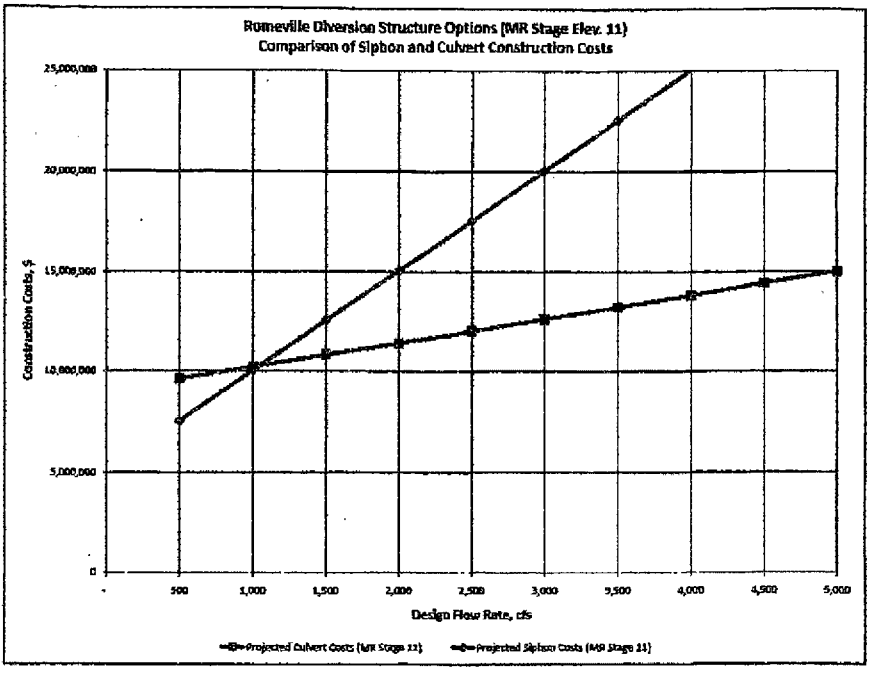


Figure L13.7-1 Romeville Diversion Structure Options Comparison of Siphon and Culvert Construction Costs

Earthen Canal vs. Concrete-lined Canal

Earthen canals are typically used for the transport of water and for drainage in open areas. Concrete-lined channels can be used to increase the hydraulic conveyance capacity. Concrete-lined channels are also used in areas with right-of-way constrictions, or areas with very high real estate acquisition costs. For this project, alternate concrete-lined channel designs and opinion of estimated costs were prepared for the Romeville alignment. As shown in the following **Figure L13.7-2**, the earthen channels are less expensive. Therefore, earthen channels are recommended for this project. The figure also shows the cost trend for a lower earthen canal, which would also require de-silting the outfall drainage channels, as discussed in Section L2.6. This item should be re-evaluated during the final designs.

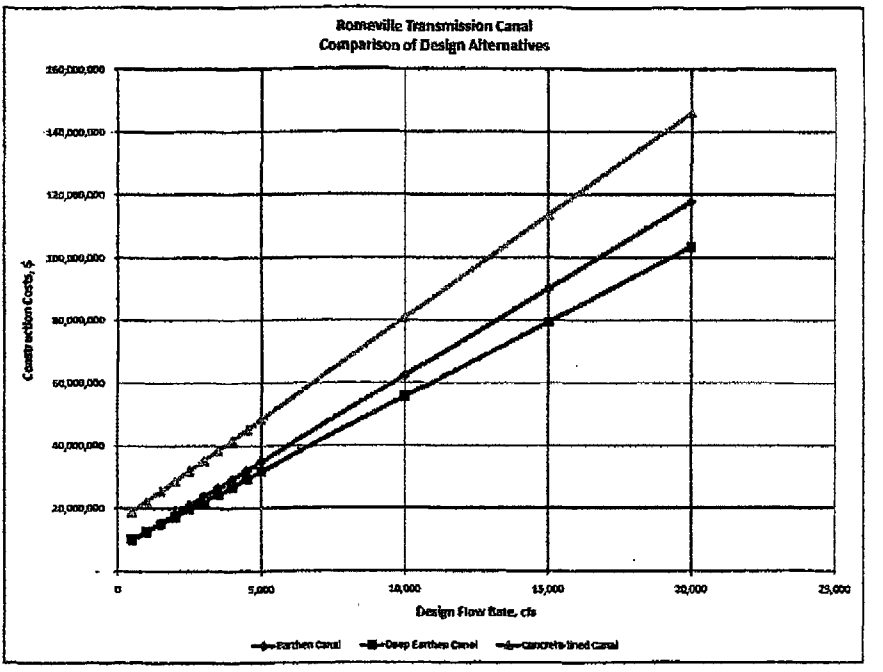


Figure 13.7-2 Romeville Transmission Canal – Comparison of Construction Costs for Design Alternatives

Diversion Culvert Design Basis

As discussed in the hydraulic design of the diversion culvert, three Mississippi River stages were analyzed as the design basis. Construction opinion of estimated costs were developed for the Romeville diversion culvert designed for Mississippi River stage Elev. 5 and for Elev. 11. The following figure demonstrates the major increases in construction costs to be able to divert the full design flow rate at the lower stages in the Mississippi River.

Railroad Culverts vs. Railroad Bridge

(To be analyzed during final design)

Road Culverts vs. Road Bridge

(To be analyzed during final design)

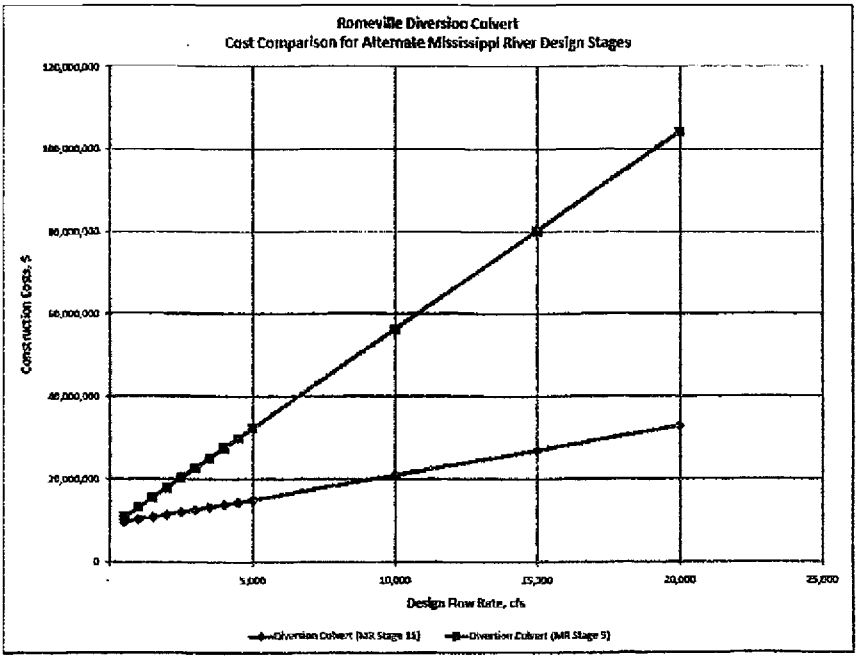


Figure L13.7-3 Romeville Diversion Culvert – Design for MR Stage 5 vs. 11 Construction Costs

Additional cost comparisons and evaluations need to be provided in the design phase to select alternate elements, including the following:

L13.8 Cost Risk Analysis

A detailed risk analysis will be prepared as part of developing the MCACES-II construction opinion of estimated cost.

This section addresses the risks and uncertainties of cost escalation related to the conceptual construction opinion of estimated costs in three major categories: costs/pricing, excess excavated material, and construction conditions.

L13.8.1 Cost Risks

The construction opinion of estimated costs have the following risk factors:

- Quantities – The earthwork quantities were developed from conceptual design drawings and used the old LiDAR topographic data. The quantities can be

expected to vary substantially compared to future quantities developed from topographic surveys.

- Pricing – The unit pricing was based on a nationwide database of prices, vendor data, and contractor input, all considered as budgetary level, and not firm quotes.
- Geotechnical – The geotechnical investigation was not available, and assumptions had to be made on soil and groundwater conditions.
- Structural designs – No structural designs have been prepared, and certain dimensions and quantities (i.e. – structural concrete) were based on professional experience on other large civil works projects.
- Inflation – future inflation trends are unknown.
- Price trends – there are currently lower prices due to the recession, but prices could increase as the economy improves.
- Higher prices in Louisiana – the area experienced high labor and material prices, causing significant construction price increases due to the extensive reconstruction activity after Hurricane Katrina.
- Scope changes – scope changes will impact pricing.

Upland Areas
The diversion culvert and the transmission canal involve heavy civil construction, with construction cost/pricing information readily available. The quantities could vary significantly, as discussed above. The prices used should establish adequate budgets.

Swamp
Price risk is high for the control structures and the berm gaps in the Swamp. There is little database information on costs for work in such conditions. Access will be difficult and could cause a major price escalation.

Transition Areas
The Highway 61 cross culverts and drainage channels will be constructed in the Swamp conditions, but with excellent access from Highway 61. The work involves common construction practices with readily available construction pricing information. The quantities still need to be better defined with on-the-ground topographic surveys. The current price risk level is moderate, and the price risk at the end of final design will be much lower, with more confidence in quantities.

Summary of Construction Cost Estimate Risks
Diversion structure and transmission canal – moderate risk

Control structures and berm gaps – high risk

Highway 61 Cross Culverts – moderate risk

L13.8.2 Beneficial Use of Excess Excavated Material
This section addresses the risks and uncertainties of finding a beneficial use for the excess excavated material, or disposing it with minimal impacts, and the related risks to project cost escalations.

Upland Areas
Construction of the transmission canal will result in large volumes of excess excavated material, with a much smaller excess volume from the diversion culvert. The opinion of estimated costs are based on the assumption that there is a market for fill material, and that the construction contractor will be able to sell the material, or dispose of it off of the Blind River project site for use on other unrelated projects. This assumption is based on the excess material being suitable for fill, and on the current or recent shortage of fill material in South Louisiana. If the material can't be sold or disposed of off-site, a disposal area will have to be acquired for the project. The price risk should be considered moderate, as the quality of the spoil material is not yet defined.

A temporary levee will be constructed on the river side of the east Mississippi River levee to allow open-cut construction of the diversion culverts through the levee. The current design concept and cost estimating is based on the use of excess material from the transmission canal for the temporary levee. If the material is not suitable for levee construction, appropriate soil will have to be imported to the site, at a significant cost increase.

After the geotechnical investigation identifies the soil properties, the final approach to spoil disposal can be developed, possibly using the following approaches. If the approach is clearly defined, the construction contractor can then include the necessary costs in the bid, reducing the risks of changed costs during contract performance.

- Suitable for fill – Require the contractor to remove the material from the site, becoming the owner of the spoil. Allow it to be sold or disposed, as determined by market conditions.
- Unsuitable material – Acquire a spoil disposal site for placement of the material.

Swamp
Small volumes of excess excavated material will result from excavation of the berm gaps and construction of the control structures in the Swamp. The material will not be removed from the Swamp, but will be disposed of locally. The current concept is to place the excess excavated material on and adjacent to the existing spoil banks along the existing drainage channels. This will increase the size and height of the existing berms (spoil banks), thus developing a beneficial use for the spoil material by creating additional refuge areas for wildlife to escape flood conditions in the Swamp.

Transition Areas
The excess excavated material at the Highway cross culverts will be disposed of in the Swamp, creating wildlife refuge areas, creating a beneficial use.

Summary of Risks from Excess Excavated Materials
In summary, the cost escalation risks due to excess excavated material disposal are:

- Diversion structure and transmission canal – moderate risk, as the material quality is still unknown
- Control structures and berm gaps – low risk, as the excess material will be beneficially disposed of locally
- Highway 61 cross culverts – low risk, as the excess material will be beneficially disposed of locally

L13.8.3 Construction Conditions
The project will be constructed under two very different site conditions: upland areas and the Swamp. This section discusses construction risks primarily impacting costs and completion schedule.

Upland Areas
The diversion culvert and most of the transmission canal will be constructed in upland areas using conventional construction techniques. The downstream end of the transmission canal is in the Swamp and subject to the risks described in the next section. The sites are in an area of industrial, commercial, and residential development, and site conditions and required construction approaches are known from experience with such developments. The two components have direct access from two paved public roads. Also, large equipment and high volume items could be delivered to the diversion culvert site via barges on the Mississippi River. Some of the major construction risks and how these were considered in design and cost estimating are:

- Mississippi River flood conditions – A temporary levee will be designed and constructed to permanent levee standards, reducing risks from Mississippi River flooding.
- Unknown underground conditions – These two components are in largely undeveloped agricultural areas. The geotechnical investigations will define soil conditions. Therefore, risks from unknown conditions will be reduced.
- Groundwater – High groundwater conditions, high volumes of groundwater, and special water control techniques were anticipated in the construction cost estimates, reducing risks of additional costs.
- Extended wet weather – Extended wet weather could delay the project schedule and increase costs incurred during delays. These two components are

in upland areas, with positive drainage towards the Swamp, reducing the impact of wet weather.

- Conventional construction techniques – The components will be constructed with conventional and well-established construction practices and with convention equipment, resulting in reduced risks.
- Floods – Minimal risk of losing equipment, materials, and partially constructed facilities to flood damage, as the sites are above flood elevations or protected by the temporary levee.

The opinion of estimated costs developed to date considered these conditions; therefore, risks of cost escalations due to them are reduced.

Swamp Conditions

The control structures and the berm gaps will be constructed at remote sites deep within the Swamp. Special construction equipment and construction techniques will be necessary to work in a setting with soft and saturated soils, standing water, and extended periods of high water. Access will be via barges and work boats in the existing drainage channels. Risks include:

- Use of inappropriate construction equipment
- Construction techniques not suited to the Swamp
- Difficulty in moving large construction equipment, materials (large control gates and high volumes of concrete), and labor to the work sites

The risks to the contractor would be in the form of equipment mired in muck, low productivity, higher costs for access, extended delays to the schedule due to wet conditions, and higher direct costs to perform the work. The bidders can be expected to increase bid prices to cover such risks, and the contractor can be expected to more aggressively pursue change orders and claims to recover cost over-runs.

The construction opinion of estimated costs to date considered these risks, using higher unit prices for the work, and estimating additional costs to gain access. However, these risks need to be re-evaluated as the designs progress to determine if there is sufficient cost coverage. Another consideration that can be reviewed during the design phase is to allow a construction access road to one or more of the control structures, thereby reducing access costs.

Transition Areas

The Highway 61 crossings and channels between the road and the KCS RR will have excellent direct access from Highway 61. The work site conditions will be similar to the other sites deeper in the Swamp; however, spoil from the proposed drainage channels can be placed to establish raised access roads and work pads above the Swamp conditions. The direct access from Highway 61 to the work sites greatly reduces the access costs.

Summary of Construction Risks

In summary, the construction risks and uncertainties, primarily related to cost and schedule, are:

- Diversion structure and transmission canal – low risk
- Control structures and berm gaps – high risk
- Highway 61 Cross Culverts – low risk

L14. SCHEDULE FOR DESIGN AND CONSTRUCTION

L14.1 Design Schedule

The design services for Blind River are in two distinct parts: Preliminary and Final. The preliminary design services will include additional field investigations to refine the hydraulic modeling. The hydraulic modeling will refine the expected water surface elevations for the project and define flow patterns through the swamp based on the diversion flows and downstream water level conditions. Additional geotechnical and surveying services will be required to provide data for property acquisition and hydraulic modeling of water surfaces.

Schedule for design services is as follows:

Preliminary design field services	6 months
Preliminary design supplemental hydraulic modeling	3 months
Preliminary design supplemental water quality modeling	2 months
Preliminary design calculations	4 months
Preliminary engineering drawings	3 months
Preliminary engineering specifications	2 months
Preliminary design opinion of estimated cost	1 month
Total Preliminary Engineering Duration	12 months
(Note: activities are in some cases concurrent)	
Final design calculations	2 months
Final design drawings	6 months
Final design specifications	3 months
Final design opinion of estimated cost	1 month
Final design bid documents	1 month
Total Final Engineering Duration	10 months
(Note: activities are in some cases concurrent)	

L14.2 Construction Schedule

The construction for Blind River will involve several pipeline, utility and transportation relocations that will impact the construction schedule. It is not known whether the temporary and permanent relocations will be performed under the project contract(s) or will be contracted independently by the pipeline or utility owner. The railroad in many cases provides their own relocation design and construction. These relocations will need to be carefully coordinated with the primary construction contract(s).

Each element of the project can be constructed concurrently under a single contract or with multiple contracts since several specialized services are required. The diversion structure will involve temporarily relocating the flood protection levee and electrical and mechanical skilled workers. The transmission channel will require large earth moving equipment and compaction equipment. The berm gaps and control structures will require barge operations for installation. It may be more cost effective to procure each of these under separate contracts to optimize the use of specialty services. The proposed schedule will consider separate relocation and construction contracts.

Utility Temporary Relocations	4 months
Pipeline Permanent Relocations	8 months
Railroad Temporary Relocations	6 months
Utility Permanent Relocations	4 months
Railroad Permanent Relocations	12 months
Diversion Structure Levee Temporary Relocation	6 months
Diversion Structure Construction	15 months
Transmission Channel Construction	8 months
Berm Gap and Control Structure Construction	10 months
Total Construction Duration	24 months
(Note: activities are in some cases concurrent)	
Start up and training activities	4 months

L15 REAL ESTATE AND RIGHT-OF-WAY REQUIREMENTS

L15.1 Scope of Requirements

This section presents the basis for real estate necessary to accommodate the construction, operation, and maintenance of the proposed Blind River project. The project will require acquisition of permanent rights-of-way, temporary construction easements, and permits to construct and operate the proposed facilities. The following paragraphs provide the basis for determining actual real estate acquisition dimensions and locations.

The detailed real estate analysis and acquisition process is described in Appendix K of the main report.

Current land ownership in the project area is identified, in general terms, on Figure L15-1. Following is a summary of ownership, as it impacts the proposed project:

Diversion Facility

- The general area is in private ownership, with private ownership extending across the levee, across the batture, to the edge of the Mississippi River.
- The Pontchartrain Levee District has a levee easement for the levee.
- LA 44 is in an 80-foot wide road right-of-way owned by State of Louisiana.

Transmission Canal

- The general area is in private ownership.
- The Canadian National Railroad is in a 100-foot wide right-of-way.
- LA 3125 is in a 300-foot wide road right-of-way owned by State of Louisiana.
- The east end of the transmission canal alignment is in the Maurepas Wildlife Management Area, owned by the State of Louisiana, Department of Wildlife and Fisheries
- Several utilities and pipelines cross the alignment – these facilities are apparently in easements.

Control Structures

- All of the control structures are in the Maurepas Wildlife Management Area, owned by the State of Louisiana, Department of Wildlife and Fisheries

Cross Culverts and Interconnecting Channels at Highway 61 Corridor

- Highway 61 is in a 300-foot wide road right-of-way owned by State of Louisiana.
- Ownership of the corridor between the KCS RR and Highway 61 is unclear.
- Pipelines in the corridor are apparently in easements.

Road and Railroad Crossings

It is considered that rights-of-way or easements will not be acquired across the roads and railroads to accommodate the components. Instead, the road and railroad owners will allow construction, operation, and maintenance under a permit approval.

L15.2 Permanent Real Estate Acquisition Requirements

L15.2.1 Diversion Facility

The diversion site size will be determined by final design and layout of the diversion culvert and inlet canal, and the ancillary facilities planned at the site. Current planning of a 400-foot wide easement needs to be verified as the design advances.

L15.2.2 Transmission Canal

Most of the transmission canal alignment crosses undeveloped land in private ownership. The downstream end (east end) is within the wildlife management area owned by the State. The right-of-way width has been developed to accommodate the canal, berms on both sides of the canal, and additional strips on both sides for drainage and mowing access. The typical canal section and right-of-way width is further defined as follows:

- Berms – 12-foot wide minimum top width to allow maintenance vehicle access, 4:1 side slopes (interior), and 4:1 or 5:1 exterior side slopes for mowing safety.
- Right-of-way width – 500 feet
- Without berms – minimum of 30 feet each side for large maintenance equipment and drainage
- With berms – minimum of 10 feet beyond the outer toe of berm on each side, for a local drainage swale and mowing access
- ROW drainage – provide a small drainage swale at the ROW line and discharge to local drainage.

The calculated right-of-way width varies as existing ground elevations vary along the alignment. The current design for the 3,000 cfs transmission canal requires a maximum width of approximately 315 feet. The current acquisition plan has identified a 500-foot wide strip, a width that will be adequate for the current design. The final plan may require wider berms than the required minimum to allow a balance of cut and fill quantities to optimize construction costs.

The transmission canal will cross several existing local drainage channels. Some or all of these may need to be relocated. Additional permanent right-of-way may be required to accommodate these drainage relocations.

The box culverts at LA 44, CN RR, and LA 3125 will be installed under permits.

L15.2.3 Control Structures

The proposed control structures are located in the Swamp, on land owned by the State. Therefore, no real estate acquisition will be required.

Alternate access may be considered, consisting of a permanent access road to each

control structure. Such access routes are likely completely within lands owned by the State, and no additional real estate acquisition will be required.

L15.2.4 Cross Culverts and Interconnecting Channels at KCS RR/Highway 61 Corridor

The proposed box culverts will be installed under Highway 61 by permit.

The land ownership of the corridor between the KCS RR and Highway 61 is unclear, although it is considered to be private. Rights-of-way may need to be acquired to promote drainage under the railroad crossing and the HWY 61 culverts. The right-of-way width should be established, as discussed for the transmission canal to provide sufficient space for the channel, berms, and drainage.

L15.3 Temporary Construction Easements

This section defines temporary construction easements and temporary access easements required to construct the proposed project components. Dimensions of the actual temporary easements will be defined in the final design phase, as the components are designed, construction phasing and sequence are determined, and temporary easements needs are finalized.

L15.3.1 Diversion Facility

The land ownership on the batture and at the levee is unclear. The existing levee will be temporarily removed at the box culvert crossing. The soil will have to be stockpiled near the site in a temporary construction easement. This stockpile site should be between the levee and the temporary LA 44 relocation. If the soil is stockpiled on the batture, it would be subject to flooding from the Mississippi River.

The temporary levee and the limits for the existing levee removal extend past the right-of-way requirements for the permanently installed facilities. Temporary construction easements will be required for the levee work.

L15.3.2 Transmission Canal

The transmission canal has good access from LA 44 and from LA 3125 and the proposed permanent right-of-way is adequate for the construction activities. Therefore, no temporary construction or access easements are required for the transmission canal. However, see the following items for construction at the transportation facilities crossings.

L15.3.3 LA 44 Temporary Relocation

The proposed diversion box culvert will be installed under LA 44 by open-cut construction. LA 44 will be relocated temporarily to the east, and the existing pavement removed to accommodate the box culvert construction. The road relocation will require a temporary construction easement approximately 1,000 feet long and 80 feet wide. The actual temporary easement dimensions will be

determined in final design, as the temporary pavement relocation design is completed.

L15.3.4 CN RR Temporary Relocation

The proposed transmission canal will have a multi-cell concrete box culvert installed under the CN railroad tracks by open-cut construction. The railroad will have to be temporarily relocated (shoofly) to accommodate the construction. The final design requirements have not yet been obtained from the railroad. It is likely that the shoofly will have to be designed to maintain full operating speeds, resulting in a long shoofly layout. The existing railroad right-of-way is 100 feet wide, and the shoofly might be located totally in the existing right-of-way. For planning purposes, it is considered that the shoofly will have to be at least partially outside of the right-of-way. Consider that the construction easement will be 2,000 feet long and 50 feet wide.

L15.3.5 LA 3125 Temporary Relocation

The proposed diversion box culvert will be installed under LA 3125 by open-cut construction. LA 3125 will be relocated temporarily to one side, and the existing pavement removed to accommodate the box culvert construction. The existing road right-of-way is 300 feet wide, and this should be adequate space to contain the temporary relocation totally within the existing right-of-way. The temporary relocation can be done in phases, if necessary, to avoid acquiring temporary construction easements.

L15.3.6 Control Structures

The proposed control structures are located in the Swamp, on land owned by the State. Access will be via the existing drainage channels. No temporary construction or access easements are necessary.

L15.3.7 Cross Culverts at Highway 61

Concrete box culverts will be constructed under Highway 61 at four locations by open-cut construction. The pavement will be temporarily relocated to accommodate the construction. Highway 61 has a 300-foot wide right-of-way, and the temporary relocations can be done within that space. Several phases may be necessary.

L15.3.8 Interconnecting Channel at KCS RR/Highway 61 Corridor

Interconnecting channels may be excavated across the corridor between the KCS RR and Highway 61. The ownership of the corridor is unclear. All access will be from Highway 61 and no temporary access easements will be needed. If an adequate permanent right-of-way width is acquired, temporary construction easements will not be necessary.

L16 INFRASTRUCTURE RELOCATIONS

L16.1 Purpose and Scope

The purpose of this section is to identify public and private infrastructure that may impact the design, construction, operation, and maintenance of the Blind River diversion project. The categories of facilities include public utilities, private utilities, pipelines, roads, and railroads. Central facilities, such as water treatment, water storage, water pump stations, water wells, wastewater pump stations, and wastewater treatment plants are also included in the public infrastructure category. The investigation included both underground and overhead utilities.

The investigations included the site of the various project components and adjacent areas to identify constraints on project alignments, location of components, and to identify concerns for safety and potential disruptions to utility service and pipeline operations. Relocation costs will be developed for those utilities and pipelines conflicting with the project, and which need to be relocated to accommodate the project.

Drainage facilities will require redesign and relocations to accommodate the project. These are addressed in Section L7 Civil Design and were not included in the relocation discussions.

Through-out the remainder of this section, the term "utility" is typically used to apply to all categories of infrastructure.

L16.2 Investigation Process

The conceptual phase investigation and analysis effort was performed in three steps:

- Identify utilities and pipelines in and adjacent to the project area, and obtain contact information.
- Obtain facility data and record drawings from the owners or operators and determine if conflicts may exist.
- Request budgetary relocation estimates from the owners, as the project is in the conceptual and feasibility phases.
- In the next phases of the project, preliminary and final design, the following steps will be taken to better define the relocation needs and costs:
- Request that the utility/pipeline owner probe their underground facility, if appropriate, to determine accurate plan and profile locations
- Pot-hole critical locations, if necessary, to obtain more accurate location data
- Have the surveyor tie in the probe stakes and pot-holes

- Analyze component location and design, and refine relocation requirements
- Prepare exhibits of relocations and coordinate requirements with the utility/pipeline owner
- Obtain relocation opinion of estimated costs from the utility/pipeline owner

Relocation Design and Reimbursement

In most cases, the private utility owners will be fully responsible for the design and relocation of their facility. The State will enter into a contract with the private utility owners to have the relocations completed prior to start of project construction in the area.

Public utilities adjacent to public roadways are common civil construction items, and could be included in the construction contract.

The railroad relocations and reconstruction will likely be done by the owner through a reimbursement agreement with the State. Careful coordination would be required during construction, as the temporary railroad relocation and reconstruction and the project construction will be done in planned sequential phases.

Data Collection

Existing private utilities and pipelines within the vicinity of the restoration area, the diversion facility, and the transmission canal were identified through LA OneCall, record drawings, and limited field investigations. Using coordinates provided by CDM, LA OneCall alerted utility owners and operators within the project area. Owners of known utilities, including power, pipelines, and telecommunication were individually contacted in order to obtain specific details about their facilities. Each owner received a letter of transmittal from CDM, a USACE "Existing Utilities" questionnaire, and an aerial photograph of the project's boundaries. As-built drawings and alignment sheets were requested from each company along with the completed questionnaire.

To date, CDM has not received responses from all utility and pipeline owners, and the investigation efforts are still in progress. The utility research effort will continue through the next design phases and it can be anticipated that additional utilities will be found. This is due to, among other things, incomplete records, non-responsive owners, and facilities being sold multiple times.

As the utility data was collected, the information was tabulated and plotted in GIS. The figures primarily show major utility conflicts. Minor utilities in the roadway right of way are not shown, but are tabulated at the end of this section. **Figure L16.1-1** shows initial plotting of utility data for the project area. **Figure L16.1-2** shows a detail at the proposed control structure near the east end of the transmission canal. **Figure L16.1-3** is a detail of a potential culvert crossing and interconnecting channel at the KCS RR/Highway 61 corridor. At the end of this section, **Table L16.1-1** and **Table L16.1-2** lists the utilities identified to date.

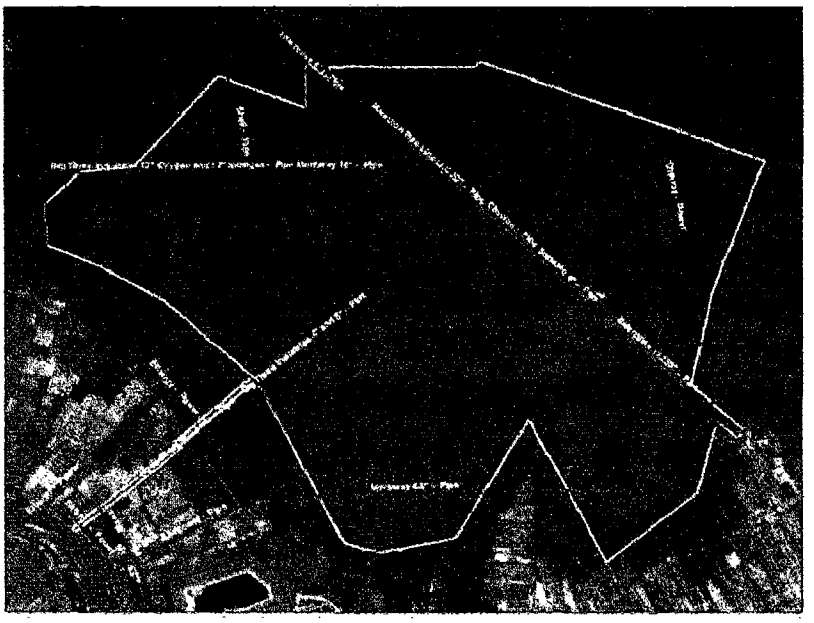


Figure L16.1-1Utilities and Pipelines in Project Area

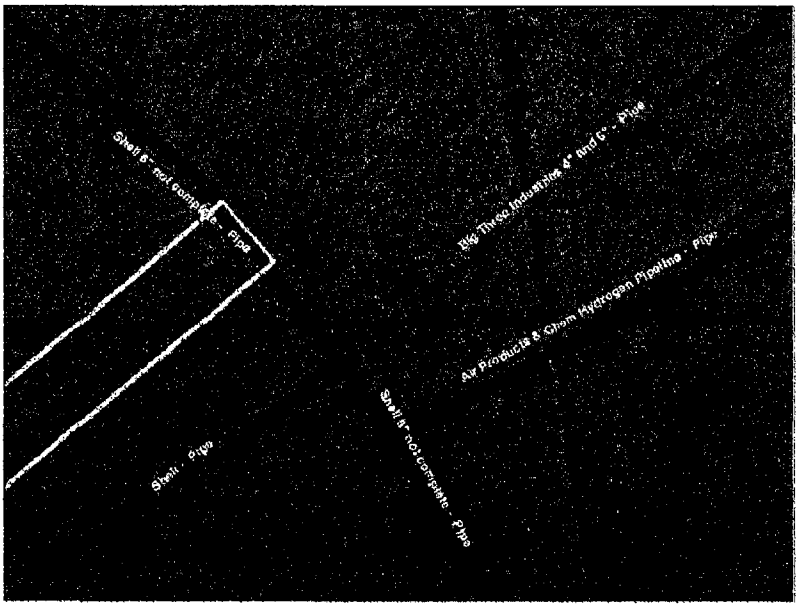


Figure L16.1-2 Pipelines at East End of Transmission Canal

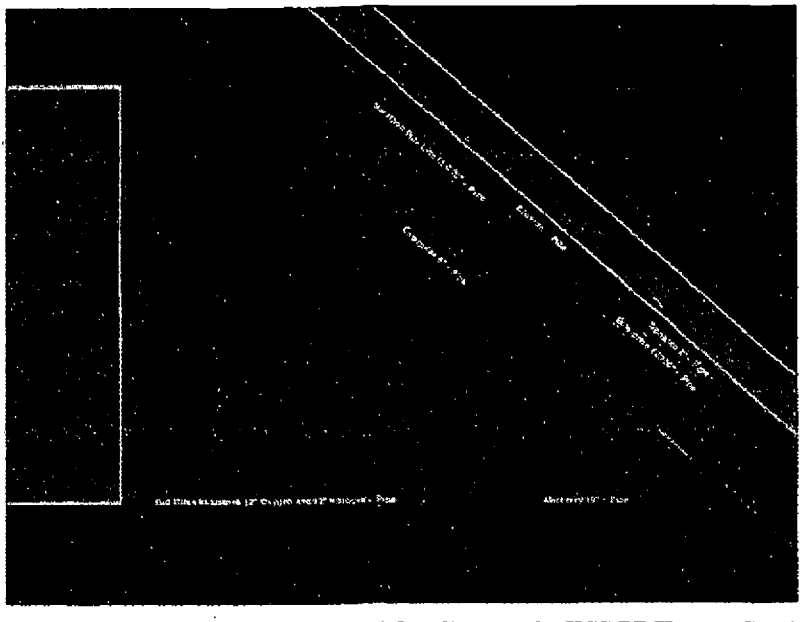


Figure L16.1-3 Utilities and Pipelines at the KCS RR/Hwy 61 Corridor

Note that there is conflicting information on owner names, line sizes, and product transported. These are expected to be resolved as additional data is collected and verified directly with the owners. No central facilities were found in or adjacent to the project area which would impact the project. The table uses shading to indicate utilities located, but not requiring adjustment or temporary relocation. The utility information will be plotted on the design drawings in the PED design phase.

L16.3 Underground Utilities and Pipelines

This section describes the known underground utilities, addresses the clearance criteria, presents a conflict analysis, and defines proposed relocations for underground utilities (public and private) and pipelines. **Table L16.1-1** and **Table L16.1-2** also summarize the conflict and relocation recommendations.

L16.3.1 Descriptions

AT&T Distribution

AT&T has two routes of telecommunication lines, both of which run across the proposed Romeville diversion alignment. Buried lines run parallel to LA 44 on the eastern side and the other line may run parallel to LA 3125. The lines are considered active; however, any further information concerning the type of line,

clearance, size, and date installed has been withheld as proprietary.

Air Liquide America

Air Liquide operates two carbon steel pipelines that run parallel to the southeast side of the transmission canal from the Occidental Chemical (OxyChem) plant to the existing St. James Parish drainage channel at the Swamp. The 4-inch line carries pressurized nitrogen and the 6-inch line carries pressurized oxygen. The lines were installed in 1977 at a depth of approximately 5 feet. Design life is unknown. Both lines continue past the St. James Parish drainage channel in a northeasterly direction, intersecting Air Liquide's two 12-inch pipelines at US 61.

Gulf South Pipeline Company, LP

Gulf South Pipeline Company, LP operates a 24-inch, carbon steel pipeline that carries natural gas. The line was built in 1990 and has a design life of 100 years. Correspondence with the Gulf South Pipeline's Engineering Operations division confirms interference with the pipeline and the transfer canal between stations 63+00 and 64+00. The pipeline runs parallel to LA 3125. It was also noted that Gulf South owns an abandoned 18-inch pipeline that runs adjacent to the 24-inch line, approximately 20 – 30 feet towards the Mississippi River.

Petrologistics Olefins, L.L.C.

Petrologistics Olefins, LLC operates a 6-inch, steel pipeline that carries ethylene to and from the OxyChem plant. The line was built in 1980 with a design life 50 years, assuming adequate corrosion protection. The depth varies from 6.5 to 7.2 feet of cover. The pipeline will cross the transfer canal at three locations. The pipeline splits on the east side of the OxyChem plant. The line traveling away from the plant parallels the Canadian National Railroad and subsequently crosses the transfer canal. The pipeline exiting the OxyChem plant runs parallel to the diversion channel on the eastern side for approximately .5 miles before it encroaches 30 to 40 yards onto the proposed route of the transfer canal (90°49'21"W 30°4'27"N). It continues to travel along the route of the proposed channel, crossing LA 3125. The pipeline turns parallel to LA 3125 and travels WNW. It again intersects the proposed diversion channel at N. Dornier Road. Alignment sheets have been provided by Petrologistics' pipeline supervisor.

Shell Pipeline Company, LP

Shell Pipeline Company, LP owns and operates a 6-inch, steel pipeline that carries ethylene. The line was built in 1967 with a design life of 100 years. The depth varies between 5 to 6 feet of cover. Upon exiting OxyChem, the line runs parallel to the proposed location of the transfer canal. The line crosses perpendicularly at the St. James Parish canal and immediately turns northeast, where it follows another canal within the project boundaries. Shell Pipeline's Land and Permitting Department confirmed that the pipeline runs parallel to the diversion channel and does not cross.

Texas Brine Company, L.L.C.

Texas Brine Company, LLC operates a 14-inch carbon steel pipeline that carries saturated salt brine. The line was installed in 1980 and has a design life of 75 years. The average depth is 5 feet. An intersection point occurs approximately 700 feet southwest of the St. James Parish canal. Pipeline markers for Texas Brine were identified by the surveying team between stations 73+00 and 74+00, 190 feet towards the southern ROW boundary. Another marker was located at station 83+00. Exact direction of the line at this station is unclear.

Williams Gas Pipeline (Transcontinental Pipeline Company)

Williams Gas Pipeline operates a 12-inch, steel pipeline that carries natural gas. The line was installed in 1971 and has an indefinite design life. Depth of the pipeline varies between 10 to 15 feet. Field survey crews have located this pipeline between stations 63+00 and 64+00. It runs parallel to LA 3125 and approximately 50 feet south of the Gulf South Pipeline.

L16.3.2 Conflict Analysis and Proposed Relocations

All underground utilities that conflict with the project will be permanently adjusted vertically under the project component, or re-routed to eliminate the conflict. For vertical adjustments, the USACE requires 10 feet vertical clearance below the constructed facility to the utility. All underground utilities crossing the project alignment for the diversion culvert and the transmission canal are less than 10 feet deep. The project facilities are deeper than 10 feet; therefore, all such crossing underground utilities will need to be adjusted vertically. The current plan is to do a vertical adjustment, and not relocate the utilities around the project.

Diversion Culvert

- Pipelines – none
- An underground AT&T telecommunications cable may be in the LA 44 right-of-way, and will need to be adjusted vertically under the culvert. As an alternate, the utility could be relocated to be over top of the box culvert, as there is sufficient space above the top of the box culvert.
- Parish water line may be in the LA 44 right-of-way and will need to be adjusted vertically under the culvert. As an alternate, the utility could be relocated to be over top of the box culvert, as there is sufficient space above the top of the box culvert.

Transmission Canal

- There are seven pipelines crossing the proposed transmission canal alignment, six of which will need to be adjusted vertically. The seventh line is apparently abandoned and can be removed from the proposed right-of-way.

- A pipeline is mapped in GIS as crossing the east end of the transmission canal on the west side of the existing perimeter drainage channel. It is likely that the pipeline is actually on the east side of the existing drainage channel. Therefore, there is no conflict.
- West of LA 3125, a Petrologistics pipeline encroaches into the southeast side of the proposed transmission canal right-of-way for a distance of 2,000 feet. The pipeline will have to be probed or pot-holed to define the actual extent of the encroachment. The general area is undeveloped and the transmission canal alignment could be adjusted instead of relocating the pipeline.
- Several pipelines are located on the southeast side of the proposed right-of-way, but outside of the proposed taking. Therefore, there are no conflicts.
- An underground fiber optics cable is in the Canadian National (CN) RR right-of-way, which conflicts with construction.
- An underground AT&T telecommunications cable may be in the LA 3125 right-of-way, and will need to be adjusted vertically under the culvert. As an alternate, the utility could be relocated to be over top of the box culvert, as there is sufficient space above the top of the box culvert.
- Parish water line may be in the LA 3125 right-of-way and will need to be adjusted vertically under the culvert. As an alternate, the utility could be relocated to be over top of the box culvert, as there is sufficient space above the top of the box culvert.

Control Structure Nos. 1-6A and 1-6B (near the transmission canal outfall)

- Up to five pipelines may be in the area of the control structures, as shown on Figure **L16.1-2**. Of these, two are likely far enough from the sites to not conflict with the project. These need to be identified for construction. The other pipelines are in easements adjacent to the existing drainage channels, and likely close to the proposed control structures. The proposed structure can probably be designed to avoid conflicts, thereby avoiding relocations.
- There are no other underground utilities at the area

Control Structure Nos. 1-8A and 1-8B2 (near Grand Point)

There are no known underground utilities or pipelines near the control structure site, as shown on **Figure L16.1-1**.

Control Structure No. 1-7 (near Highway 61)

Utility investigations are incomplete in the area. There are underground utilities and pipelines in the general area, but the control structure site has not yet been analyzed. The location is flexible and will be sited to avoid utilities.

Cross Culverts along the Highway 61 Corridor

There are four locations proposed for cross culverts. See Figure L16.1-3 for one location, typical of all locations.

- There may be six pipelines in the corridor between the KCS RR and Highway 61. All of these are outside of the highway right of way and are not expected to need adjustment.
- No underground telecommunication lines have been identified, but may be found after site investigations.

L16.4 Overhead Utilities

This section addresses the clearance criteria, conflict analysis, and proposed relocations for underground utilities (public and private) and pipelines.

L16.4.1 O/H Utility Descriptions

AT&T Distribution

AT&T has two routes of telecommunication lines. Both lines run across the proposed Romeville diversion channel. A pair of aerial and buried lines runs parallel to LA-44 on the eastern side. The other line is aerial and runs parallel to LA-3125. The lines are considered active; however, any further information concerning the type of line, clearance, size, and date installed has been withheld as proprietary. A cost analysis for the removal and relocation of the buried telecommunication line will be performed upon receiving more information.

Entergy Louisiana, LLC

Entergy Louisiana, LLC owns and operates aerial power transmission and distribution lines that cross the proposed diversion channel. One distribution line runs parallel to LA 44; the other runs parallel to the Canadian National Railroad. Aside from drawings marking the route of the distribution lines, no other information was received by CDM. Entergy also owns and operates a 230 kilo-Volt transmission line, which provides service to various substations and interconnects various generating plants. The line runs parallel to LA 3125, on the northeastern side. It was installed between 1966 and 1967 and was designed to last sixty years. The distribution lines will have to be relocated during construction in order to provide a safe working space for the machinery, equipment, and personnel needed to construct culverts at each location. Steel towers spaced 400 – 500 feet apart support the transmission line. Construction of the diversion channel should not interfere with the towers. The only precaution taken will be a survey of the vertical clearance at the midpoint between the two towers. Heavy loading during summer and winter months may be of concern during excavation. Entergy will advise the maximum available vertical clearance of the power lines before construction of this phase. Entergy is currently performing cost estimations for the temporary relocation of the two distribution lines.

L16.4.2 Conflict Analysis and Proposed Relocations

Diversion Culvert

At LA 44, the poles for the overhead power and telecommunication lines conflict with the project, and will have to be relocated.

Transmission Canal

- At the CN RR, there may be an overhead power line.
- At LA 3125, overhead lines include power, telecommunications, and CATV. The poles conflict with the project and will need to be relocated.
- Approximately 800 feet east of LA 3125, an electric transmission lines crosses the proposed alignment. The towers are spaced at approximately 500 feet and one tower conflicts with the transmission canal. It is most likely that the single tower will be replaced with two towers that will span across the canal.

Control Structures

- There are no known overhead utilities at the two control structures near the transmission canal and near Grand Point.
- The area has not been investigated for the control structure near Highway 61.

Cross Culverts at the Highway 61 Corridor

- There is an electric transmission line in the corridor. The culverts will be located to avoid conflicts with the poles/towers.

L16.5 Transportation Facilities

The culverts at the roads and railroad are large hydraulic structures, and will have to be constructed by open-cut techniques. Three existing transportation routes will be temporarily relocated during the construction phase of this project - LA 44, LA 3125, and the Canadian National Railroad.

L16.5.1 Transportation Descriptions

LA 44 is a two-lane asphalt road (one lane each direction) in an 80-foot wide right-of-way. Drainage is by open ditch.

LA 3125 is a two-lane asphalt road (one lane each direction) in an 300-foot wide right-of-way. Drainage is by open ditch.

The CN RR has a single track in a 100-foot wide right-of-way.

L16.5.2 Conflicts and Proposed Temporary Relocations

The temporary relocations will be designed to the standards of the UMTCD.

LA 44

The diversion culvert will be constructed across LA 44 in an open-cut excavation.

This requires the existing northbound and southbound lanes of LA 44 to be removed for construction. Re-routing traffic from LA 44 to LA 3125 is an unacceptable detour route. Therefore, local traffic will be maintained through the construction area at all times by providing a temporary detour road. The detour road will be an asphalt road approximately 1,000 feet long with 2 – 12' lanes (one each direction).

LA 3125

A detour will be required for construction of the LA 3125 crossing, due to the unacceptable length of potential detour routes if the road were closed. The detour was not designed in the conceptual phase, but was considered to be 1,000 feet long, consisting of a 2-lane asphalt road (1 – 12' lane each direction) with shoulders. LA 3125 has a wide right-of-way, and the work should be done in one detour phase.

The following sequence will be required for each highway detour:

- Construct the temporary detour road
- Remove the existing pavement at the culvert crossing
- Construct the culvert
- Reconstruct highway in the existing location
- Remove the temporary detour road

Canadian National Railroad (CN RR)

The CN RR is an active rail line serving the mid-west and the south Louisiana port area. Based on informal discussions with railroad representatives, rail service must be maintained at all times, and speed reductions will likely not be allowed. The design assumes a 2,000-foot long shoofly (temporary track) to allow open-cut construction of the box culverts across the existing CN RR tracks. The shoofly will include turnouts at each end to expedite final switch-over to the shoofly. The railroad will likely discourage a temporary rail crossing at the work site. Such a crossing is not necessary, as access is available to both sides of the railroad from the existing public roads.

The proposed construction sequence at the CN RR is as follows:

- Construct the shoofly and re-route rail traffic
- Remove the existing tracks at the culvert crossing
- Construct the culvert
- Reconstruct the railroad tracks in the existing location and place rail traffic back on the original alignment
- Remove the shoofly track

LA 44, LA 3125, and the CN RR are to remain open to traffic at all times, except for brief periods to switch over traffic, as allowed by the permits.

L16.6 Construction Coordination

Underground Utilities

Each underground utility needs to be relocated prior to start of construction, to avoid scheduling conflicts and delays with the project's construction contractor. Each utility owner should be notified by the construction contractor prior to start of construction in the vicinity of the utility.

Overhead Utilities

Temporary relocations will occur prior to construction and relocate after construction is complete. No extraordinary conditions exist for temporary relocations. The one transmission tower will need to be removed necessitating the addition of two transmission towers on the line north of LA3125.

Transportation Facilities

Detours will be provided ahead of construction and permanent roads and railroads replaced upon completion. The detours and relocations are all considered not to be extraordinary.

L16.7 Opinion of estimated costs

Opinion of estimated costs for utility relocations are included in the MCACES cost estimate for the project. During preliminary design when construction drawings become available additional cost estimates will be obtained from the utility owners.

L16.8 Summary Tables

The following tables summarize the utilities located and contacted. The items which are shaded do not conflict with the project and will not be relocated. The remaining are part of the relocation opinion of estimated cost.

Table L16.1-1
Utility and Pipeline Relocations

Shaded utilities will not be relocated.

Item No.	Owner	Utility/Pipeline Description	Location	Relocation Description
Diversion Alignment - Diversion Culvert and Transmission Canal				
Utilities				
1	Entergy Louisiana, LLC	Electric Distribution - O/H	LA 44 ROW - Sta. 5+56	Temporary relocation
2	AT&T	Telecommunication Cable - O/H	LA 44 ROW - Sta. 5+56	Temporary relocation
3	???	CATV - O/H	LA 44 ROW - Sta. 5+56	Temporary relocation
4	AT&T - (verify exists??)	Telecommunication Cable - U/G	LA 44 ROW	Permanent - adjust below canal
5	St. James Parish	Water Line	LA 44 ROW	Permanent - adjust below canal
6	Entergy Louisiana, LLC	Electric Distribution - O/H	CN RR - Sta. 20+75	Temporary relocation
7	AT&T	Fiber Optics - U/G	CN RR - Sta. 21+40	Permanent - adjust below canal
8	Entergy Louisiana, LLC	Electric Distribution - Overhead	LA 3125 ROW - Sta. 99+75	Temporary relocation
9	AT&T	Telecommunication cable - overhead	LA 3125 ROW - Sta. 99+75	Temporary relocation
10	???	CATV	LA 3125 ROW - Sta. 99+75	Temporary relocation
11	AT&T - (verify exists??)	Telecommunication Cable - U/G	LA 3125 ROW	Permanent - adjust below canal
12	St. James Parish	Water Line	LA 3125 ROW	Permanent - adjust below canal
Pipelines				
13	Petroligistics Olefins, LLC	Pipeline - 6" Steel - Ethylene	Near CN RR ROW	Permanent - adjust below canal
14	Petroligistics Olefins, LLC	Pipeline - 6" Steel - Ethylene	Sta. 62+00 to 82+00	Permanent - remove laterally from ROW
15	Williams Gas Pipeline	Pipeline - 12" Steel - Natural Gas	Sta. 63+25	Permanent - adjust below canal
16	Gulf South Pipeline Co., LP	Pipeline - 18" Steel (Abandoned)	Sta. 63+50	Remove
17	Gulf South Pipeline Co., LP	Pipeline - 24" Steel - Natural Gas	Sta. 63+75	Permanent - adjust below canal
18	Texas Brine Co., LLP	Pipeline - 14" Steel - Brine	Sta. 73+00	Permanent - adjust below canal
19	Texas Brine Co., LLP	Pipeline - 14" (??) Steel - Brine	Sta. 83+00	Permanent - adjust below canal
20	Petroligistics Olefins, LLC	Pipeline - 6" Steel - Ethylene	200' east of LA 3125	Permanent - adjust below canal
Control Structure 1-6A				
Locate structure to avoid conflicts				

1508

Table L16.1-2
Utility and Pipeline Relocations

Item No.	Owner	Utility/Pipeline Description	Location	Relocation Description
Control Structure 1-6B				
Locate structure to avoid conflicts				
Control Structure 1-7				
Locate structure to avoid conflicts				
Control Structure 1-8A				
No utilities or pipelines known to be in immediate area				
Control Structure 1-8B				
No utilities or pipelines known to be in immediate area				
Control Structure 3-2				
No utilities or pipelines known to be in immediate area				
Cross Culverts at Hwy 61				
	(4 locations - each the same)			
21	Marathon Pipeline, LLC	Pipeline - 20" - Unknown product	KCS RR and Hwy 61	No adjustment anticipated
22	Air Liquide America	Pipeline - 12" Steel - Nitrogen	KCS RR and Hwy 61	No adjustment anticipated
23	Air Liquide America	Pipeline - 12" Steel - Oxygen	KCS RR and Hwy 61	No adjustment anticipated
24	Sorrento	Pipeline - 8" - Unknown product	KCS RR and Hwy 61	No adjustment anticipated
25	Montery	Pipeline - 16" - Unknown product	KCS RR and Hwy 61	No adjustment anticipated
26	Chevron	Pipeline - Unknown size and product	KCS RR and Hwy 61	No adjustment anticipated

Notes:

1. Stationing is from the Romeville Transmission Canal survey.
2. O/H = Overhead
3. U/G = Underground
4. CN RR = Canadian National Railroad
5. KCS RR = Kansas City Southern Railroad

1509

Volume IV

APPENDIX L—Annex L-1

Detailed Construction Cost Estimates for Studied Alternatives

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Annex L-1 Detailed Construction Cost Estimates for Studied Alternatives

Summary Tables

Table L-1-S1 Summary of Detailed Construction Cost Estimates – Elements Sized for Diversion Flow Rate
Table L-1-S2 Summary of Detailed Construction Cost Estimates – Water Distribution and Water Management Elements
Table L-1-S3 Summary of Projected Construction Costs – Elements Sized for Diversion Flow Rate
Table L-1-S4 Summary of Projected Construction Costs – Water Distribution and Water Management Elements

Projected Cost Tables

Table L-1-P1 Romeville Diversion Culvert (MR Stage Elev. 11) – Projected Costs
Table L-1-P2 Romeville Diversion Culvert (MR Stage Elev. 5) – Projected Costs
Table L-1-P3 Romeville Diversion Siphon (MR Stage Elev. 17) – Projected Costs
Table L-1-P4 Romeville Diversion Siphon (MR Stage Elev. 11) – Projected Costs
Table L-1-P5 Romeville Earthen Transmission Canal – Projected Costs
Table L-1-P6 Romeville Deep Earthen Transmission Canal – Projected Costs
Table L-1-P7 Romeville Concrete-lined Transmission Canal – Projected Costs
Table L-1-P8 South Bridge Diversion Culvert (MR Stage Elev. 12) – Projected Costs
Table L-1-P9 South Bridge Earthen Transmission Canal – Projected Costs

Figures

Figure L-1-1 Romeville Diversion Culvert (MR Stage Elev. 11) – Construction Costs
Figure L-1-2 Romeville Diversion Culvert (MR Stage Elev. 11) – Unit Construction Costs
Figure L-1-3 Romeville Diversion Culvert (MR Stage Elev. 5) – Construction Costs
Figure L-1-4 Romeville Diversion Culvert (MR Stage Elev. 5) – Unit Construction Costs
Figure L-1-5 Romeville Diversion Siphon – Construction Costs
Figure L-1-6 Romeville Diversion Siphon – Unit Construction Costs
Figure L-1-7 Romeville Earthen Transmission Canal – Construction Costs
Figure L-1-8 Romeville Earthen Transmission Canal – Unit Construction Costs
Figure L-1-9 Romeville Deep Earthen Transmission Canal – Construction Costs
Figure L-1-10 Romeville Deep Earthen Transmission Canal – Unit Construction Costs
Figure L-1-11 Romeville Concrete-lined Transmission Canal – Construction Costs
Figure L-1-12 Romeville Concrete-lined Transmission Canal – Unit Construction Costs
Figure L-1-13 Romeville Batture Crossing – Siphon Pipe vs. Inlet Canal
Figure L-1-14 South Bridge Diversion Culvert – Construction Costs
Figure L-1-15 South Bridge Diversion Culvert – Unit Construction Costs
Figure L-1-16 South Bridge Earthen Transmission Canal – Construction Costs
Figure L-1-17 South Bridge Earthen Transmission Canal – Unit Construction Costs
Figure L-1-18 Control Gates – Costs
Figure L-1-19 Control Gates – Unit Costs

TOC 1

Figure L-1-20 Berm Gaps – Construction Costs

Detailed Cost Estimate Tables

Table L-1-1 Romeville Diversion Culvert (MR Stage Elev. 11) – Construction Cost Estimate
Table L-1-2 Romeville Diversion Culvert (MR Stage Elev. 5) – Construction Cost Estimate
Table L-1-3 Romeville Diversion Siphon – Construction Cost Estimate
Table L-1-4 Romeville Earthen Transmission Canal – Construction Cost Estimate
Table L-1-5 Romeville Deep Earthen Transmission Canal – Construction Cost Estimate
Table L-1-6 Romeville Concrete-lined Transmission Canal – Construction Cost Estimate
Table L-1-7 Romeville Batture Crossing – Siphon Pipe – Construction Cost Estimate
Table L-1-8 Romeville Batture Crossing – Inlet Canal – Construction Cost Estimate
Table L-1-9 South Bridge Diversion Culvert – Construction Cost Estimate
Table L-1-10 South Bridge Earthen Transmission Canal – Construction Cost Estimate
Table L-1-11 North Distribution Canal – Construction Cost Estimate
Table L-1-12 Parish Ditch Widening – Construction Cost Estimate
Table L-1-13 Control Structures – Construction Cost Estimate
Table L-1-14 Berm Gap (20 feet wide) – Construction Cost Estimate
Table L-1-15 Berm Gap (100 feet wide) – Construction Cost Estimate
Table L-1-16 Berm Gap (250 feet wide) – Construction Cost Estimate
Table L-1-17 Berm Gap (500 feet wide) – Construction Cost Estimate
Table L-1-18 Circulation Improvements at KCS RR and Hwy 61 Corridor
Table L-1-19 Instrumentation/Communications
Table L-1-20 Conway Canal – Diversion Ditch to HU 200 – Construction Cost Estimate
Table L-1-21 Conway Canal Berm Gap (20 feet wide)
Table L-1-22 Conway Canal Berm Gap (100 feet wide)
Table L-1-23 Conway Canal Berm Gap (250 feet wide)
Table L-1-24 Conway Canal Berm Gap (500 feet wide)

Table L-1-S1
Summary of Detailed Construction Cost Estimates
Elements Sized for Diversion Flow Rate

Item	Design Flow Rate, cfs												
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	10,000	15,000	20,000
Romeville Diversion Structure													
Diversion Culvert (MR Stage Elev. 11)	9,153,737	10,128,425		11,693,241		12,800,722		13,453,364		15,427,856	21,898,619	25,746,959	33,346,343
Diversion Culvert (MR Stage Elev. 5)	10,975,299	13,166,220	15,261,434	17,592,978	21,015,384	22,726,745		27,498,278		32,137,682	56,418,986		
Diversion Siphon (MR Stage Elev. 17)	6,426,784	8,330,427		11,895,838		15,565,390		18,557,782		21,427,733			
Romeville Transmission Canal													
Transmission Canal - Earthen	9,436,344	12,101,285		17,876,998		25,025,053		29,054,443		34,799,096	61,933,496	90,012,347	117,774,453
Transmission Canal - Deep Earthen	10,355,370	12,013,931		16,553,530		22,556,705		27,096,304		32,442,126	55,140,120	79,683,714	103,187,931
Transmission Canal - Concrete-lined	19,545,274	21,955,741		28,468,673		35,003,421		41,508,201		48,042,838	80,660,115	113,468,551	146,091,164
Romeville Batture Crossing													
Siphon Pipe	2,397,690	3,071,811		4,339,551		5,652,093		6,715,317		7,759,510			
Inlet Canal	3,502,038	3,566,173		3,678,747		3,742,882		3,783,845		3,929,608	4,445,532	4,607,291	5,151,920
South Bridge Alignment													
Diversion Culvert	9,765,469	11,293,665		12,594,577		15,032,428		15,549,601		17,539,603	26,631,005	37,321,241	45,982,457
Transmission Canal - Earthen	13,012,974	16,134,543		23,422,852		29,806,801		36,195,720		43,579,382	76,305,682	109,462,806	142,858,168
North Distribution Canal			15,487,186		29,279,679								
Parish Ditch Widening			9,934,275										

1514

Table L-1-S2

Summary of Detailed Construction Cost Estimates
Water Distribution and Water Management Elements

Item	Construction Cost, $
Control Gates (cost per structure)	
Control Structure No. 1-2	4,231,000
Control Structure No. 1-3	5,395,306
Control Structure No. 1-4	5,080,010
Control Structure No. 1-5	2,796,173
Control Structure No. 1-6E	4,477,824
Control Structure No. 1-6S	2,547,032
Control Structure No. 1-6N	2,547,779
Control Structure No. 1-7	2,667,155
Control Structure No. 3-1	7,387,468
Control Structure No. 3-2	4,039,939
Berm Gaps (cost per gap)	
20-foot wide gap	39,319
100-foot wide gap	58,238
250-foot wide gap	65,937
500-foot wide gap	123,039
Circulation Improvements at KCS RR/ Hwy 61 Corridor (cost per location)	
Small capacity culvert (1 - 4' x 4' box culvert)	2,122,182
Large capacity culvert (4 - 5' x 5' box culverts)	3,510,978
Bridge	2,972,254
Improve Existing Parish Drainage Channel	9,934,275
Diversions from Conway Canal	
Diversion Ditch to HU 200	673,049
Berm Gaps (cost per gap)	
20-foot wide gap	37,465
100-foot wide gap	63,328
250-foot wide gap	80,880
500-foot wide gap	110,780
Instrumentation	
Romeville - HU 100's	907,465
South Bridge - HU 100's and 200's	1,221,415
South Bridge - all HU's	1,288,690
Dual Diversion - HU 100's and 200's	1,445,665
Dual Diversion - all HU's	1,512,940

Table L-1-S3
Summary of Projected Construction Costs
Elements Sized for Diversion Flow Rate

Item	Design Flow Rate, cfs												
	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	10,000	15,000	20,000
Romeville Diversion Structure													
Diversion Culvert (MR Stage Elev. 11)	9,600,000	10,200,000	10,800,000	11,400,000	12,000,000	12,600,000	13,200,000	13,800,000	14,400,000	15,000,000	21,000,000	27,000,000	32,900,000
Diversion Culvert (MR Stage Elev. 5)	10,800,000	13,200,000	15,600,000	18,000,000	20,400,000	22,800,000	25,200,000	27,600,000	30,000,000	32,400,000	56,300,000	80,300,000	104,300,000
Diversion Siphon (MR Stage Elev. 17)	6,700,000	8,400,000	10,100,000	11,700,000	13,400,000	15,100,000	16,800,000	18,500,000	20,100,000	21,800,000			
Diversion Siphon (MR Stage Elev. 17)	7,500,000	10,000,000	12,500,000	15,000,000	17,600,000	20,100,000	22,600,000	25,100,000	27,600,000	30,100,000			
Romeville Transmission Canal													
Transmission Canal - Earthen	9,800,000	12,600,000	15,300,000	18,100,000	20,900,000	23,600,000	26,400,000	29,200,000	31,900,000	34,700,000	62,400,000	90,000,000	117,700,000
Transmission Canal - Deep Earthen	10,200,000	12,500,000	14,900,000	17,300,000	19,700,000	22,100,000	24,500,000	26,900,000	29,300,000	31,700,000	55,600,000	79,500,000	103,400,000
Transmission Canal - Concrete-lined	18,800,000	22,100,000	25,400,000	28,600,000	31,900,000	35,100,000	38,400,000	41,700,000	44,900,000	48,200,000	80,800,000	113,400,000	146,000,000
South Bridge Alignment													
Diversion Culvert	9,800,000	10,700,000	11,600,000	12,500,000	13,500,000	14,400,000	15,300,000	16,200,000	17,200,000	18,100,000	27,400,000	36,700,000	45,900,000
Transmission Canal - Earthen	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000	13,100,000

1516

Table L-1-P1

Romeville Diversion Culvert (MR Stage Elev. 11)

Projected Costs

Design Flow Rate, cfs	Detailed Estimates		Projected Costs		Difference (Projected-Estimated)	Costs To Use
	Cost, $	Unit Cost, $/cfs	Cost, $	Unit Costs $/cfs		
500	9,153,737	18,307	9,631,576	19,263	477,839	9,600,000
1,000	10,128,425	10,128	10,229,479	10,229	101,054	10,200,000
1,500			10,827,381	7,218		10,800,000
2,000	11,693,241	5,847	11,425,284	5,713	-267,957	11,400,000
2,500			12,023,186	4,809		12,000,000
3,000	12,800,722	4,267	12,621,089	4,207	-179,633	12,600,000
3,500			13,218,991	3,777		13,200,000
4,000	13,453,364	3,363	13,816,894	3,454	363,529	13,800,000
4,500			14,414,796	3,203		14,400,000
5,000	15,427,856	3,086	15,012,699	3,003	-415,157	15,000,000
10,000	21,898,619	2,190	20,991,724	2,099	-906,896	21,000,000
15,000	25,746,959	1,716	26,970,749	1,798	1,223,790	27,000,000
20,000	33,346,343	1,667	32,949,774	1,647	-396,569	32,900,000
Intercept	9,033,674					
Slope	1,196					

Table L-1-P2

Romeville Diversion Culvert (MR Stage Elev. 5)

Projected Costs

Design Flow Rate, cfs	Detailed Estimates Cost, $	Detailed Estimates Unit Cost, $/cfs	Projected Costs Cost, $	Projected Costs Unit Costs $/cfs	Difference (Projected-Estimated)	Costs To Use
500	10,975,299	21,951	10,760,740	21,521	-214,559	10,800,000
1,000	13,166,220	13,166	13,159,667	13,160	-6,553	13,200,000
1,500	15,261,434	10,174	15,558,594	10,372	297,160	15,600,000
2,000	17,592,978	8,796	17,957,521	8,979	364,543	18,000,000
2,500	21,015,384	8,406	20,356,447	8,143	-658,936	20,400,000
3,000	22,726,745	7,576	22,755,374	7,585	28,630	22,800,000
3,500			25,154,301	7,187		25,200,000
4,000	27,498,278	6,875	27,553,228	6,888	54,950	27,600,000
4,500			29,952,155	6,656		30,000,000
5,000	32,137,682	6,428	32,351,082	6,470	213,400	32,400,000
10,000	56,418,986	5,642	56,340,351	5,634	-78,634	56,300,000
15,000			80,329,621	5,355		80,300,000
20,000			104,318,890	5,216		104,300,000
Intercept	8,361,813					
Slope	4,798					

Table L-1-P3
Romeville Diversion Siphon (MR Stage Elev. 17)
Projected Costs

Design Flow Rate, cfs	Detailed Estimates Cost, $	Unit Cost, $/cfs	Projected Costs Cost, $	Unit Costs $/cfs	Difference (Projected-Estimated)	Costs To Use
500	6,426,784	12,854	6,708,708	13,417	281,924	6,700,000
1,000	8,330,427	8,330	8,386,776	8,387	56,349	8,400,000
1,500			10,064,844	6,710		10,100,000
2,000	11,895,838	5,948	11,742,913	5,871	-152,925	11,700,000
2,500			13,420,981	5,368		13,400,000
3,000	15,565,390	5,188	15,099,049	5,033	-466,341	15,100,000
3,500			16,777,117	4,793		16,800,000
4,000	18,557,782	4,639	18,455,186	4,614	-102,596	18,500,000
4,500			20,133,254	4,474		20,100,000
5,000	21,427,733	4,286	21,811,322	4,362	383,589	21,800,000
Intercept	5,030,639					
Slope	3,356					

Table L-1-P4

Romeville Diversion Siphon (MR Stage Elev. 11)

Projected Costs

Design Flow Rate, cfs	Detailed Estimates		Projected Costs		Difference (Projected-Estimated)	Costs To Use
	Cost, $	Unit Cost, $/cfs	Cost, $	Unit Costs $/cfs		
500			7,535,219	15,070		7,500,000
1,000			10,039,798	10,040		10,000,000
1,500			12,544,378	8,363		12,500,000
2,000			15,048,958	7,524		15,000,000
2,500			17,553,537	7,021		17,600,000
3,000			20,058,117	6,686		20,100,000
3,500			22,562,696	6,446		22,600,000
4,000			25,067,276	6,267		25,100,000
4,500			27,571,855	6,127		27,600,000
5,000			30,076,435	6,015		30,100,000

Intercept

Slope

Table L-1-P5

Romeville Earthen Transmission Canal

Projected Costs

Design Flow Rate, cfs	Detailed Estimates		Projected Costs		Difference (Projected-Estimated)	Costs To Use
	Cost, $	Unit Cost, $/cfs	Cost, $	Unit Costs $/cfs		
500	9,436,344	18,873	9,788,624	19,577	-9,416,767	9,800,000
1,000	12,101,285	12,101	12,555,730	12,556	-12,088,729	12,600,000
1,500			15,322,837	10,215		15,300,000
2,000	17,876,998	8,938	18,089,943	9,045	-17,867,953	18,100,000
2,500			20,857,049	8,343		20,900,000
3,000	25,025,053	8,342	23,624,155	7,875	-25,017,178	23,600,000
3,500			26,391,261	7,540		26,400,000
4,000	29,054,443	7,264	29,158,368	7,290	-29,047,153	29,200,000
4,500			31,925,474	7,095		31,900,000
5,000	34,799,096	6,960	34,692,580	6,939	-34,792,157	34,700,000
10,000	61,933,496	6,193	62,363,642	6,236	-61,927,260	62,400,000
15,000	90,012,347	6,001	90,034,704	6,002	-90,006,344	90,000,000
20,000	117,774,453	5,889	117,705,766	5,885	-117,768,567	117,700,000
Intercept	7,021,518					
Slope	5,534					

Table L-1-P6

Romeville Deep Earthen Transmission Canal

Projected Costs

Design Flow Rate, cfs	Detailed Estimates		Projected Costs		Difference (Projected-Estimated)	Costs To Use
	Cost, $	Unit Cost, $/cfs	Cost, $	Unit Costs $/cfs		
500	10,355,370	20,711	10,151,520	20,303	-203,850	10,200,000
1,000	12,013,931	12,014	12,541,395	12,541	527,464	12,500,000
1,500			14,931,271	9,954		14,900,000
2,000	16,553,530	8,277	17,321,146	8,661	767,616	17,300,000
2,500			19,711,022	7,884		19,700,000
3,000	22,556,705	7,519	22,100,897	7,367	-455,808	22,100,000
3,500			24,490,773	6,997		24,500,000
4,000	27,096,304	6,774	26,880,648	6,720	-215,656	26,900,000
4,500			29,270,524	6,505		29,300,000
5,000	32,442,126	6,488	31,660,399	6,332	-781,727	31,700,000
10,000	55,140,120	5,514	55,559,154	5,556	419,034	55,600,000
15,000	79,683,714	5,312	79,457,909	5,297	-225,805	79,500,000
20,000	103,187,931	5,159	103,356,664	5,168	168,732	103,400,000
Intercept	7,761,644					
Slope	4,780					

Table L-1-P7

Romeville Concrete-lined Transmission Canal

Projected Costs

Design Flow Rate, cfs	Detailed Estimates Cost, $	Detailed Estimates Unit Cost, $/cfs	Projected Costs Cost, $	Projected Costs Unit Costs $/cfs	Difference (Projected-Estimated)	Costs To Use
500	19,545,274	39,091	18,845,017	37,690	-700,258	18,800,000
1,000	21,955,741	21,956	22,105,185	22,105	149,444	22,100,000
1,500			25,365,353	16,910		25,400,000
2,000	28,468,673	14,234	28,625,521	14,313	156,848	28,600,000
2,500			31,885,689	12,754		31,900,000
3,000	35,003,421	11,668	35,145,857	11,715	142,436	35,100,000
3,500			38,406,025	10,973		38,400,000
4,000	41,508,201	10,377	41,666,193	10,417	157,992	41,700,000
4,500			44,926,362	9,984		44,900,000
5,000	48,042,838	9,609	48,186,530	9,637	143,692	48,200,000
10,000	80,660,115	8,066	80,788,211	8,079	128,096	80,800,000
15,000	113,468,551	7,565	113,389,892	7,559	-78,659	113,400,000
20,000	146,091,164	7,305	145,991,573	7,300	-99,591	146,000,000
Intercept	15,584,849					
Slope	6,520					

Table L-1-P8

South Bridge Diversion Culvert (MR Stage Elev. 11)

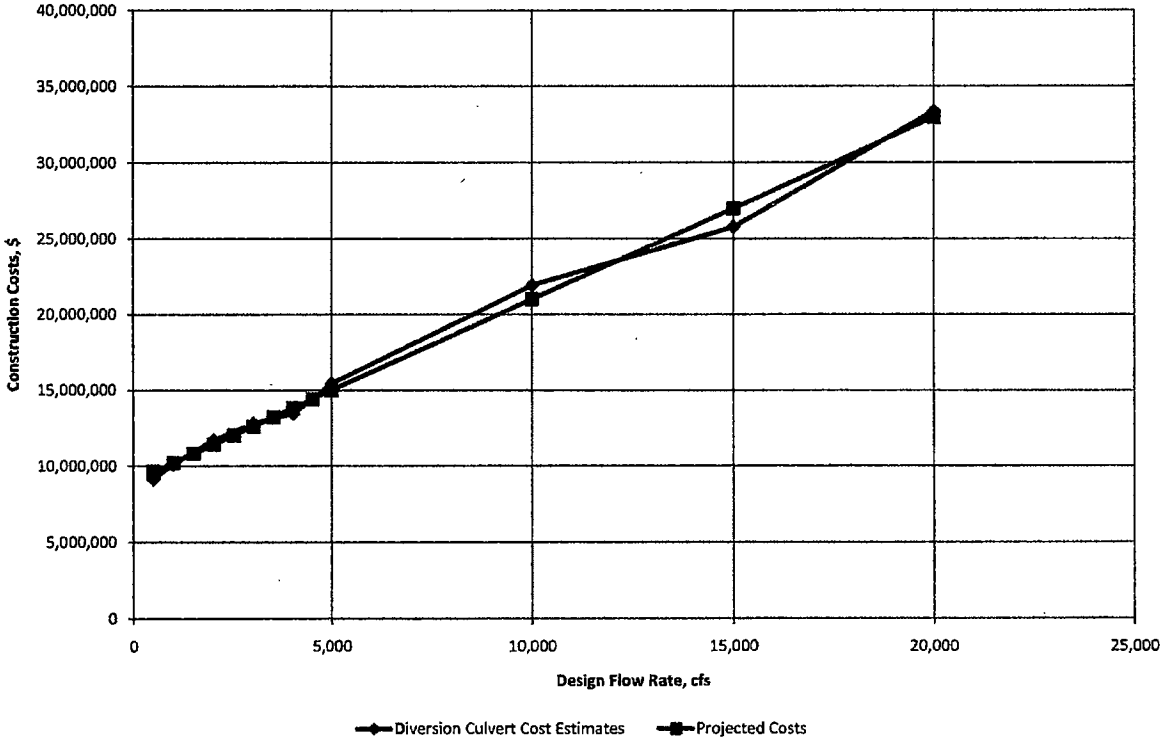
Projected Costs

Design Flow Rate, cfs	Detailed Estimates Cost, $	Detailed Estimates Unit Cost, $/cfs	Projected Costs Cost, $	Projected Costs Unit Costs $/cfs	Difference (Projected-Estimated)	Costs To Use
500	9,765,469	19,531	9,750,999	19,502	-14,469	9,800,000
1,000	11,293,665	11,294	10,679,134	10,679	-614,532	10,700,000
1,500			11,607,268	7,738		11,600,000
2,000	12,594,577	6,297	12,535,402	6,268	-59,174	12,500,000
2,500			13,463,537	5,385		13,500,000
3,000	15,032,428	5,011	14,391,671	4,797	-640,757	14,400,000
3,500			15,319,806	4,377		15,300,000
4,000	15,549,601	3,887	16,247,940	4,062	698,339	16,200,000
4,500			17,176,074	3,817		17,200,000
5,000	17,539,603	3,508	18,104,209	3,621	564,606	18,100,000
10,000	26,631,005	2,663	27,385,553	2,739	754,548	27,400,000
15,000	37,321,241	2,488	36,666,897	2,444	-654,344	36,700,000
20,000	45,982,457	2,299	45,948,241	2,297	-34,216	45,900,000
Intercept	8,822,865					
Slope	1,856					

Table L-1-P9
South Bridge Earthen Transmission Canal
Projected Costs

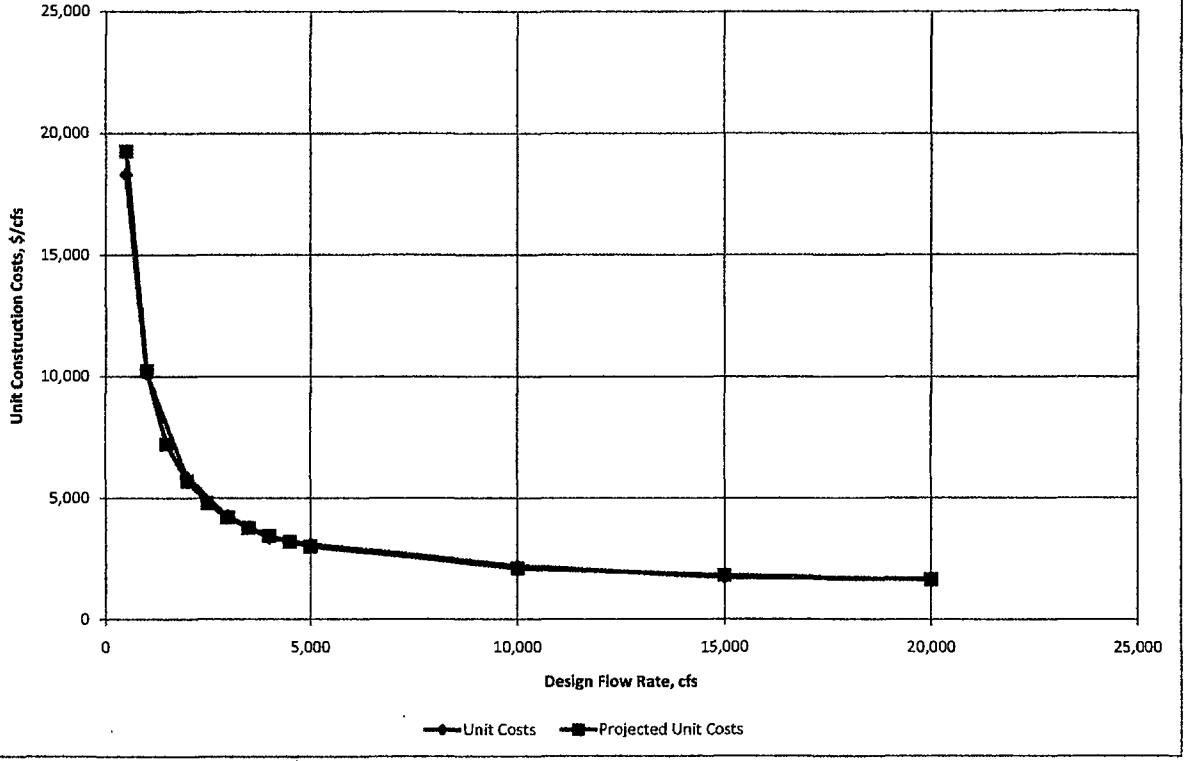
Design Flow Rate, cfs	Detailed Estimates Cost, $	Detailed Estimates Unit Cost, $/cfs	Projected Costs Cost, $	Projected Costs Unit Costs $/cfs	Difference (Projected-Estimated)	Costs To Use
500	13,012,974	26,026	13,145,223	26,290	132,249	13,100,000
1,000	16,134,543	16,135	16,470,865	16,471	336,323	16,500,000
1,500			19,796,508	13,198		19,800,000
2,000	23,422,852	11,711	23,122,150	11,561	-300,703	23,100,000
2,500			26,447,792	10,579		26,400,000
3,000	29,806,801	9,936	29,773,434	9,924	-33,367	29,800,000
3,500			33,099,076	9,457		33,100,000
4,000	36,195,720	9,049	36,424,718	9,106	228,999	36,400,000
4,500			39,750,360	8,833		39,800,000
5,000	43,579,382	8,716	43,076,003	8,615	-503,379	43,100,000
10,000	76,305,682	7,631	76,332,424	7,633	26,742	76,300,000
15,000	109,462,806	7,298	109,588,845	7,306	126,039	109,600,000
20,000	142,858,168	7,143	142,845,266	7,142	-12,902	142,800,000
Intercept	9,819,581					
Slope	6,651					

Figure L-1-1
Romeville Diversion Culvert (MR Stage Elev. 11)
Construction Costs



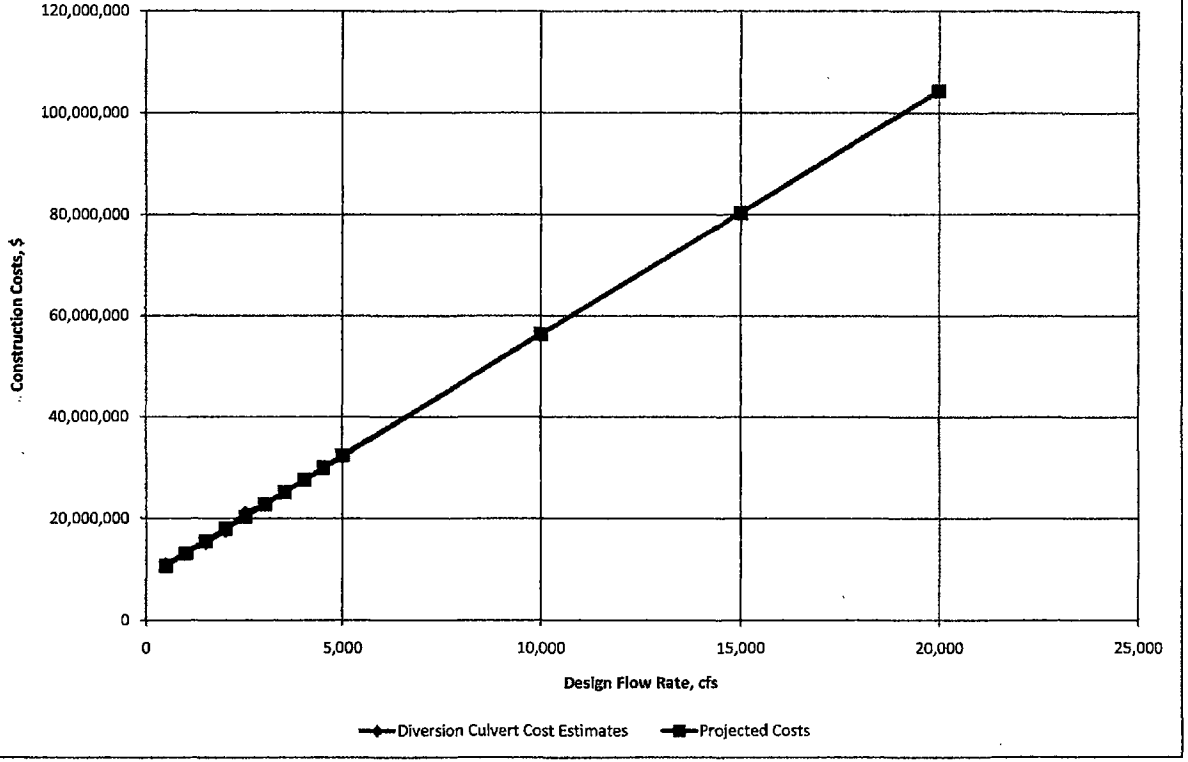
1526

Figure L-1-2
Romeville Diversion Culvert (MR Stage Elev. 11)
Unit Construction Costs



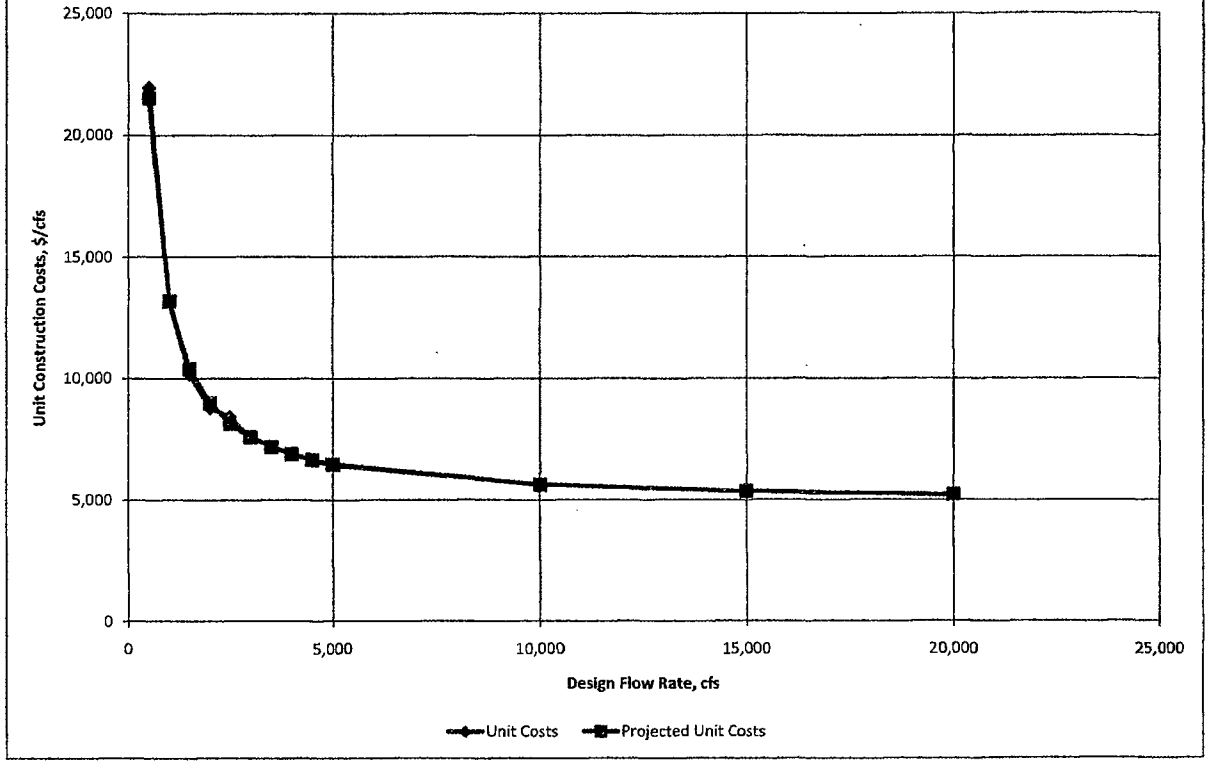
1527

Figure L-1-3
Romeville Diversion Culvert (MR Stage Elev. 5)
Construction Costs



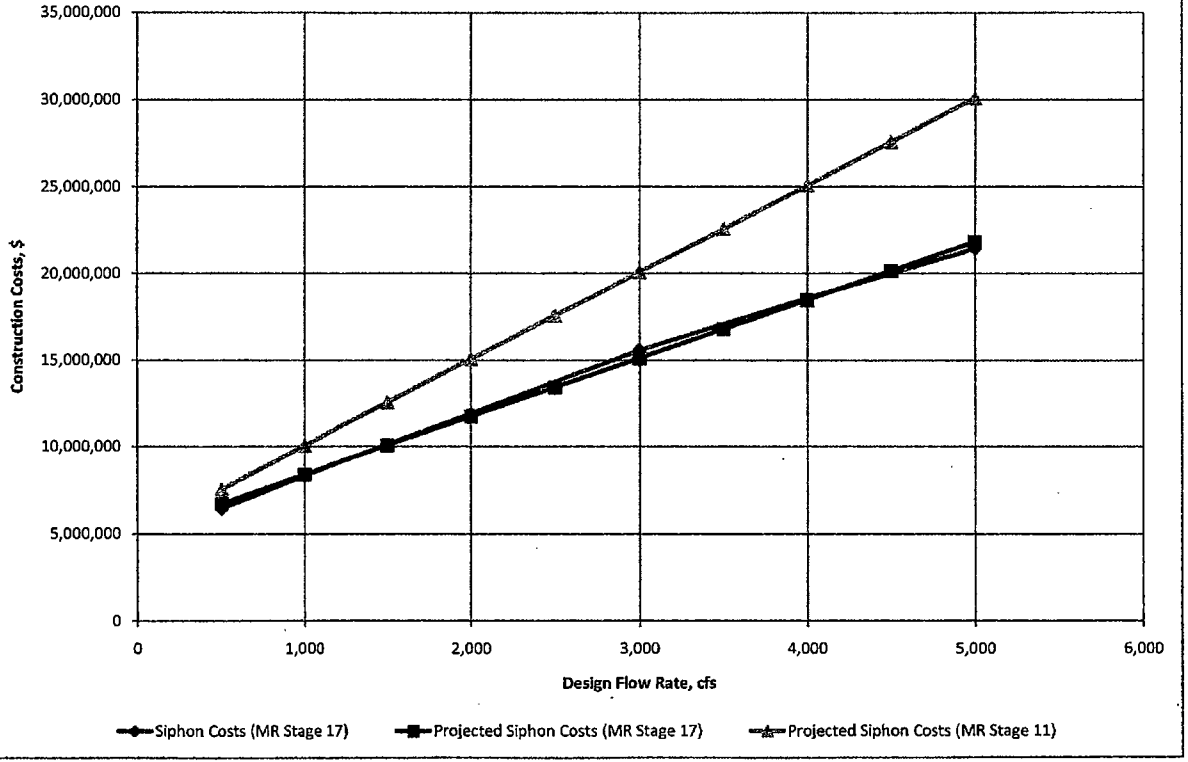
1528

Figure L-1-4
Romeville Diversion Culvert (MR Stage Elev. 5)
Unit Construction Costs



1529

Figure L-1-5
Romeville Diversion Siphon
Construction Costs



1530

Figure L-1-6
Romeville Diversion Siphon
Unit Construction Costs

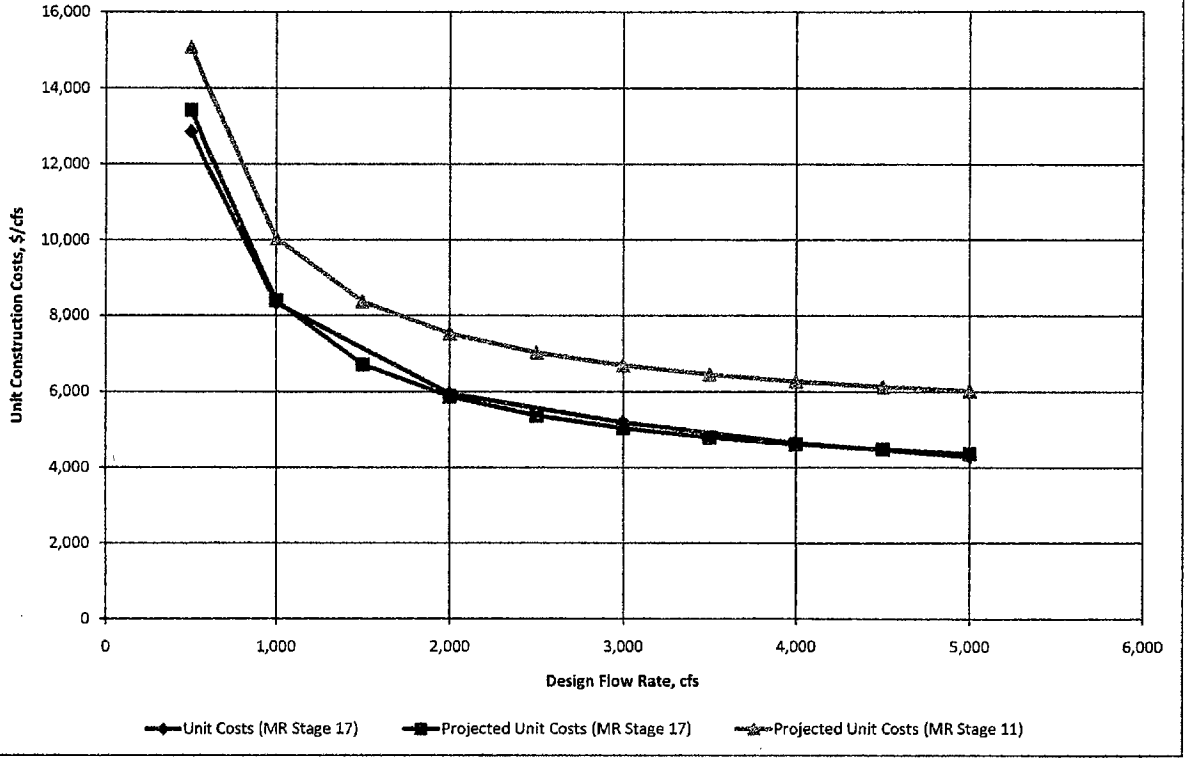
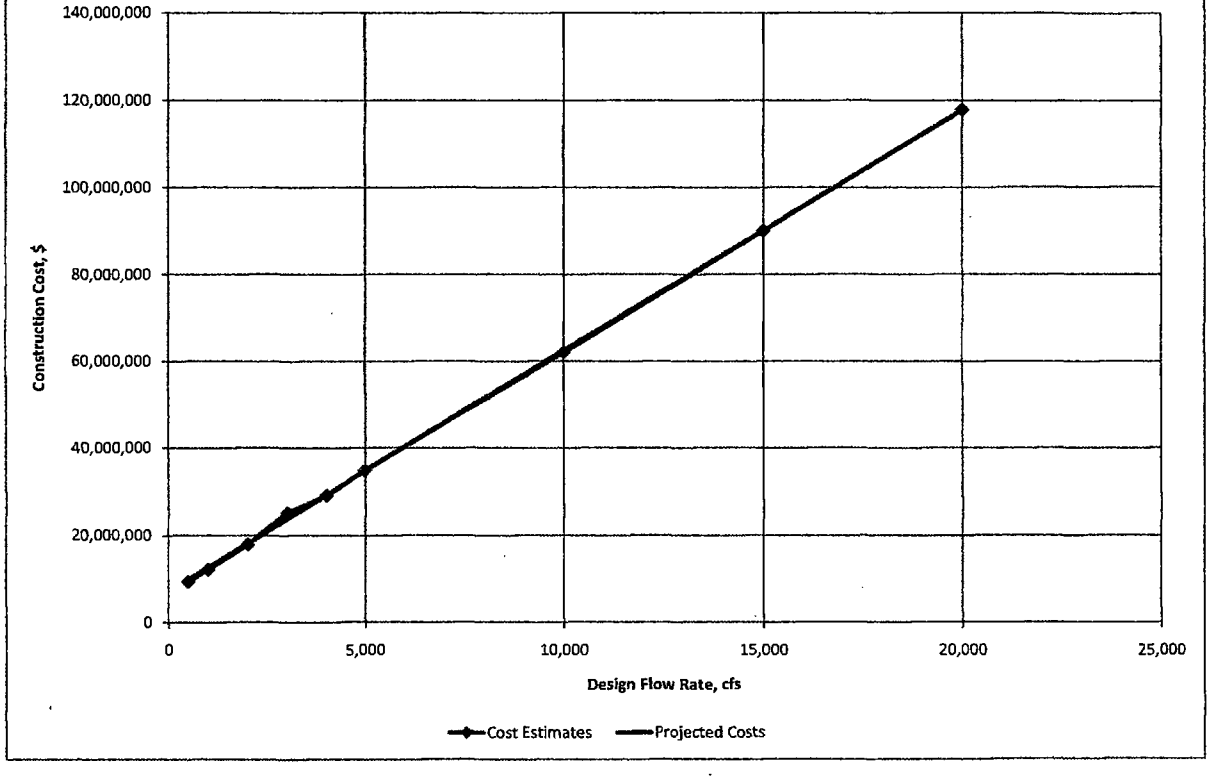


Figure L-1-7
Romeville Earthen Transmission Canal
Construction Costs



1532

Figure L-1-8
Romeville Earthen Transmission Canal
Unit Construction Costs

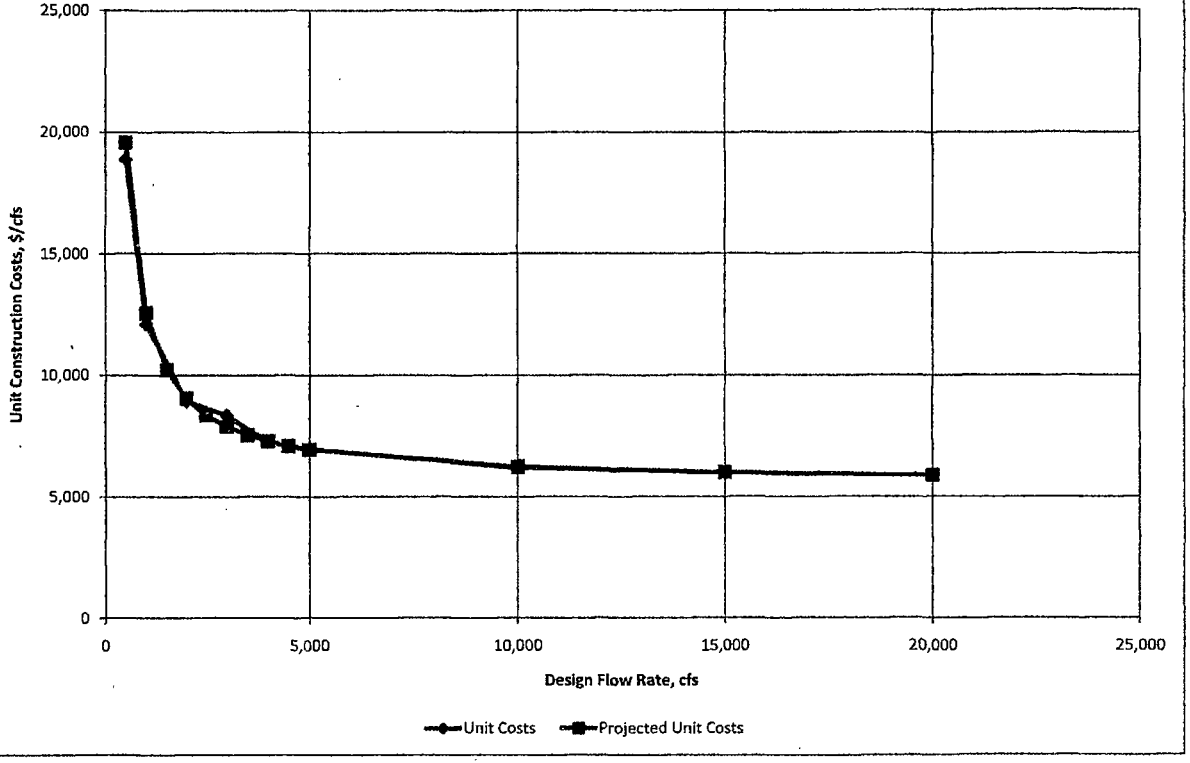
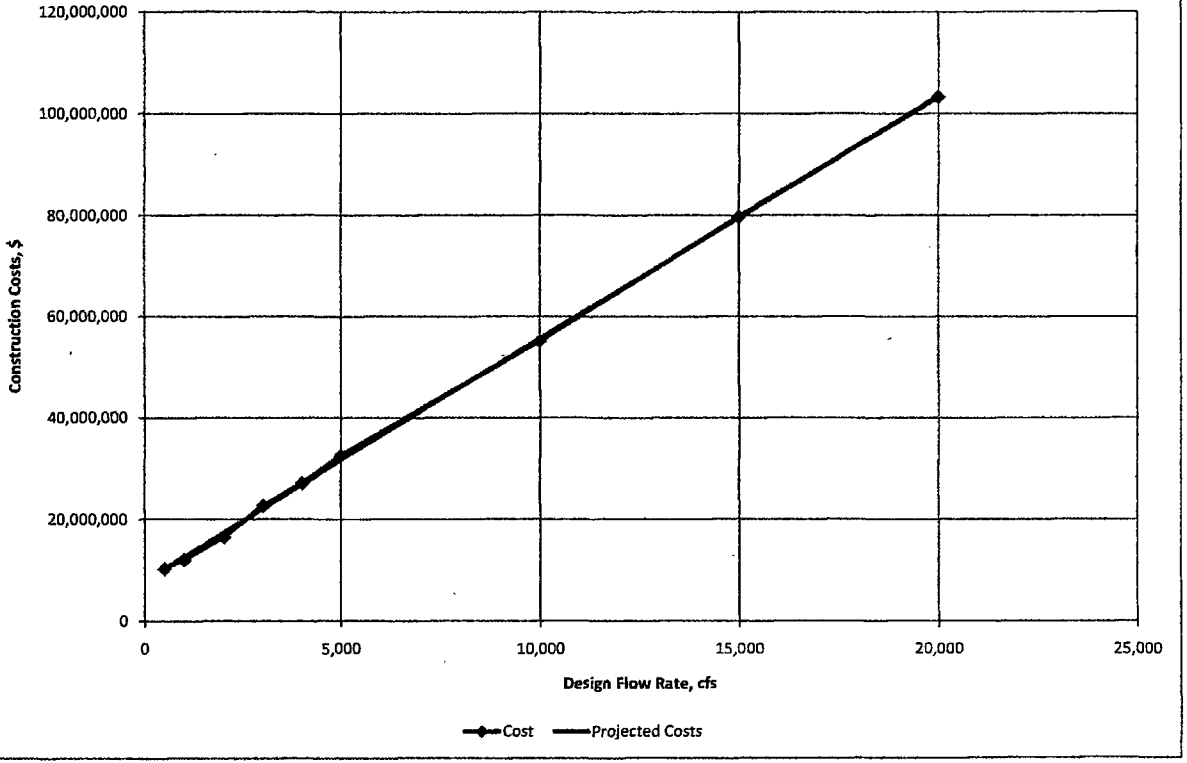


Figure L-1-9
Romeville Deep Earthen Transmission Canal
Construction Costs



1534

Figure L-1-10
Romeville Deep Earthen Transmission Canal
Unit Construction Costs

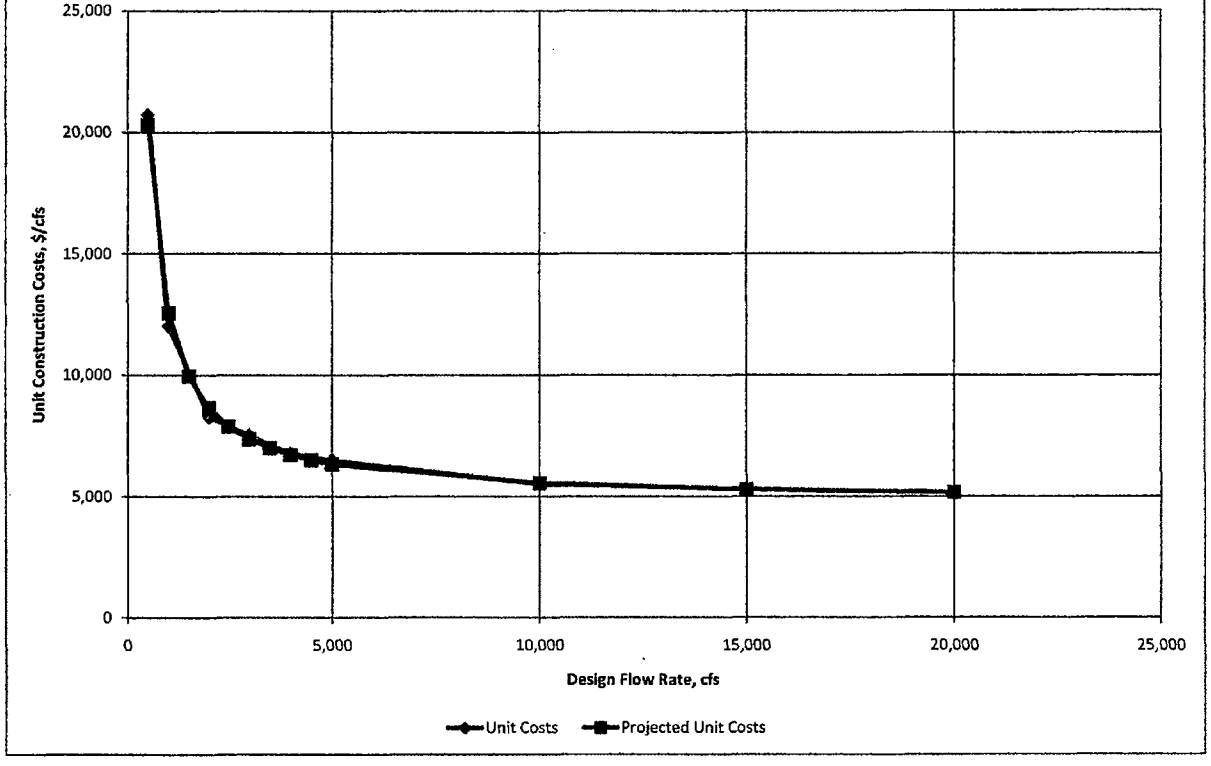
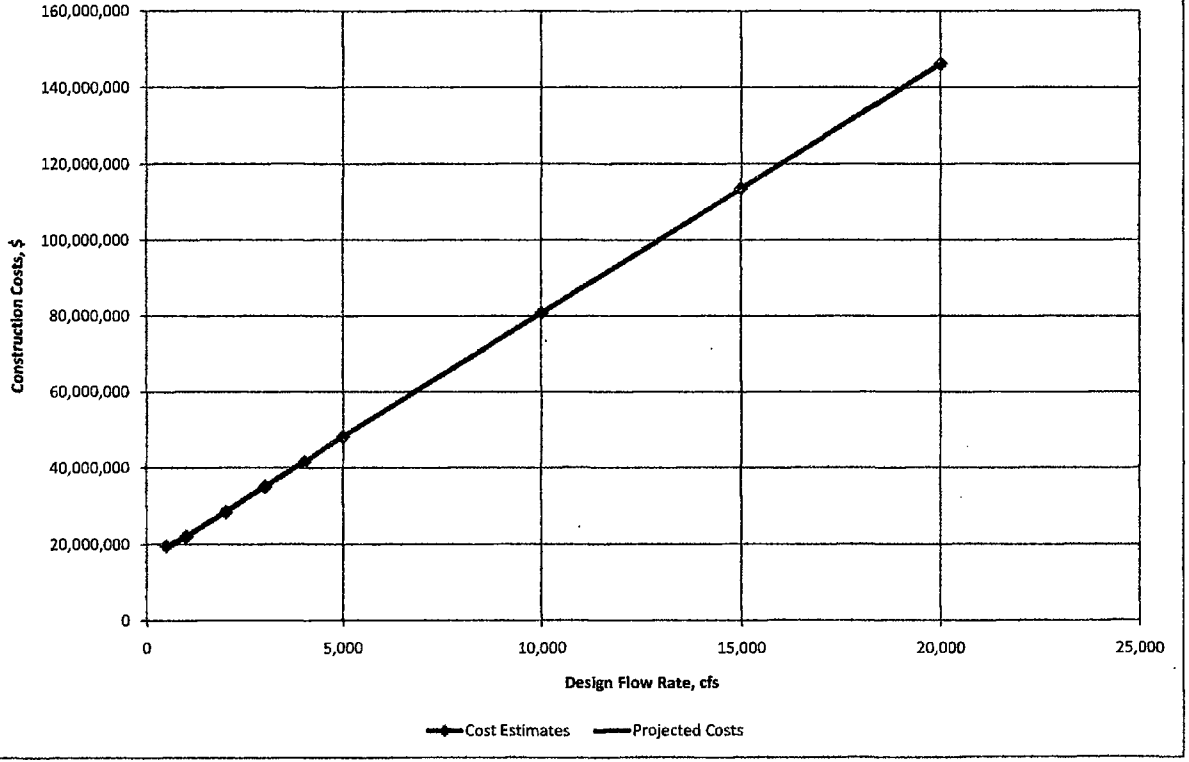


Figure L-1-11
Romeville Concrete-lined Transmission Canal
Construction Costs



1536

Figure L-1-12
Romeville Concrete-lined Transmission Canal
Unit Construction Costs

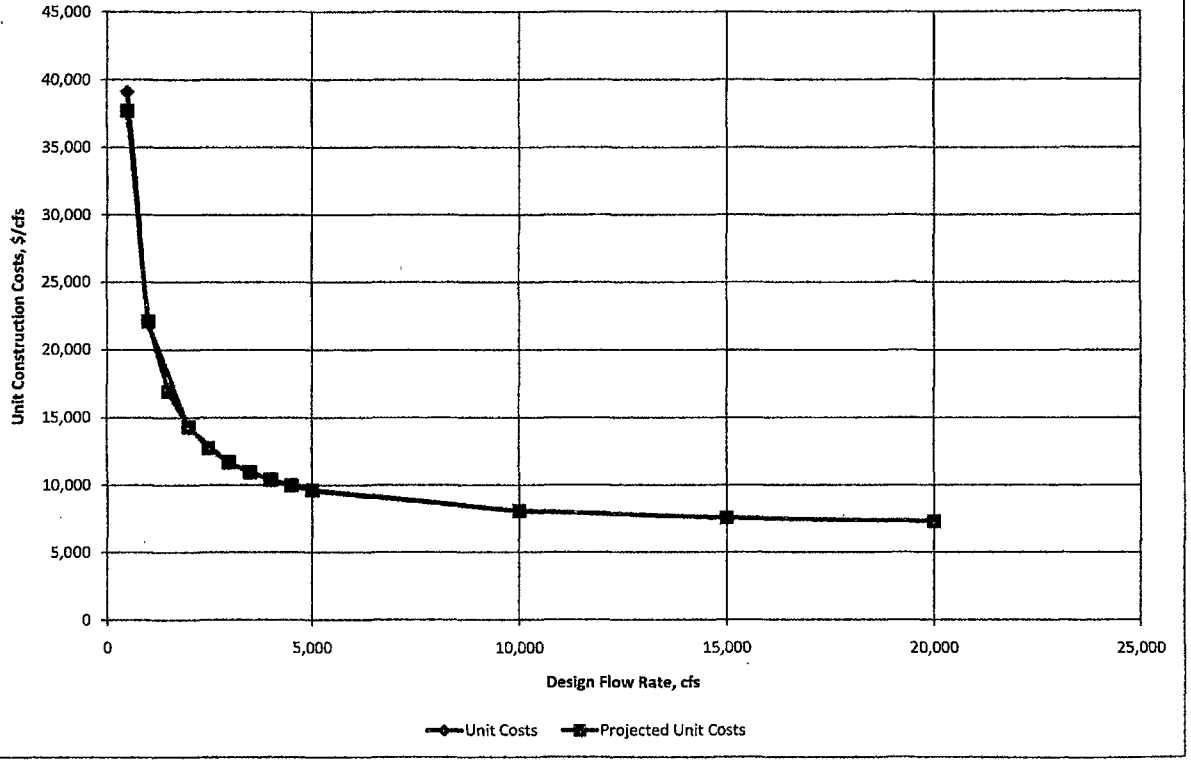


Figure L-1-13
Romeville Batture Crossing
Siphon Pipe vs. Inlet Canal

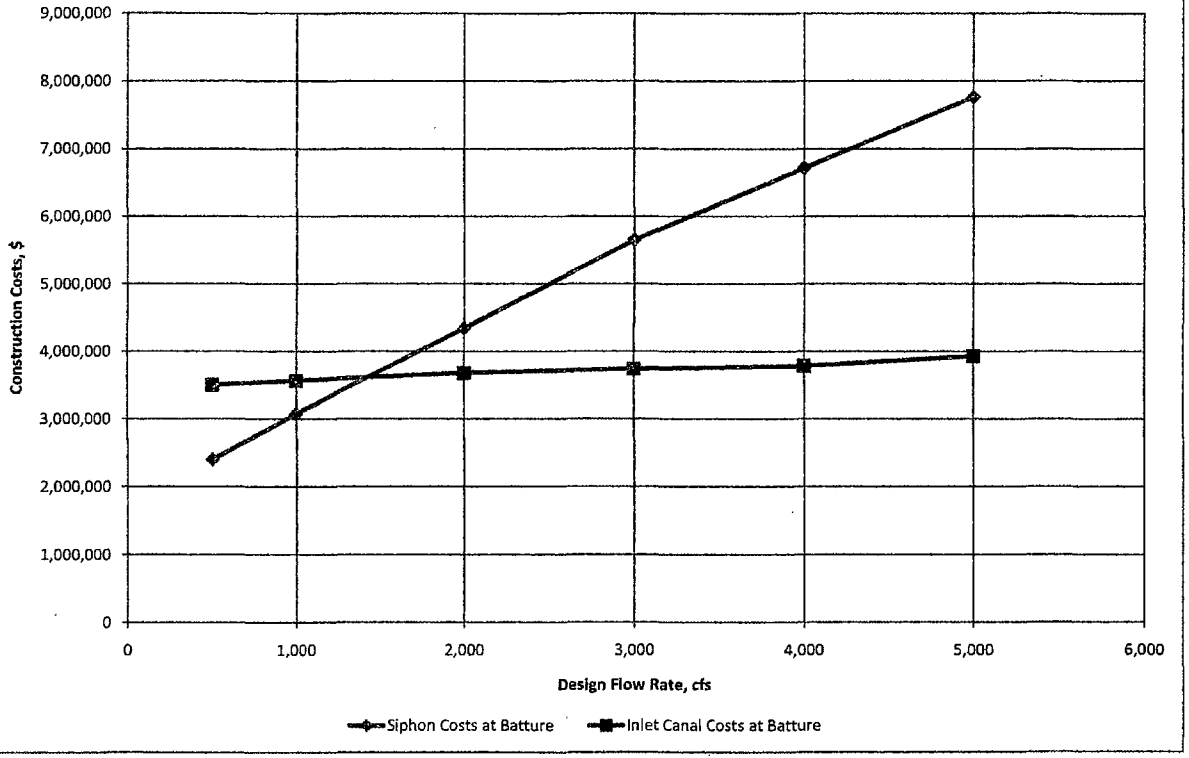


Figure L-1-14
South Bridge Diversion Culvert
Construction Costs

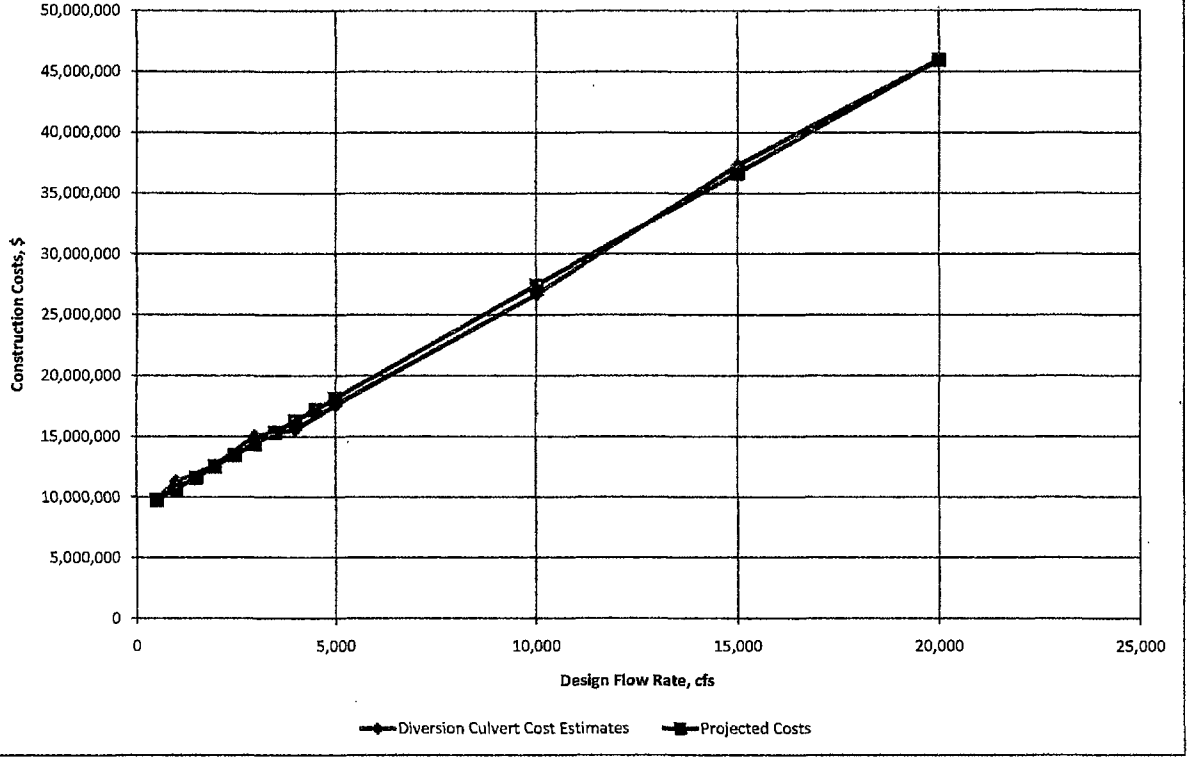
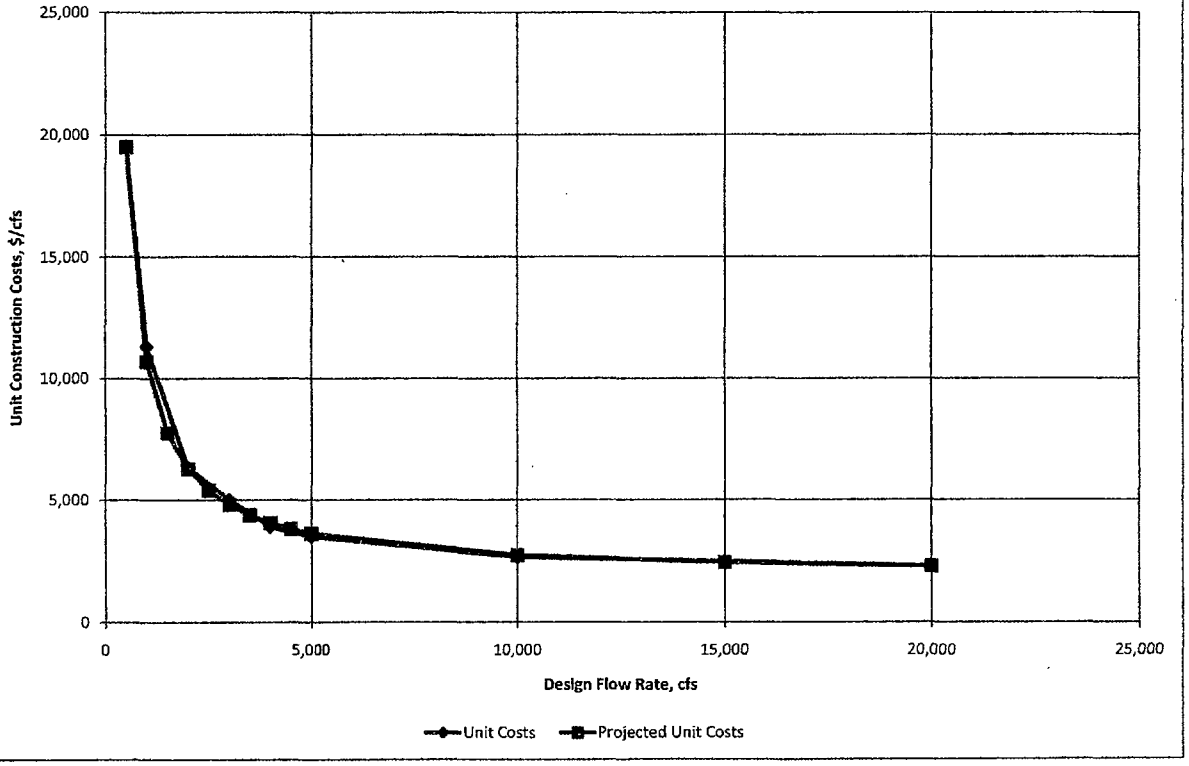
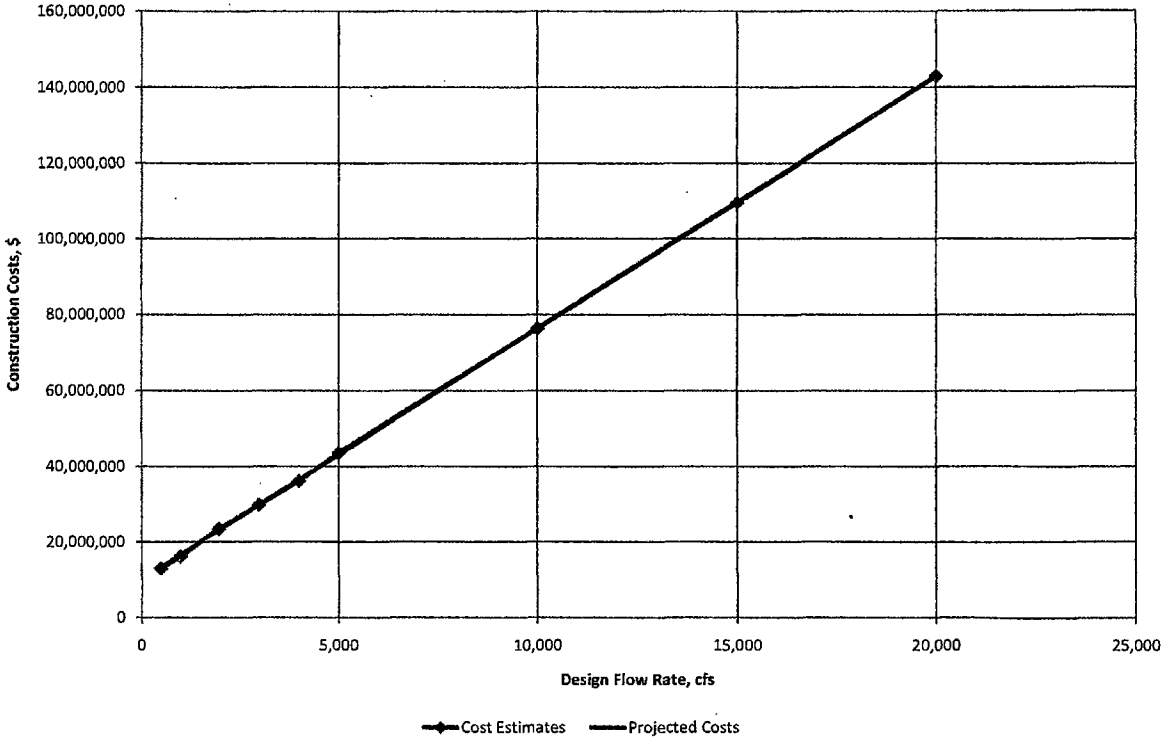


Figure L-1-15
Romeville Diversion Culvert
Unit Construction Costs



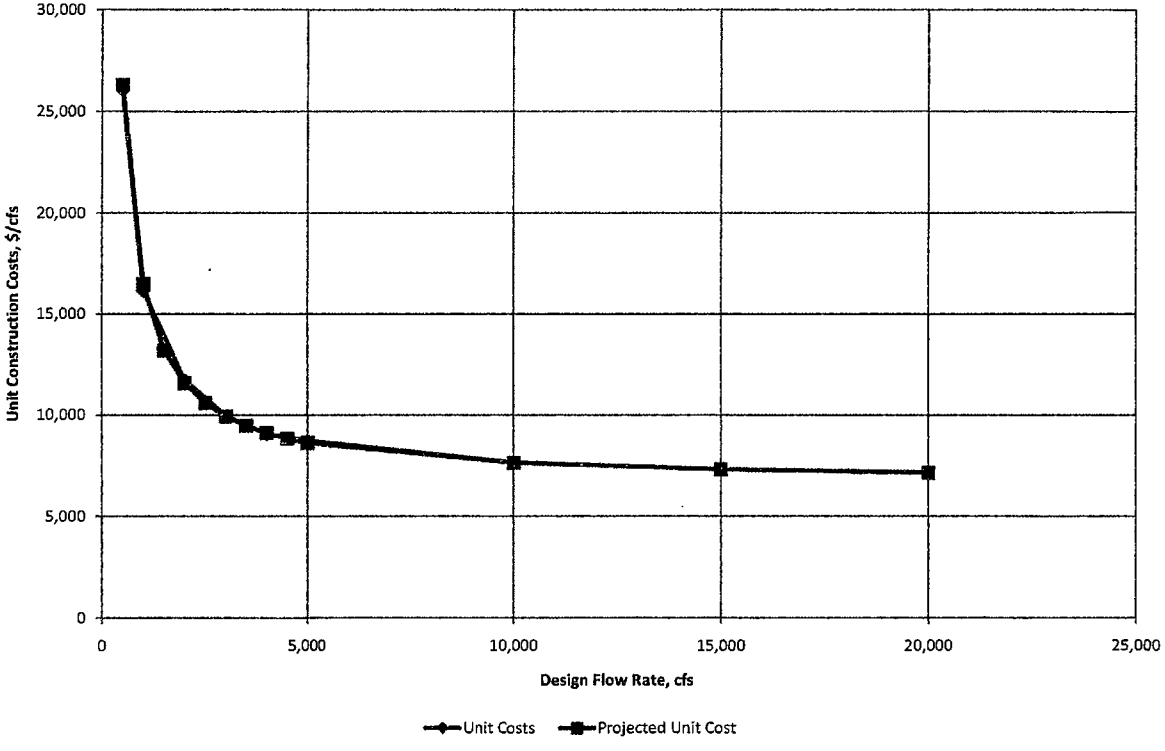
1540

Figure L-1-16
South Bridge Earthen Transmission Canal
Construction Costs



1541

Figure L-1-17
South Bridge Earthen Transmission Canal
Unit Construction Costs



1542

Figure L-1-18
Control Structures
Construction Cost vs. Gate Area

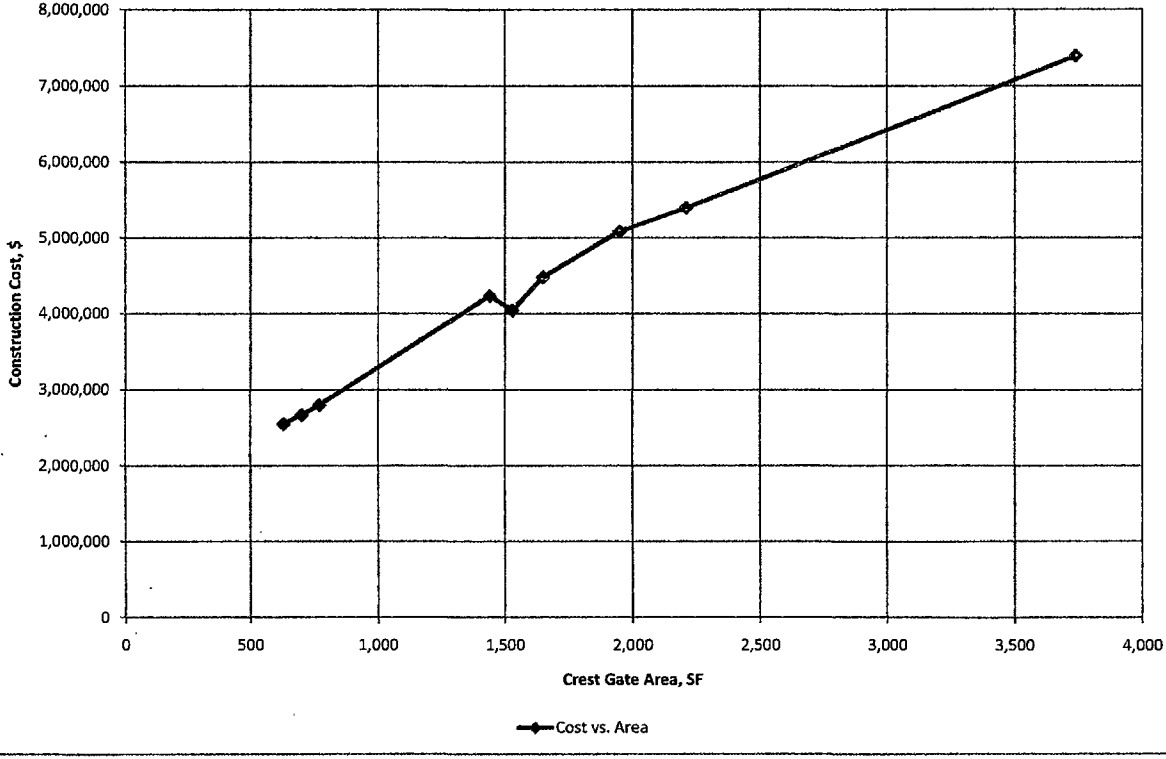
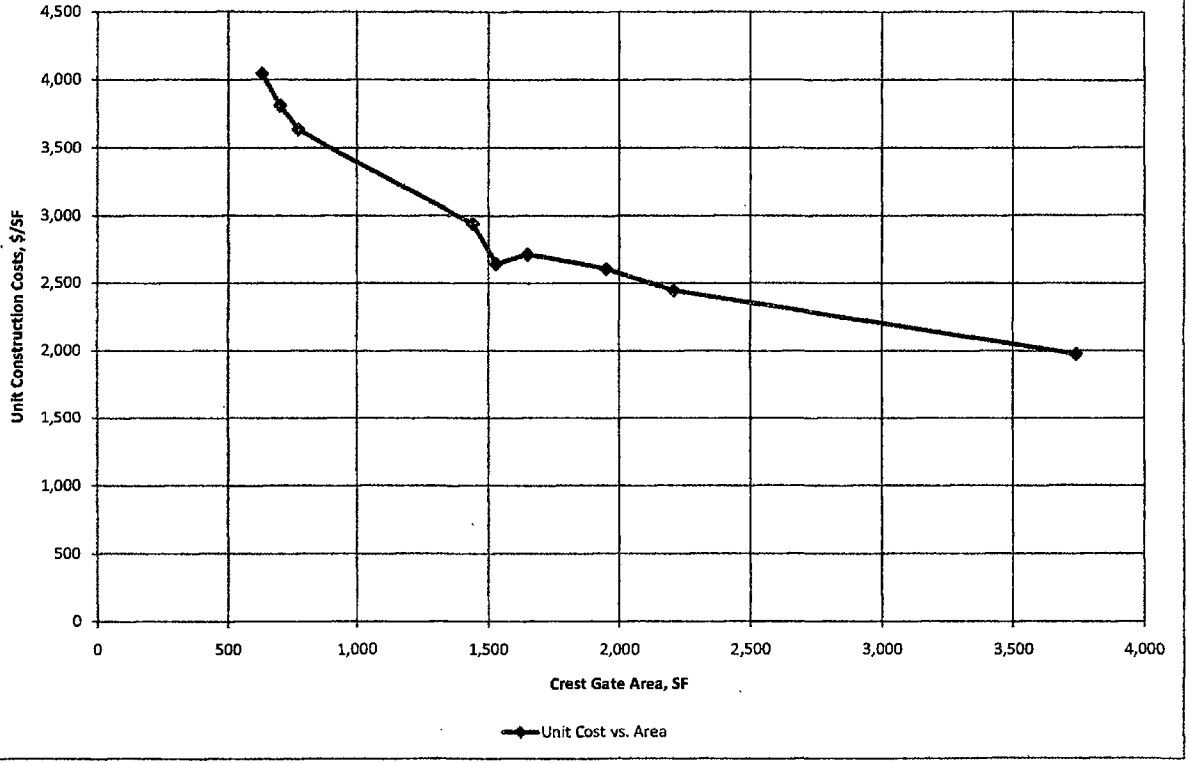
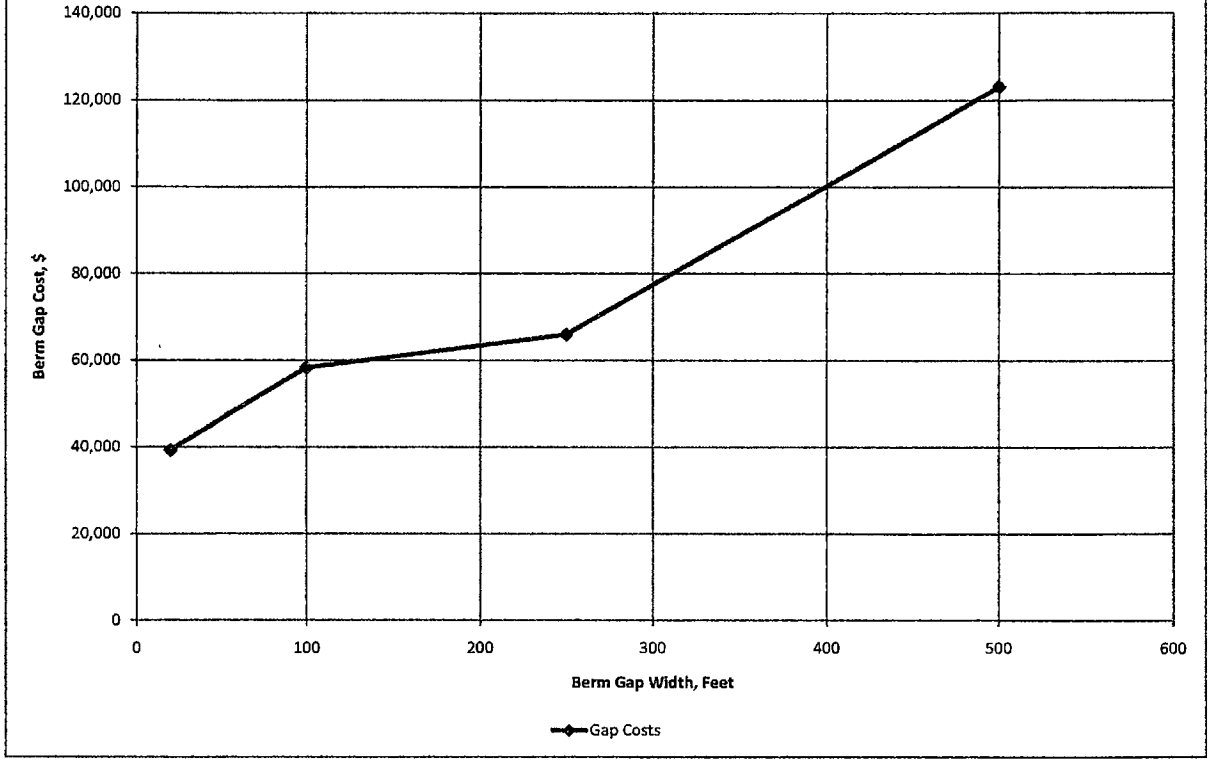


Figure L-1-19
Control Structures
Unit Construction Cost vs. Gate Area



1544

Figure L-1-20
Berm Gaps
Construction Costs



1545

Table L-1-1
Romeville Diversion Culvert (MR Stage Elev. 11)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Temporary Miss. Rvr. Levee Relocation																				
	Import Fill (use inlet canal excavation)	CY	15		0	0	0		0	0		0		0		0		0		0	
	Place Fill (use inlet canal material)	CY	6	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200
	Excavate/remove temporary levee	CY	4	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800
	Haul off excess spoils	CY	6	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200
	Permanent Levee removal and replacement																				
	Remove existing concrete slope paving																				
	Demolition	SY	9	1,770	15,930	1,810	16,290	1,870	16,830	1,910	17,190	1,930	17,370	2,000	18,000	2,290	20,610	2,380	21,420	2,680	24,120
	Disposal	CY	13	395	5,135	400	5,200	420	5,460	420	5,460	430	5,590	450	5,850	510	6,630	530	6,890	600	7,800
	Excavate existing levee (stockpile on site)	CY	4	28,100	112,400	27,700	110,800	28,400	113,600	27,400	109,600	26,800	107,200	28,400	113,600	35,500	142,000	31,100	124,400	36,000	144,000
	Fill existing levee	CY	6	28,100	168,600	27,700	166,200	28,400	170,400	27,400	164,400	26,800	160,800	28,400	170,400	35,500	213,000	31,100	186,600	36,000	216,000
	Replace concrete slope paving - 8"	SY	75	1,770	132,750	1,810	135,750	1,870	140,250	1,910	143,250	1,930	144,750	2,000	150,000	2,290	171,750	2,380	178,500	2,680	201,000
	Coffer Dam - Mississippi River																				
	Steel Sheet Pile - PZ-35	SF	62	17,000	1,054,000	17,200	1,066,400	17,600	1,091,200	17,800	1,103,600	18,000	1,116,000	18,500	1,147,000	20,300	1,258,600	20,900	1,295,800	22,800	1,413,600
	Inlet Canal																				
	Excavation	CY	4	60,000	240,000	61,400	245,600	63,700	254,800	65,100	260,400	65,800	263,200	68,900	275,600	79,700	318,800	83,000	332,000	94,300	377,200
	Haul off excess spoils	CY	6	24,300	145,800	25,700	154,200	28,000	168,000	29,400	176,400	30,100	180,600	33,200	199,200	44,000	264,000	47,300	283,800	58,600	351,600
	Riprap at Miss. Rvr. (54" deep)	SY	100	5,200	520,000	5,350	535,000	5,590	559,000	5,740	574,000	5,810	581,000	6,130	613,000	7,260	726,000	7,600	760,000	8,800	880,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)																				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	8,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500
	Riprap at Culvert Inlet - (18" deep)	SY	50	580	29,000	600	30,000	640	32,000	660	33,000	670	33,500	710	35,500	860	43,000	910	45,500	1,070	53,500
	Concrete Channel Lining at Culvert	SY	50	390	19,500	400	20,000	430	21,500	440	22,000	450	22,500	480	24,000	580	29,000	610	30,500	720	36,000
	Diversion Culvert - CIP Boxes																				
	Excavation	CY	4	13,100	52,400	15,500	62,000	18,200	72,800	21,200	84,800	22,800	91,200	25,800	102,400	34,000	136,000	43,200	172,800	54,500	218,000
	Haul off excess spoils	CY	6	3,090	18,540	4,500	27,000	6,500	39,000	8,600	51,600	9,700	58,200	12,200	73,200	19,500	117,000	27,900	167,400	38,800	232,800
	Cement Stabilized Sand Backfill	CY	25	1,380	34,500	1,690	42,250	1,920	48,000	2,230	55,750	2,390	59,750	2,540	63,500	2,970	74,250	3,610	90,250	4,180	104,500
	Backfill	CY	10	10,010	100,100	11,000	110,000	11,700	117,000	12,600	126,000	13,100	131,000	13,400	134,000	14,500	145,000	15,300	153,000	15,700	157,000
	14" Concrete Piling	VLF	45	8,600	387,000	11,800	531,000	17,100	769,500	20,300	913,500	21,900	985,500	28,800	1,296,000	53,400	2,403,000	60,800	2,736,000	86,400	3,888,000
	Concrete Culvert - CIP																				
	Floor slab	CY	300	380	114,000	525	157,500	760	228,000	910	273,000	980	294,000	1,280	384,000	2,370	711,000	2,710	813,000	3,840	1,152,000
	Walls	CY	600	360	216,000	500	300,000	760	456,000	950	570,000	1,050	630,000	1,310	786,000	1,900	1,140,000	2,660	1,596,000	3,650	2,190,000
	Roof slab	CY	750	380	285,000	525	393,750	760	570,000	910	682,500	980	735,000	1,280	960,000	2,370	1,777,500	2,710	2,032,500	3,840	2,880,000
	Headwalls - 2																				
	Footing	CY	300	220	66,000	250	75,000	280	84,000	310	93,000	320	96,000	350	105,000	440	132,000	500	150,000	610	183,000
	Headwalls	CY	600	255	153,000	265	159,000	280	168,000	290	174,000	300	180,000	320	192,000	385	231,000	390	234,000	440	264,000
	Gate Tower - CIP																				
	Walls	CY	600	190	114,000	240	144,000	300	180,000	310	186,000	320	192,000	390	234,000	680	408,000	1,550	930,000	1,980	1,188,000
	Grating - Steel - Heavy Duty	SF	75	200	15,000	320	24,000	480	36,000	600	45,000	660	49,500	880	66,000	1,680	126,000	1,960	147,000	2,800	210,000
	Sluice gates with motor operators																				
	500 cfs (2 - 5' x 5' Boxes)	EA	53,000	2	106,000																
	1,000 cfs (2 - 8' x 7' Boxes)	EA	99,000			2	198,000														

1546

Table L-1-1

Romeville Diversion Culvert (MR Stage Elev. 11)

Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	2,000 cfs (3 - 8' x 8' Boxes)	EA	112,000					3	336,000												
	3,000 cfs (3 - 10 x 10 Boxes)	EA	165,000							3	495,000										
	4,000 cfs (3 - 11 x 11 Boxes)	EA	200,000									3	600,000								
	5,000 cfs (4 - 11 x 11 Boxes)	EA	200,000											4	800,000						
	10,000 cfs (7 - 12 x 10 Boxes)	EA	195,000													7	1,365,000				
	15,000 cfs (7 - 14 x 14 Boxes)	EA	239,000															7	1,673,000		
	20,000 cfs (10 - 14 x 14 Boxes)	EA	239,000																	10	2,390,000
	Stop Logs - 2 sets																				
	500 cfs (2 - 5' x 5' Boxes)	EA	13,000	4	52,000																
	1,000 cfs (2 - 8' x 7' Boxes)	EA	21,000			4	84,000														
	2,000 cfs (3 - 8' x 8' Boxes)	EA	23,000					6	138,000												
	3,000 cfs (3 - 10 x 10 Boxes)	EA	29,000							6	174,000										
	4,000 cfs (3 - 11 x 11 Boxes)	EA	37,000									6	222,000								
	5,000 cfs (4 - 11 x 11 Boxes)	EA	37,000											8	296,000						
	10,000 cfs (7 - 12 x 10 Boxes)	EA	36,000													14	504,000				
	15,000 cfs (7 - 14 x 14 Boxes)	EA	56,000															14	784,000		
	20,000 cfs (10 - 14 x 14 Boxes)	EA	56,000																	20	1,120,000
	Cutoff Wall - PZ-22	SF	64	6,420	410,880	6,540	418,560	6,740	431,360	6,860	439,040	6,920	442,880	7,180	459,520	8,100	518,400	8,380	536,320	9,340	597,760
	Trash Rack/Bar Screens	SF	100	80	8,000	160	16,000	275	27,500	425	42,500	520	52,000	685	68,500	1,190	119,000	1,940	194,000	2,780	278,000
	Site Work - 6 Acres																				
	Clearing & Grubbing	AC	2,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200
	Strip & Stockpile topsoil - 6"	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Site Drainage																				
	Drainage swales	LF	10	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000
	Drainage pipe - 18" RCP	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	33	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000
	Site road excavation and grading	CY	6	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000
	Site road fill	CY	10	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000
	Site road - gravel - 12"	SY	9	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000
	Site road - asphalt driveway	SY	40	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000
	Site lighting	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Place topsoil	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Seeding/turf establishment	AC	3,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000
	Building	LS	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000
	Electrical Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Instrumentation Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Utility relocations in LA 44 ROW																				
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Overhead power line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Dewatering																				
	Culvert	LF	100	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000

Table L-1-1
Romeville Diversion Culvert (MR Stage Elev. 11)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Inlet Canal	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Site - misc. items	LF	25	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000
	SWPPP	LS	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
	LA 44 Detour - 2 lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Structural fill	CY	14	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Pavement Demolition																				
	LA 44 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 44 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Reconstruction - 2 lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Structural fill	CY	14	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				6,122,901		6,774,866		7,821,566		8,562,356		8,998,906		10,319,636		14,647,906		17,222,046		22,305,246
	O/H and Profit Markup		30%		1,836,870		2,032,460		2,346,470		2,568,707		2,699,672		3,095,891		4,394,372		5,166,614		6,691,574
	Subtotal				7,959,771		8,807,326		10,168,036		11,131,063		11,698,578		13,415,527		19,042,278		22,388,660		28,996,820
	Contingency		15%		1,193,966		1,321,099		1,525,205		1,669,659		1,754,787		2,012,329		2,856,342		3,358,299		4,349,523

1548

Table L-1-1
Romeville Diversion Culvert (MR Stage Elev. 11)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Total Cost				9,153,737		10,128,425		11,693,241		12,800,722		13,453,364		15,427,856		21,898,619		25,746,959		33,346,343

1549

Table L-1-2
Romeville Diversion Culvert (MR Stage Elev. 5)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		1,500 cfs		2,000 cfs		2,500 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Temporary Miss. Rvr. Levee Relocation																				
	Import Fill (use inlet canal excavation)	CY	15		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Place Fill (use inlet canal material)	CY	6	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200
	Excavate/remove temporary levee	CY	4	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800	35,700	142,800
	Haul off excess spoils	CY	6	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200	35,700	214,200
	Permanent Levee removal and replacement																				
	Remove existing concrete slope paving																				
	Demolition	SY	9	1,850	16,650	1,929	17,361	2,022	18,198	2,128	19,152	2,277	20,493	2,352	21,168	2,570	23,130	2,725	24,525	3,771	33,939
	Disposal	CY	13	411	5,343	429	5,577	449	5,837	473	6,149	506	6,578	523	6,799	571	7,423	606	7,878	838	10,894
	Excavate existing levee (stockpile on site)	CY	4	29,458	117,832	29,792	119,168	31,951	127,804	34,400	137,600	37,854	151,416	39,581	158,324	44,620	178,480	48,219	192,876	72,405	289,620
	Fill existing levee	CY	6	29,458	176,748	29,792	178,752	31,951	191,706	34,400	206,400	37,854	227,124	39,581	237,486	44,620	267,720	48,219	289,314	72,405	434,430
	Replace concrete slope paving - 8"	SY	75	1,850	138,750	1,929	144,675	2,022	151,650	2,128	159,600	2,277	170,775	2,352	176,400	2,570	192,750	2,725	204,375	3,771	282,825
	Coffer Dam - Mississippi River																				
	Steel Sheet Pile - PZ-35	SF	62	17,480	1,083,760	18,000	1,116,000	18,600	1,153,200	19,280	1,195,360	20,240	1,254,880	20,720	1,284,640	22,120	1,371,440	23,120	1,433,440	29,840	1,850,080
	Inlet Canal																				
	Excavation	CY	4	62,980	251,920	66,035	264,140	69,560	278,240	73,555	294,220	79,195	316,780	82,015	328,060	90,240	360,960	96,115	384,460	135,595	542,380
	Haul off excess spoils	CY	6	27,280	163,680	30,335	182,010	33,860	203,160	37,855	227,130	43,495	260,970	46,315	277,890	54,540	327,240	60,415	362,490	99,895	599,370
	Riprap at Miss. Rvr. (54" deep)	SY	100	5,516	551,600	5,833	583,300	6,200	620,000	6,616	661,600	7,202	720,200	7,496	749,600	8,351	835,100	8,962	896,200	13,069	1,306,900
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)																				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	8,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500
	Riprap at Culvert Inlet - (18" deep)	SY	50	623	31,150	667	33,350	717	35,850	773	38,650	853	42,650	893	44,650	1,010	50,500	1,093	54,650	1,653	82,650
	Concrete Channel Lining at Culvert	SY	50	416	20,800	444	22,200	478	23,900	516	25,800	569	28,450	596	29,800	673	33,650	729	36,450	1,102	55,100
	Diversion Culvert - CIP Boxes																				
	Excavation	CY	4	16,037	64,148	20,089	80,356	22,992	91,968	26,281	105,124	30,924	123,696	33,246	132,984	40,018	160,072	44,855	179,420	77,360	309,440
	Haul off excess spoils	CY	6	5,085	30,510	8,011	48,066	10,323	61,938	12,942	77,652	16,640	99,840	18,489	110,934	23,881	143,286	27,733	166,398	53,618	321,708
	Cement Stabilized Sand Backfill	CY	25	1,647	41,175	2,038	50,975	2,216	55,400	2,418	60,450	2,702	67,550	2,844	71,100	3,259	81,475	3,556	88,900	5,547	138,675
	Backfill	CY	10	10,952	109,520	12,078	120,780	12,669	126,690	13,339	133,390	14,284	142,840	14,757	147,570	16,137	161,370	17,122	171,220	23,742	237,420
	14" Concrete Piling	VLF	45	15,467	696,015	22,400	1,008,000	30,400	1,368,000	39,467	1,776,015	52,267	2,352,015	58,667	2,640,015	77,333	3,479,985	90,667	4,080,015	180,267	8,112,015
	Concrete Culvert - CIP																				
	Floor slab	CY	300	687	206,100	996	298,800	1,351	405,300	1,754	526,200	2,323	696,900	2,607	782,100	3,437	1,031,100	4,030	1,209,000	8,012	2,403,600
	Walls	CY	600	569	341,400	948	568,800	1,138	682,800	1,327	796,200	1,707	1,024,200	1,896	1,137,600	2,276	1,365,600	2,465	1,479,000	4,741	2,844,600
	Roof slab	CY	750	687	515,250	996	747,000	1,351	1,013,250	1,754	1,315,500	2,323	1,742,250	2,607	1,955,250	3,437	2,577,750	4,030	3,022,500	8,012	6,009,000
	Headwalls - Z																				
	Footing	CY	300	256	76,800	298	89,400	331	99,300	369	110,700	422	126,600	449	134,700	527	158,100	582	174,600	956	286,800
	Headwalls	CY	600	275	165,000	297	178,200	322	193,200	350	210,000	391	234,600	412	247,200	470	282,000	510	306,000	793	475,800
	Gate Tower - CIP																				
	Walls	CY	600	263	157,800	357	214,200	453	271,800	563	337,800	717	430,200	795	477,000	1,020	612,000	2,702	1,621,200	4,713	2,827,800
	Grating - Steel - Heavy Duty	SF	75	420	31,500	640	48,000	900	67,500	1,200	90,000	1,600	120,000	1,800	135,000	2,420	181,500	2,880	216,000	5,760	432,000
	Sluice gates with motor operators																				
	500 cfs (3 - 7 x 6 Boxes)	EA	81,000	3	243,000																
	1,000 cfs (4 - 8 x 8 Boxes)	EA	117,000			4	468,000														

1550

Table L-1-2
Romeville Diversion Culvert (MR Stage Elev. 5)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		1,500 cfs		2,000 cfs		2,500 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	1,500 cfs (5 - 9 x 8 Boxes)	EA	129,000					5	645,000												
	2,000 cfs (6 - 10 x 8 Boxes)	EA	140,000							6	840,000										
	2,500 cfs (8 - 10 x 8 Boxes)	EA	140,000									8	1,120,000								
	3,000 cfs (9 - 10 x 8 Boxes)	EA	140,000											9	1,260,000						
	4,000 cfs (11 - 11 x 8 Boxes)	EA	151,000													11	1,661,000				
	5,000 cfs (12 - 12 x 8 Boxes)	EA	161,000															12	1,932,000		
	10,000 cfs (24 - 12 x 8 Boxes)	EA	161,000																	24	3,864,000
	Stop Logs - 2 sets																				
	500 cfs (3 - 7 x 6 Boxes)	EA	18,700	6	112,200																
	1,000 cfs (4 - 8 x 8 Boxes)	EA	24,000			8	192,000														
	1,500 cfs (5 - 9 x 8 Boxes)	EA	25,500					10	255,000												
	2,000 cfs (6 - 10 x 8 Boxes)	EA	26,400							12	316,800										
	2,500 cfs (8 - 10 x 8 Boxes)	EA	26,400									16	422,400								
	3,000 cfs (9 - 10 x 8 Boxes)	EA	26,400											18	475,200						
	4,000 cfs (11 - 11 x 8 Boxes)	EA	26,800													22	589,600				
	5,000 cfs (12 - 12 x 8 Boxes)	EA	26,900															24	645,600		
	10,000 cfs (24 - 12 x 8 Boxes)	EA	26,900																	48	1,291,200
	Cutoff Wall - PZ-22	SF	64	6,680	427,520	6,940	444,160	7,240	463,360	7,580	485,120	8,060	515,840	8,300	531,200	9,000	576,000	9,500	608,000	12,860	823,040
	Trash Rack/Bar Screens	SF	100	178	17,800	362	36,200	509	50,900	679	67,900	905	90,500	1,018	101,800	1,369	136,900	1,629	162,900	3,258	325,800
	Site Work - 6 Acres																				
	Clearing & Grubbing	AC	2,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200
	Strip & Stockpile topsoil - 6"	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Site Drainage																				
	Drainage swales	LF	10	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000
	Drainage pipe - 18" RCP	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	33	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000
	Site road excavation and grading	CY	6	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000
	Site road fill	CY	10	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000
	Site road - gravel - 12"	SY	9	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000
	Site road - asphalt driveway	SY	40	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000
	Site lighting	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Place topsoil	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Seeding/turf establishment	AC	3,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000
	Building	LS	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000
	Electrical Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Instrumentation Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Utility relocations in LA 44 ROW																				
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Overhead power line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Dewatering																				
	Culvert	LF	100	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000	320	32,000

Table L-1-2
Romeville Diversion Culvert (MR Stage Elev. 5)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		1,500 cfs		2,000 cfs		2,500 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Inlet Canal	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Site - misc. items	LF	25	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000
	SWPPP	LS	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
	LA 44 Detour - 2 lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Structural fill	CY	14	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Pavement Demolition																				
	LA 44 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 44 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Reconstruction - 2 lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Structural fill	CY	14	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				7,341,337		8,806,836		10,208,317		11,767,878		14,057,119		15,201,836		18,393,497		21,496,777		37,738,452
	O/H and Profit Markup		30%		2,202,401		2,642,051		3,062,495		3,530,363		4,217,134		4,560,551		5,518,049		6,449,033		11,321,536
	Subtotal				9,543,738		11,448,887		13,270,812		15,298,241		18,274,247		19,762,387		23,911,546		27,945,810		49,059,988
	Contingency		15%		1,431,561		1,717,333		1,990,622		2,294,736		2,741,137		2,964,358		3,586,732		4,191,872		7,358,998

1552

Table L-1-2
Romeville Diversion Culvert (MR Stage Elev. 5)
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		1,500 cfs		2,000 cfs		2,500 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Total Cost				**10,975,299**		**13,166,220**		**15,251,434**		**17,592,978**		**21,015,384**		**22,726,745**		**27,498,278**		**32,137,682**		**56,418,986**

1553

Table L-1-3
Romeville Diversion Siphon (500 cfs)
Construction Cost Estimate

Item No.	Description	Unit	500 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	12,100	62	750,200
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	12,900	35	451,500
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	2,300	64	147,200
	Concrete Wall - 12" Thick	CY	15	450	6,750
	Riprap at Miss. Rvr. (54" deep)	SY	1,500	100	150,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (3) 60" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 60"	LF	2,700	350	945,000
	60" Butterfly Valve, Flg., w/Motor Op.	EA	3	81,200	243,600
	60" Knife Gate Valve, Flg., w/Motor Op.	EA	3	60,800	182,400
	Inlet screens, 60"	SF	60	100	6,000
	Excavate Pipe Trench	CY	8,185	4	32,740
	Cement Stabilized Sand - Pipe Zone	CY	2,160	25	54,000
	Bank Sand Bedding - Pipe Zone	CY	1,070	15	16,050
	Native Backfill	CY	5,000	10	50,000
	Haul Trench Spoils	CY	3,230	6	19,380
	Concrete Pipe Supports				
	Footings	CY	85	450	38,250
	Vertical	CY	40	1,000	40,000
	Access Walkways	SF	1,050	75	78,750
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	30,000	30,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3
Romeville Diversion Siphon (500 cfs)
Construction Cost Estimate

Item No.	Description	Unit	500 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (500 cfs)
Construction Cost Estimate

Item No.	Description	Unit	500 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				4,298,852
	O/H and Profit Markup			30%	1,289,656
	Subtotal				5,588,508
	Contingency			15%	838,276
	Total Cost				**6,426,784**

Table L-1-3
Romeville Diversion Siphon (1,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	1,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	12,800	62	793,600
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	13,500	35	472,500
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	2,700	64	172,800
	Concrete Wall - 12" Thick	CY	25	450	11,250
	Riprap at Miss. Rvr. (54" deep)	SY	1,800	100	180,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (4) 72" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 72"	LF	3,600	445	1,602,000
	72" Butterfly Valve, Flg., w/Motor Op.	EA	4	96,500	386,000
	72" Knife Gate Valve, Flg., w/Motor Op.	EA	4	86,600	346,400
	Inlet screens, 72"	SF	115	100	11,500
	Excavate Pipe Trench	CY	12,200	4	48,800
	Cement Stabilized Sand - Pipe Zone	CY	3,820	25	95,500
	Bank Sand Bedding - Pipe Zone	CY	1,890	15	28,350
	Native Backfill	CY	6,470	10	64,700
	Haul Trench Spoils	CY	5,710	6	34,260
	Concrete Pipe Supports				
	Footings	CY	140	450	63,000
	Vertical	CY	70	1,000	70,000
	Access Walkways	SF	1,260	75	94,500
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	40,000	40,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3
Romeville Diversion Siphon (1,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	1,000 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (1,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	1,000 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				5,572,192
	O/H and Profit Markup			30%	1,671,658
	Subtotal				7,243,850
	Contingency			15%	1,086,577
	Total Cost				**8,330,427**

Table L-1-3
Romeville Diversion Siphon (2,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	2,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	14,200	62	880,400
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	15,000	35	525,000
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	3,400	64	217,600
	Concrete Wall - 12" Thick	CY	40	450	18,000
	Riprap at Miss. Rvr. (54" deep)	SY	2,500	100	250,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (7) 72" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 72"	LF	6,300	445	2,803,500
	72" Butterfly Valve, Flg., w/Motor Op.	EA	7	96,500	675,500
	72" Knife Gate Valve, Flg., w/Motor Op.	EA	7	86,600	606,200
	Inlet screens, 72"	SF	200	100	20,000
	Excavate Pipe Trench	CY	20,300	4	81,200
	Cement Stabilized Sand - Pipe Zone	CY	6,870	25	171,750
	Bank Sand Bedding - Pipe Zone	CY	3,390	15	50,850
	Native Backfill	CY	10,100	10	101,000
	Haul Trench Spoils	CY	10,300	6	61,800
	Concrete Pipe Supports				
	Footings	CY	250	450	112,500
	Vertical	CY	130	1,000	130,000
	Access Walkways	SF	1,770	75	132,750
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	62,000	62,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3

Romeville Diversion Siphon (2,000 cfs)

Construction Cost Estimate

Item No.	Description	Unit	2,000 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (2,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	2,000 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				7,957,082
	O/H and Profit Markup			30%	2,387,125
	Subtotal				10,344,207
	Contingency			15%	1,551,631
	Total Cost				**11,895,838**

Table L-1-3
Romeville Diversion Siphon (3,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	3,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	15,300	62	948,600
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	16,100	35	563,500
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	4,000	64	256,000
	Concrete Wall - 12" Thick	CY	55	450	24,750
	Riprap at Miss. Rvr. (54" deep)	SY	3,000	100	300,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (8) 84" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 84"	LF	7,200	575	4,140,000
	84" Butterfly Valve, Flg., w/Motor Op.	EA	8	119,100	952,800
	84" Knife Gate Valve, Flg., w/Motor Op.	EA	8	111,000	888,000
	Inlet screens, 84"	SF	310	100	31,000
	Excavate Pipe Trench	CY	27,500	4	110,000
	Cement Stabilized Sand - Pipe Zone	CY	10,100	25	252,500
	Bank Sand Bedding - Pipe Zone	CY	4,990	15	74,850
	Native Backfill	CY	12,400	10	124,000
	Haul Trench Spoils	CY	15,100	6	90,600
	Concrete Pipe Supports				
	Footings	CY	330	450	148,500
	Vertical	CY	195	1,000	195,000
	Access Walkways	SF	2,060	75	154,500
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	100,000	100,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3
Romeville Diversion Siphon (3,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	3,000 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (3,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	3,000 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				10,411,632
	O/H and Profit Markup			30%	3,123,490
	Subtotal				13,535,122
	Contingency			15%	2,030,268
	Total Cost				**15,565,390**

Table L-1-3
Romeville Diversion Siphon (4,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	4,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	16,400	62	1,016,800
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	17,200	35	602,000
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	4,600	64	294,400
	Concrete Wall - 12" Thick	CY	70	450	31,500
	Riprap at Miss. Rvr. (54" deep)	SY	3,500	100	350,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (10) 84" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 84"	LF	9,000	575	5,175,000
	84" Butterfly Valve, Flg., w/Motor Op.	EA	10	119,100	1,191,000
	84" Knife Gate Valve, Flg., w/Motor Op.	EA	10	111,000	1,110,000
	Inlet screens, 84"	SF	390	100	39,000
	Excavate Pipe Trench	CY	34,200	4	136,800
	Cement Stabilized Sand - Pipe Zone	CY	12,700	25	317,500
	Bank Sand Bedding - Pipe Zone	CY	6,280	15	94,200
	Native Backfill	CY	15,200	10	152,000
	Haul Trench Spoils	CY	19,000	6	114,000
	Concrete Pipe Supports				
	Footings	CY	420	450	189,000
	Vertical	CY	250	1,000	250,000
	Access Walkways	SF	2,440	75	183,000
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	110,000	110,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3
Romeville Diversion Siphon (4,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	4,000 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (4,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	4,000 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				12,413,232
	O/H and Profit Markup			30%	3,723,970
	Subtotal				16,137,202
	Contingency			15%	2,420,580
	Total Cost				**18,557,782**

Table L-1-3
Romeville Diversion Siphon (5,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	5,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	17,200	62	1,066,400
	Coffer Dam - Levee Crossing (Temporary)				
	Steel Sheet Pile - PZ-27	SF	17,900	35	626,500
	Cutoff Wall				
	Steel Sheet Piling - PZ-22	SF	5,000	64	320,000
	Concrete Wall - 12" Thick	CY	80	450	36,000
	Riprap at Miss. Rvr. (54" deep)	SY	3,900	100	390,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	15	8,500	127,500
	Siphon Piping - (10) 96" Dia. - 900 LF				
	A53 CW Standard Pipe PE, 96"	LF	9,000	690	6,210,000
	96" Butterfly Valve, Flg., w/Motor Op.	EA	10	145,500	1,455,000
	96" Knife Gate Valve, Flg., w/Motor Op.	EA	10	127,500	1,275,000
	Inlet screens, 96"	SF	510	100	51,000
	Excavate Pipe Trench	CY	40,400	4	161,600
	Cement Stabilized Sand - Pipe Zone	CY	15,900	25	397,500
	Bank Sand Bedding - Pipe Zone	CY	7,830	15	117,450
	Native Backfill	CY	16,700	10	167,000
	Haul Trench Spoils	CY	23,700	6	142,200
	Concrete Pipe Supports				
	Footings	CY	480	450	216,000
	Vertical	CY	310	1,000	310,000
	Access Walkways	SF	2,590	75	194,250
	Vacuum Start-up System				
	Vacuum Pumping Equipment	LS	1	140,000	140,000
	Vacuum Piping	LS	1	20,000	20,000
	Equipment Building	LS	1	50,000	50,000

Table L-1-3
Romeville Diversion Siphon (5,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	5,000 cfs Qty	Unit Price	Cost, $
	Electrical Allowance	LS	1	100,000	100,000
	Instrumentation Allowance	LS	1	100,000	100,000
	Site Work - 6 Acres				
	Clearing & Grubbing	AC	6	2,200	13,200
	Strip & Stockpile topsoil - 6"	CY	5,000	2	10,000
	Site Drainage				
	Drainage swales	LF	2,000	10	20,000
	Drainage pipe - 18" RCP	LF	200	35	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	3,000	33	99,000
	Site road excavation and grading	CY	2,000	6	12,000
	Site road fill	CY	1,000	10	10,000
	Site road - gravel - 12"	SY	2,000	9	18,000
	Site road - asphalt driveway	SY	250	40	10,000
	Site lighting	LS	1	5,000	5,000
	Place topsoil	CY	5,000	2	10,000
	Seeding/turf establishment	AC	6	3,000	18,000
	Utility relocations in LA 44 ROW				
	Communication line	LS	1	5,000	5,000
	Communication line	LS	1	5,000	5,000
	Overhead power line	LS	1	5,000	5,000
	Dewatering				
	Culvert	LF	320	100	32,000
	Pipe Trenches	LF	400	50	20,000
	Site - misc. items	LF	1,000	25	25,000
	SWPPP	LS	1	10,000	10,000
	LA 44 Relocation - 2 lanes - 1,000 feet				
	Excavation & Grading	CY	2,963	10	29,630
	Structural fill	CY	1,670	14	23,380
	Lime Stabilization 12" Deep, 5% Lime	SY	4,889	6	29,334
	Stone Base	CY	1,086	15	16,290
	Bituminous Base Course 4"	SY	2,667	12	32,004
	Bituminous Binder Course 3"	SY	2,667	9	24,003
	Bituminous Top Course 1"	SY	2,667	3	8,001
	Gravel shoulders	CY	494	10	4,940

Table L-1-3
Romeville Diversion Siphon (5,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	5,000 cfs Qty	Unit Price	Cost, $
	Painted Lines 4" Wide	LF	3,000	0.20	600
	Signage	LS	1	1,500	1,500
	Drainage Pipe 18" RCP	LF	140	75	10,500
	Seeding/Turf Establishment	AC	2	3,000	6,000
	LA 44 Demolition				
	Demolish Existing Pavement	SY	2,700	9	24,300
	Haul Demo'ed Pavement	CY	450	13	5,850
	Seeding/Turf Establishment	AC	3	3,000	9,000
	Subtotal - Direct Costs				14,332,932
	O/H and Profit Markup			30%	4,299,880
	Subtotal				18,632,812
	Contingency			15%	2,794,922
	Total Cost				**21,427,733**

Table L-1-4
Romeville Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Earthen Channel																				
	Clearing & Grubbing	AC	2,200	57	125,400	65	143,000	87	191,400	106	233,200	126	277,200	144	316,800	238	523,600	336	739,200	430	946,000
	Strip Topsoil - 6"	CY	2	46,000	92,000	52,700	105,400	70,300	140,600	85,200	170,400	101,400	202,800	116,000	232,000	192,000	384,000	270,400	540,800	347,500	695,000
	Excavation	CY	4	169,000	676,000	305,000	1,220,000	559,000	2,236,000	792,000	3,168,000	1,046,000	4,184,000	1,300,000	5,200,000	2,470,000	9,880,000	3,692,000	14,768,000	4,899,000	19,596,000
	Fill (embankment)	CY	6	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000
	Import fill material	CY	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haul off spoils	CY	6	56,000	336,000	192,000	1,152,000	446,000	2,676,000	879,000	5,274,000	933,000	5,598,000	1,190,000	7,140,000	2,350,000	14,100,000	3,579,000	21,474,000	4,786,000	28,716,000
	Place topsoil	CY	2	46,000	92,000	52,700	105,400	70,300	140,600	85,200	170,400	101,400	202,800	116,000	232,000	192,000	384,000	270,400	540,800	347,500	695,000
	Seeding/Establish Turf	AC	3,000	55	165,000	52	156,000	54	162,000	54	162,000	54	162,000	52	156,000	54	162,000	54	162,000	54	162,000
	Drainage ditch at ROW	LF	10	30,050	300,500	30,200	302,000	30,500	305,000	30,800	308,000	31,100	311,000	31,400	314,000	32,800	328,000	34,200	342,000	35,700	357,000
	Drainage outfall pipes - 24" RCP	LF	50	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000
	Fence - 4-strand Barbed Wire	LF	15	30,050	450,750	30,200	453,000	30,500	457,500	30,800	462,000	31,100	466,500	31,400	471,000	32,800	492,000	34,200	513,000	35,700	535,500
	Stilling Basin at Culvert/Siphon Outfall																				
	Concrete channel lining - 100 LF	SY	50	890	44,500	1,250	62,500	1,920	96,000	2,600	130,000	3,200	160,000	3,860	193,000	6,910	345,500	10,200	510,000	13,300	665,000
	Riprap - 18" - 50 LF	SY	50	450	22,500	630	31,500	960	48,000	1,300	65,000	1,600	80,000	1,930	96,500	3,460	173,000	5,100	255,000	6,700	335,000
	Canadian National RR Crossing																				
	(12' x 8' CIP Box Culverts - 100 LF)		6	5,270	31,620	6,100	36,600	8,610	51,660	11,110	66,660	13,620	81,720	16,120	96,720	28,640	171,840	41,160	246,960	53,690	322,140
	Excavation	CY	300	230	69,000	330	99,000	640	192,000	950	285,000	1,260	378,000	1,570	471,000	3,130	939,000	4,685	1,405,500	6,240	1,872,000
	Culvert floor - CIP	CY	600	180	108,000	240	144,000	420	252,000	595	357,000	770	462,000	950	570,000	1,840	1,104,000	2,730	1,638,000	3,615	2,169,000
	Culvert walls - CIP	CY	750	230	172,500	330	247,500	640	480,000	950	712,500	1,260	945,000	1,570	1,177,500	3,130	2,347,500	4,685	3,513,750	6,240	4,680,000
	Culvert roof - CIP	CY																			
	Headwalls		300	220	66,000	250	75,000	345	103,500	440	132,000	530	159,000	625	187,500	1,090	327,000	1,560	468,000	2,025	607,500
	Footing	CY	600	125	75,000	140	84,000	170	102,000	210	126,000	240	144,000	275	165,000	440	264,000	610	366,000	780	468,000
	Wall	CY	25	595	14,875	645	16,125	800	20,000	960	24,000	1,120	28,000	1,270	31,750	2,045	51,125	2,820	70,500	3,600	90,000
	Cement Stabilized Sand Backfill	CY	10	3,340	33,400	3,500	35,000	3,985	39,850	4,465	44,650	4,950	49,500	5,430	54,300	7,840	78,400	10,250	102,500	12,670	126,700
	Backfill - excavated material	CY	6	1,930	11,580	2,600	15,600	4,625	27,750	6,645	39,870	8,670	52,020	10,690	64,140	20,800	124,800	30,910	185,460	41,020	246,120
	Haul off spoils	CY	50	180	9,000	250	12,500	390	19,500	510	25,500	640	32,000	780	39,000	1,390	69,500	2,030	101,500	2,660	133,000
	Concrete Channel Lining - 10 LF each end	SY	50	180	9,000	250	12,500	390	19,500	510	25,500	640	32,000	780	39,000	1,390	69,500	2,030	101,500	2,660	133,000
	Riprap - 10 LF each end	SY																			
	CN RR Relocation - 2,000 LF		2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Clearing & Grubbing	AC	20	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000
	Embankment	LF	35	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000
	Ballast	LF	200	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000
	Railroad Track Work	LF	150,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000
	Turnout	EA	15	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000
	Remove temporary embankment & ballast	LF	15	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000
	Remove temporary rail	LF	6,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000
	Remove Turnout	EA	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	Seeding	AC																			
	CN RR Reconstruction - 200 LF		20	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000
	Embankment	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Ballast	LF	200	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000
	Railroad Track Work	LF	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	Seeding	AC																			
	LA 3125 Crossing																				

1572

Table 1-1-4
Romeville Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	(12' x 8' CIP Box Culverts - 300 LF)																				
	Excavation	CY	6	8,400	50,400	9,975	59,850	14,700	88,200	19,400	116,400	24,200	145,200	28,900	173,400	52,500	315,000	76,200	457,200	99,800	598,800
	Culvert floor - CIP	CY	300	330	99,000	485	145,500	960	288,000	1,430	429,000	1,910	573,000	2,375	712,500	4,740	1,422,000	7,100	2,130,000	9,465	2,839,500
	Culvert walls - CIP	CY	600	290	174,000	385	231,000	675	405,000	965	579,000	1,255	753,000	1,545	927,000	2,985	1,791,000	4,430	2,658,000	5,875	3,525,000
	Culvert roof - CIP	CY	750	330	247,500	485	363,750	960	720,000	1,430	1,072,500	1,910	1,432,500	2,375	1,781,250	4,740	3,555,000	7,100	5,325,000	9,465	7,098,750
	Headwalls																				
	Footing	CY	300	185	55,500	210	63,000	300	90,000	385	115,500	475	142,500	560	168,000	995	298,500	1,435	430,500	1,870	561,000
	Wall	CY	600	65	39,000	70	42,000	80	48,000	90	54,000	100	60,000	115	69,000	165	99,000	220	132,000	270	162,000
	Cement Stabilized Sand Backfill	CY	25	1,545	38,625	1,690	42,250	2,125	53,125	2,565	64,125	3,000	75,000	3,440	86,000	5,620	140,500	7,795	194,875	9,975	249,375
	Backfill - excavated material	CY	10	3,775	37,750	3,730	37,300	3,580	35,800	3,435	34,350	3,290	32,900	3,145	31,450	2,420	24,200	1,690	16,900	970	9,700
	Haul off spoils	CY	6	4,625	27,750	6,245	37,470	11,120	66,720	15,965	95,790	20,910	125,460	25,755	154,530	50,080	300,480	74,510	447,060	98,830	592,980
	Concrete Channel Lining - 10 LF each end	SY	50	180	9,000	250	12,500	390	19,500	510	25,500	640	32,000	780	39,000	1,390	69,500	2,030	101,500	2,660	133,000
	Riprap - 10 LF each end	SY	50	180	9,000	250	12,500	390	19,500	510	25,500	640	32,000	780	39,000	1,390	69,500	2,030	101,500	2,660	133,000
	LA 3125 Detour - 2 Lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600						
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	3	6,600	3	6,600	3	6,600
	Fill	CY	10	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	2,200	22,000	2,200	22,000	2,200	22,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	1,500	15,000	1,500	15,000	1,500	15,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	4,000	24,000	4,000	24,000	4,000	24,000
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	670	10,050	670	10,050	670	10,050
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	2,700	24,300	2,700	24,300	2,700	24,300
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	0	0	0	0	0	0
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	260	2,600	260	2,600	260	2,600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	3,000	600	3,000	600	3,000	600
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	1	1,500	1	1,500	1	1,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	140	10,500	140	10,500	140	10,500
																3	9,000	3	9,000	3	9,000
	LA 3125 Reconstruction - 2 Lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Fill	CY	10	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
	Pavement Demolition																				
	LA 3125 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 3125 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	Dewatering and Water Management																				
	Earthen Canal																				
	Dewatering	LF	50	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000
	CN RR Crossing																				

Blind River

Table L-1-4
Romeville Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Dewatering	LF	50	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000
	LA 3125																				
	Dewatering	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Utility Construction																				
	Dewatering	LF	25	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				6,598,842		8,462,437		12,501,397		17,500,037		20,317,792		24,335,032		43,310,137		62,945,697		82,359,757
	O/H and Profit Markup		30%		1,979,653		2,538,731		3,750,419		5,250,011		6,095,338		7,300,510		12,993,041		18,883,709		24,707,927
	Subtotal				8,578,495		11,001,168		16,251,816		22,750,048		26,413,130		31,635,542		56,303,178		81,829,406		107,067,684
	Contingency		10%		857,849		1,100,117		1,625,182		2,275,005		2,641,313		3,163,554		5,630,318		8,182,941		10,706,768
	Total Cost				9,436,344		12,101,285		17,876,998		25,025,053		29,054,443		34,799,096		61,933,496		90,012,347		117,774,453

1574

Table L-1-5
Romeville Deep Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Earthen Channel																				
	Clearing & Grubbing	AC	2,200																		
	Strip Topsoil - 6"	CY	2	64	140,101	70	154,848	84	184,343	101	221,212	114	250,707	131	287,576	198	435,051	268	589,899	339	744,747
	Excavation	CY	4	51,370	102,741	56,778	113,556	67,593	135,185	81,111	162,222	91,926	183,852	105,444	210,889	159,519	319,037	216,296	432,593	273,074	546,148
	Fill (embankment)	CY	6	254,173	1,016,694	317,963	1,271,850	530,593	2,122,372	796,381	3,185,525	1,009,012	4,036,047	1,274,800	5,099,200	2,237,953	8,951,810	3,480,842	13,923,366	4,597,152	18,388,607
	Import fill material	CY	15	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521	112,920	677,521
	Haul off spoils	CY	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Place topsoil	CY	2	141,253	847,519	205,042	1,230,254	417,873	2,506,037	683,461	4,100,766	896,092	5,376,549	1,161,880	6,971,278	2,225,032	13,350,194	3,367,921	20,207,528	4,484,232	26,905,389
	Seeding/Establish Turf	AC	3,000	51,370	102,741	56,778	113,556	67,593	135,185	81,111	162,222	91,926	183,852	105,444	210,889	159,519	319,037	216,296	432,593	273,074	546,148
	Drainage ditch at ROW	LF	10	91	183,003	64	191,047	64	191,047	64	191,047	64	191,047	64	191,047	64	191,047	62	186,019	62	186,019
	Drainage outfall pipes - 24" RCP	LF	50	30,150	301,500	30,250	302,500	30,450	304,500	30,700	307,000	30,900	309,000	31,150	311,500	32,150	321,500	33,200	332,000	34,250	342,500
	Fence - 4-strand Barbed Wire	LF	15	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000
				30,150	452,250	30,250	453,750	30,450	456,750	30,700	460,500	30,900	463,500	31,150	467,250	32,150	482,250	33,200	498,000	34,250	513,750
	Stilling Basin at Culvert/Siphon Outfall																				
	Concrete channel lining - 100 LF	SY	50	889	44,444	1,022	51,111	1,467	73,333	2,022	101,111	2,467	123,333	3,022	151,111	5,244	262,222	7,633	381,667	9,967	498,333
	Riprap - 18" - 50 LF	SY	50	444	22,222	511	25,556	733	36,667	1,011	50,556	1,233	61,667	1,511	75,556	2,622	131,111	3,817	190,833	4,983	249,167
	Canadian National RR Crossing																				
	(12' x 10' CIP Box Culverts - 100 LF)																				
	Excavation	CY	6	5,905	35,431	6,897	41,381	8,880	53,280	11,855	71,129	13,838	83,029	15,821	94,928	25,738	154,425	36,645	219,872	46,561	279,368
	Culvert floor - CIP	CY	300	119	35,556	222	66,667	430	128,889	741	222,222	948	284,444	1,156	346,667	2,193	657,778	3,333	1,000,000	4,370	1,311,111
	Culvert walls - CIP	CY	600	148	88,889	222	133,333	370	222,222	593	355,556	741	444,444	889	533,333	1,630	977,778	2,444	1,466,667	3,185	1,911,111
	Culvert roof - CIP	CY	750	119	88,889	222	166,667	430	322,222	741	555,556	948	711,111	1,156	866,667	2,193	1,644,444	3,333	2,500,000	4,370	3,277,778
	Headwalls				0		0		0		0		0		0		0		0		0
	Footing	CY	300	221	66,248	252	75,581	314	94,248	407	122,248	470	140,915	532	159,581	843	252,915	1,185	355,581	1,496	448,915
	Wall	CY	600	163	97,629	176	105,611	202	121,576	243	145,523	269	161,488	296	177,453	429	257,277	575	345,083	708	424,907
	Cement Stabilized Sand Backfill	CY	25	615	15,370	667	16,667	770	19,259	926	23,148	1,030	25,741	1,133	28,333	1,652	41,296	2,272	56,556	2,741	68,519
	Backfill - excavated material	CY	10	4,461	44,608	4,675	46,746	5,102	51,023	5,744	57,438	6,171	61,715	6,599	65,992	8,738	87,375	11,090	110,897	13,228	132,281
	Haul off spoils	CY	6	1,444	8,667	2,222	13,333	3,778	22,667	6,111	36,667	7,667	46,000	9,222	55,333	17,000	102,000	25,556	153,333	33,333	200,000
	Concrete Channel Lining - 10 LF each end	SY	50	178	8,889	204	10,222	293	14,667	404	20,222	493	24,667	604	30,222	1,049	52,444	1,527	76,333	1,993	99,667
	Riprap - 10 LF each end	SY	50	178	8,889	204	10,222	293	14,667	404	20,222	493	24,667	604	30,222	1,049	52,444	1,527	76,333	1,993	99,667
	CN RR Relocation - 2,000 LF																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Embankment	LF	20	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000
	Ballast	LF	35	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000
	Railroad Track Work	LF	200	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000
	Turnout	EA	150,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000
	Remove temporary embankment & ballast	LF	15	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000
	Remove temporary rail	LF	15	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000
	Remove Turnout	EA	6,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	CN RR Reconstruction - 200 LF																				
	Embankment	LF	20	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000
	Ballast	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Railroad Track Work	LF	200	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	LA 3125 Crossing																				

1575

Table L-1-5
Romeville Deep Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	(12' x 10' CIP Box Culverts - 300 LF)																				
	Excavation	CY	6	9,151	54,903	11,044	66,263	14,830	88,981	20,510	123,059	24,296	145,777	28,083	168,496	47,015	282,088	67,840	407,040	86,772	520,632
	Culvert floor - CIP	CY	300	173	51,157	328	98,403	643	192,894	1,115	334,630	1,430	429,120	1,745	523,611	3,320	996,065	5,053	1,515,764	6,627	1,988,218
	Culvert walls - CIP	CY	600	243	144,444	361	216,667	602	361,111	963	577,778	1,204	722,222	1,444	866,667	2,648	1,588,889	3,972	2,383,333	5,176	3,105,556
	Culvert roof - CIP	CY	750	171	127,890	328	246,007	643	482,234	1,115	836,574	1,430	1,072,801	1,745	1,309,028	3,320	2,490,162	5,053	3,789,410	6,627	4,970,544
	Headwalls				0		0		0		0		0		0		0		0		
	Footing	CY	300	180	54,047	209	62,769	267	80,213	355	106,380	413	123,824	471	141,269	762	228,491	1,081	324,436	1,372	411,658
	Wall	CY	600	92	54,928	96	57,344	104	62,172	116	69,415	124	74,244	132	79,073	172	103,216	216	129,774	257	153,917
	Cement Stabilized Sand Backfill	CY	25	2,620	40,508	1,766	44,144	2,056	51,412	2,493	62,315	2,783	69,583	3,074	76,852	4,528	113,194	6,127	153,171	7,581	189,514
	Backfill - excavated material	CY	10	5,615	56,152	5,594	55,942	5,553	55,526	5,490	54,901	5,448	54,484	5,407	54,067	5,198	51,984	4,969	49,692	4,761	47,608
	Haul off spoils	CY	6	3,535	21,213	5,450	32,697	9,278	55,666	15,020	90,119	18,848	113,087	22,676	136,056	41,816	250,898	62,871	377,225	82,011	492,068
	Concrete Channel Lining - 10 LF each end	SY	50	178	8,889	204	10,222	293	14,667	404	20,222	493	24,667	604	30,222	1,049	52,444	1,527	76,333	1,993	99,667
	Riprap - 10 LF each end	SY	50	178	8,889	204	10,222	293	14,667	404	20,222	493	24,667	604	30,222	1,049	52,444	1,527	76,333	1,993	99,667
	LA 3125 Detour - 2 Lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Fill	CY	10	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 3125 Reconstruction - 2 Lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Fill	CY	10	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
	Pavement Demolition																				
	LA 3125 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 3125 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	Dewatering and Water Management																				
	Earthen Canal																				
	Dewatering	LF	50	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000
	CN RR Crossing																				

1576

Table L-1-5
Romeville Deep Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Dewatering	LF	50	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000
	LA 3125																				
	Dewatering	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Utility Construction																				
	Dewatering	LF	25	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				7,241,518		8,401,351		11,575,895		15,773,920		18,948,464		22,686,801		38,559,525		55,722,877		72,159,393
	O/H and Profit Markup		30%		2,172,455		2,520,405		3,472,769		4,732,176		5,684,539		6,806,040		11,567,857		16,716,863		21,647,818
	Subtotal				9,413,973		10,921,756		15,048,664		20,506,095		24,633,003		29,492,842		50,127,382		72,439,740		93,807,210
	Contingency		10%		941,397		1,092,176		1,504,866		2,050,610		2,463,300		2,949,284		5,012,738		7,243,974		9,380,721
	Total Cost				10,355,370		12,013,931		16,553,530		22,556,705		27,096,304		32,442,126		55,140,120		79,683,714		103,187,931

1577

Table L-1-6
Romeville Concrete-lined Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Concrete-Lined Channel																				
	Clearing & Grubbing	AC	2,200	57	125,400	60	132,000	67	147,400	77	169,400	84	184,800	94	206,800	137	301,400	181	398,200	225	495,000
	Strip Topsoil - 6"	CY	2	45,963	91,926	48,667	97,334	54,074	108,148	62,185	124,370	67,593	135,186	75,704	151,408	110,852	221,704	146,000	292,000	181,148	362,296
	Excavation	CY	4	152,215	608,860	194,558	778,232	304,649	1,218,596	414,741	1,658,964	524,832	2,099,328	634,923	2,539,692	1,185,380	4,741,520	1,740,071	6,960,284	2,290,528	9,162,112
	Fill (embankment)	CY	6	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000	113,000	678,000
	Import fill material	CY	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haul off spoils	CY	6	39,295	235,770	81,638	489,828	191,729	1,150,374	301,821	1,810,926	411,912	2,471,472	522,000	3,132,000	1,072,460	6,434,760	1,627,151	9,762,906	2,177,607	13,065,642
	Place topsoil	CY	2	45,963	91,926	48,667	97,334	54,074	108,148	62,185	124,370	67,593	135,186	75,704	151,408	110,852	221,704	146,000	292,000	181,148	362,296
	Seeding/Establish Turf	AC	3,000	54	162,000	54	162,000	54	162,000	54	162,000	52	156,000	53	159,000	53	159,000	53	159,000	53	159,000
	Drainage ditch at ROW	LF	10	30,050	300,500	30,100	301,000	30,200	302,000	30,350	303,500	30,450	304,500	30,600	306,000	31,250	312,500	31,900	319,000	32,550	325,500
	Drainage outfall pipes - 24" RCP	LF	50	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000
	Fence - 4-strand Barbed Wire	LF	15	30,050	450,750	30,100	451,500	30,200	453,000	30,350	455,250	30,450	456,750	30,600	459,000	31,250	468,750	31,900	478,500	32,550	488,250
	Concrete channel lining	SY	50	146,404	7,320,200	162,626	8,131,300	204,804	10,240,200	246,982	12,349,100	289,160	14,458,000	331,337	16,566,850	542,226	27,111,300	754,737	37,736,850	965,626	48,281,300
	Riprap - 18" - 50 LF	SY	50	450	22,500	630	31,500	960	48,000	1,300	65,000	1,600	80,000	1,930	96,500	3,460	173,000	5,100	255,000	6,700	335,000
	Canadian National RR Crossing																				
	(12' x 8' CIP Box Culverts - 100 LF)																				
	Excavation	CY	6	5,270	31,620	6,100	36,600	8,610	51,660	11,110	66,660	13,620	81,720	16,120	96,720	28,640	171,840	41,160	246,960	53,690	322,140
	Culvert floor - CIP	CY	300	230	69,000	330	99,000	640	192,000	950	285,000	1,260	378,000	1,570	471,000	3,130	939,000	4,685	1,405,500	6,240	1,872,000
	Culvert walls - CIP	CY	600	180	108,000	240	144,000	420	252,000	595	357,000	770	462,000	950	570,000	1,840	1,104,000	2,730	1,638,000	3,625	2,169,000
	Culvert roof - CIP	CY	750	230	172,500	330	247,500	640	480,000	950	712,500	1,260	945,000	1,570	1,177,500	3,130	2,347,500	4,685	3,513,750	6,240	4,680,000
	Headwalls																				
	Footing	CY	300	220	66,000	250	75,000	345	103,500	440	132,000	530	159,000	625	187,500	1,090	327,000	1,560	468,000	2,025	607,500
	Wall	CY	600	125	75,000	140	84,000	170	102,000	210	126,000	240	144,000	275	165,000	440	264,000	610	366,000	780	468,000
	Cement Stabilized Sand Backfill	CY	25	595	14,875	645	16,125	800	20,000	960	24,000	1,120	28,000	1,270	31,750	2,045	51,125	2,820	70,500	3,600	90,000
	Backfill - excavated material	CY	10	3,340	33,400	3,500	35,000	3,985	39,850	4,465	44,650	4,950	49,500	5,430	54,300	7,840	78,400	10,250	102,500	12,670	126,700
	Haul off spoils	CY	6	1,930	11,580	2,600	15,600	4,625	27,750	6,645	39,870	8,670	52,020	10,690	64,140	20,800	124,800	30,910	185,460	41,020	246,120
	CN RR Relocation - 2,000 LF																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Embankment	LF	20	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000
	Ballast	LF	35	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000
	Railroad Track Work	LF	200	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000
	Turnout	EA	150,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000
	Remove temporary embankment & ballast	LF	15	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000
	Remove temporary rail	LF	15	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000
	Remove Turnout	EA	6,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	CN RR Reconstruction - 200 LF																				
	Embankment	LF	20	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000
	Ballast	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Railroad Track Work	LF	200	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	LA 3125 Crossing																				
	(12' x 8' CIP Box Culverts - 300 LF)																				
	Excavation	CY	6	8,400	50,400	9,975	59,850	14,700	88,200	19,400	116,400	24,200	145,200	28,900	173,400	52,500	315,000	76,200	457,200	99,800	598,800
	Culvert floor - CIP	CY	300	330	99,000	485	145,500	960	288,000	1,430	429,000	1,910	573,000	2,375	712,500	4,740	1,422,000	7,100	2,130,000	9,465	2,839,500
	Culvert walls - CIP	CY	600	290	174,000	385	231,000	675	405,000	965	579,000	1,255	753,000	1,545	927,000	2,985	1,791,000	4,430	2,658,000	5,875	3,525,000

1578

Table L-1-6
Romeville Concrete-lined Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Culvert road - CIP	CY	750	330	247,500	485	363,750	960	720,000	1,430	1,072,500	1,910	1,432,500	2,375	1,781,250	4,740	3,555,000	7,100	5,325,000	9,465	7,098,750
	Headwalls																				
	Footing	CY	300	185	55,500	210	63,000	300	90,000	385	115,500	475	142,500	560	168,000	995	298,500	1,435	430,500	1,870	561,000
	Wall	CY	600	65	39,000	70	42,000	80	48,000	90	54,000	100	60,000	115	69,000	165	99,000	220	132,000	270	162,000
	Cement Stabilized Sand Backfill	CY	25	1,545	38,625	1,690	42,250	2,125	53,125	2,565	64,125	3,000	75,000	3,440	86,000	5,620	140,500	7,795	194,875	9,975	249,375
	Backfill - excavated material	CY	10	3,775	37,750	3,730	37,300	3,580	35,800	3,435	34,350	3,290	32,900	3,145	31,450	2,420	24,200	1,690	16,900	970	9,700
	Haul off spoils	CY	6	4,625	27,750	6,245	37,470	11,120	66,720	15,965	95,790	20,910	125,460	25,755	154,530	50,080	300,480	74,510	447,060	98,830	592,980
	LA 3125 Detour - 2 Lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Fill	CY	10	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 3125 Reconstruction - 2 Lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Fill	CY	10	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
	Pavement Demolition																				
	LA 3125 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 3125 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	Dewatering and Water Management																				
	Earthen Canal																				
	Dewatering	LF	50	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000
	CN RR Crossing																				
	Dewatering	LF	50	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000
	LA 3125																				
	Dewatering	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Utility Construction																				
	Dewatering	LF	25	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500
					0		0		0		0		0		0		0		0		0

1579

Table L-1-6
Romeville Concrete-lined Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Subtotal - Direct Costs				13,668,024		15,353,665		19,908,163		24,477,917		29,026,714		33,596,390		56,405,675		79,348,637		102,161,653
	O/H and Profit Markup		30%		4,100,407		4,606,100		5,972,449		7,343,375		8,708,014		10,078,917		16,921,703		23,804,591		30,648,496
	Subtotal				17,768,431		19,959,765		25,880,612		31,821,292		37,734,728		43,675,307		73,327,378		103,153,228		132,810,149
	Contingency		10%		1,776,843		1,995,976		2,588,061		3,182,129		3,773,473		4,367,531		7,332,738		10,315,323		13,281,015
	Total Cost				19,545,274		21,955,741		28,468,673		35,003,421		41,508,201		48,042,838		80,660,115		113,468,551		146,091,164

1580

Table L-1-7

Romeville Batture Crossing - Siphon Pipe (500 cfs)
Construction Cost Estimate

Item No.	Description	Unit	500 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	12,100	62	750,200
	Riprap at Miss. Rvr. (54" deep)	SY	1,500	100	150,000
	Riprap at Siphon Inlet - (18" deep)	SY	580	50	29,000
	Concrete Channel Lining at Siphon Inlet	SY	390	50	19,500
	Siphon Piping - (3) 60" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 60"	LF	1,335	350	467,250
	Inlet screens, 60"	SF	60	100	6,000
	Excavate Pipe Trench	CY	3,967	4	15,868
	Cement Stabilized Sand - Pipe Zone	CY	1,628	25	40,700
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	1,673	6	10,038
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				1,603,806
	O/H and Profit Markup			30%	481,142
	Subtotal				2,084,948
	Contingency			15%	312,742
	Total Cost				**2,397,690**

Table L-1-7
Romeville Batture Crossing - Siphon Pipe (1,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	1,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	12,800	62	793,600
	Riprap at Miss. Rvr. (54" deep)	SY	1,800	100	180,000
	Riprap at Siphon Inlet - (18" deep)	SY	600	50	30,000
	Concrete Channel Lining at Siphon Inlet	SY	400	50	20,000
	Siphon Piping - (4) 72" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 72"	LF	1,780	445	792,100
	Inlet screens, 72"	SF	115	100	11,500
	Excavate Pipe Trench	CY	6,524	4	26,096
	Cement Stabilized Sand - Pipe Zone	CY	2,879	25	71,975
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	2,367	6	14,202
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				2,054,723
	O/H and Profit Markup			30%	616,417
	Subtotal				2,671,140
	Contingency			15%	400,671
	Total Cost				**3,071,811**

Table L-1-7
Romeville Batture Crossing - Siphon Pipe (2,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	2,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	14,200	62	880,400
	Riprap at Miss. Rvr. (54" deep)	SY	2,500	100	250,000
	Riprap at Siphon Inlet - (18" deep)	SY	640	50	32,000
	Concrete Channel Lining at Siphon Inlet	SY	430	50	21,500
	Siphon Piping - (7) 72" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 72"	LF	3,115	445	1,386,175
	Inlet screens, 72"	SF	200	100	20,000
	Excavate Pipe Trench	CY	11,247	4	44,988
	Cement Stabilized Sand - Pipe Zone	CY	5,175	25	129,375
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	3,837	6	23,022
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				2,902,710
	O/H and Profit Markup			30%	870,813
	Subtotal				3,773,523
	Contingency			15%	566,028
	Total Cost				**4,339,551**

Table L-1-7
Romeville Batture Crossing - Siphon Pipe (3,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	3,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	15,300	62	948,600
	Riprap at Miss. Rvr. (54" deep)	SY	3,000	100	300,000
	Riprap at Siphon Inlet - (18" deep)	SY	660	50	33,000
	Concrete Channel Lining at Siphon Inlet	SY	440	50	22,000
	Siphon Piping - (8) 84" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 84"	LF	3,560	575	2,047,000
	Inlet screens, 84"	SF	310	100	31,000
	Excavate Pipe Trench	CY	16,020	4	64,080
	Cement Stabilized Sand - Pipe Zone	CY	7,604	25	190,100
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	4,939	6	29,634
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				3,780,664
	O/H and Profit Markup			30%	1,134,199
	Subtotal				4,914,863
	Contingency			15%	737,229
	Total Cost				**5,652,093**

Table L-1-7

Romeville Batture Crossing - Siphon Pipe (4,000 cfs)

Construction Cost Estimate

Item No.	Description	Unit	4,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	16,400	62	1,016,800
	Riprap at Miss. Rvr. (54" deep)	SY	3,500	100	350,000
	Riprap at Siphon Inlet - (18" deep)	SY	670	50	33,500
	Concrete Channel Lining at Siphon Inlet	SY	450	50	22,500
	Siphon Piping - (10) 84" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 84"	LF	4,450	575	2,558,750
	Inlet screens, 84"	SF	390	100	39,000
	Excavate Pipe Trench	CY	20,010	4	80,040
	Cement Stabilized Sand - Pipe Zone	CY	9,581	25	239,525
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	6,081	6	36,486
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				4,491,851
	O/H and Profit Markup			30%	1,347,555
	Subtotal				5,839,406
	Contingency			15%	875,911
	Total Cost				**6,715,317**

Table L-1-7
Romeville Batture Crossing - Siphon Pipe (5,000 cfs)
Construction Cost Estimate

Item No.	Description	Unit	5,000 cfs Qty	Unit Price	Cost, $
	Mobilization	LS	1	100,000	100,000
	Coffer Dam - Mississippi River (Temporary)				
	Steel Sheet Pile - PZ-35	SF	17,200	62	1,066,400
	Riprap at Miss. Rvr. (54" deep)	SY	3,900	100	390,000
	Riprap at Siphon Inlet - (18" deep)	SY	710	50	35,500
	Concrete Channel Lining at Siphon Inlet	SY	480	50	24,000
	Siphon Piping - (10) 96" Dia. - 445 LF				
	A53 CW Standard Pipe PE, 96"	LF	4,450	690	3,070,500
	Inlet screens, 96"	SF	510	100	51,000
	Excavate Pipe Trench	CY	24,479	4	97,916
	Cement Stabilized Sand - Pipe Zone	CY	11,944	25	298,600
	Bank Sand Bedding - Pipe Zone	CY	0	15	0
	Native Backfill	CY	0	10	0
	Haul Trench Spoils	CY	6,857	6	41,142
	Dewatering				
	Siphon Pipe	LF	305	50	15,250
	Subtotal - Direct Costs				5,190,308
	O/H and Profit Markup			30%	1,557,092
	Subtotal				6,747,400
	Contingency			15%	1,012,110
	Total Cost				**7,759,510**

Table L-1-8
Romeville Batture Crossing - Inlet Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Coffer Dam - Mississippi River																				
	Steel Sheet Pile - PZ-35	SF	62	17,000	1,054,000	17,200	1,066,400	17,600	1,091,200	17,800	1,103,600	18,000	1,116,000	18,500	1,147,000	20,300	1,258,600	20,900	1,295,800	22,800	1,413,600
	Inlet Canal																				
	Excavation	CY	4	60,000	240,000	61,400	245,600	63,700	254,800	65,100	260,400	65,800	263,200	68,900	275,600	79,700	318,800	83,000	332,000	94,300	377,200
	Haul off excess spoils	CY	6	60,000	360,000	61,400	368,400	63,700	382,200	65,100	390,600	65,800	394,800	68,900	413,400	79,700	478,200	83,000	498,000	94,300	565,800
	Riprap at Miss. Rvr. (54" deep)	SY	100	5,200	520,000	5,350	535,000	5,590	559,000	5,740	574,000	5,810	581,000	6,130	613,000	7,260	726,000	7,600	760,000	8,800	880,000
	Riprap at Culvert Inlet - (18" deep)	SY	50	580	29,000	600	30,000	640	32,000	660	33,000	670	33,500	710	35,500	860	43,000	910	45,500	1,070	53,500
	Concrete Channel Lining at Culvert	SY	50	390	19,500	400	20,000	430	21,500	440	22,000	450	22,500	480	24,000	580	29,000	610	30,500	720	36,000
	Dewatering																				
	Inlet Canal	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				2,342,500		2,385,400		2,460,700		2,503,600		2,531,000		2,628,500		2,973,600		3,081,800		3,446,100
	O/H and Profit Markup		30%		702,750		715,620		738,210		751,080		759,300		788,550		892,080		924,540		1,033,830
	Subtotal				3,045,250		3,101,020		3,198,910		3,254,680		3,290,300		3,417,050		3,865,680		4,006,340		4,479,930
	Contingency		15%		456,788		465,153		479,837		488,202		493,545		512,558		579,852		600,951		671,990
	Total Cost				3,502,038		3,566,173		3,678,747		3,742,882		3,783,845		3,929,608		4,445,532		4,607,291		5,151,920

1587

Table L-1-9
South Bridge Diversion Culvert
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Temporary Miss. Rvr. Levee Relocation																				
	Import Fill (use inlet canal excavation)	CY	15	16,700	250,500	15,460	231,900	14,770	221,550	12,570	188,550	12,600	189,000	11,100	166,500	4,000	60,000	0	0	0	0
	Place Fill (use inlet canal material)	CY	6	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400
	Excavate/remove temporary levee	CY	4	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600	44,400	177,600
	Haul off excess spoils	CY	6	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400	44,400	266,400
	Permanent Levee removal and replacement																				
	Remove existing concrete slope paving																				
	Demolition	SY	9	585	5,265	655	5,895	810	7,290	880	7,920	960	8,640	1,040	9,360	1,420	12,780	1,860	16,740	2,210	19,890
	Disposal	CY	13	130	1,690	145	1,885	180	2,340	200	2,600	215	2,795	230	2,990	315	4,095	415	5,395	490	6,370
	Excavate existing levee (stockpile on site)	CY	4	29,000	116,000	30,800	123,200	29,400	117,600	33,100	132,400	31,100	124,400	32,900	131,600	41,300	165,200	50,900	203,600	58,700	234,800
	Fill existing levee	CY	6	29,000	174,000	30,800	184,800	29,400	176,400	33,100	198,600	31,100	186,600	32,900	197,400	41,300	247,800	50,900	305,400	58,700	352,200
	Replace concrete slope paving - 8"	SY	75	585	43,875	655	49,125	810	60,750	880	66,000	960	72,000	1,040	78,000	1,420	106,500	1,860	139,500	2,210	165,750
	Coffer Dam - Mississippi River																				
	Steel Sheet Pile - PZ-35	SF	62	16,600	1,029,200	17,000	1,054,000	17,200	1,066,400	18,000	1,116,000	18,000	1,116,000	18,500	1,147,000	21,000	1,302,000	23,800	1,475,600	26,000	1,612,000
	Inlet Canal																				
	Excavation	CY	4	27,700	110,800	28,940	115,760	29,630	118,520	31,830	127,320	31,800	127,200	33,300	133,200	40,400	161,600	48,500	194,000	55,000	220,000
	Haul off excess spoils	CY	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,100	24,600	10,600	63,600
	Riprap at Miss. Rvr. (54" deep)	SY	100	4,950	495,000	5,225	522,500	5,370	537,000	5,835	583,500	5,830	583,000	6,150	615,000	7,650	765,000	9,350	935,000	10,720	1,072,000
	Bollards/Dolphins in Miss. Rvr. (Groups of 3 pipes)																				
	5 groups - 12" Dia. Steel Pipe, 70' long	EA	8,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500	15	127,500
	Riprap at Culvert Inlet - (18" deep)	SY	50	550	27,500	585	29,250	605	30,250	670	33,500	670	33,500	710	35,500	910	45,500	1,150	57,500	1,330	66,500
	Concrete Channel Lining at Culvert	SY	50	365	18,250	390	19,500	405	20,250	445	22,250	445	22,250	475	23,750	610	30,500	765	38,250	890	44,500
	Diversion Culvert - CIP Boxes																				
	Excavation	CY	4	19,000	76,000	21,400	85,600	25,500	102,000	29,000	116,000	31,300	125,200	34,600	138,400	49,700	198,800	67,100	268,400	81,100	324,400
	Haul off excess spoils	CY	6	4,000	24,000	5,600	33,600	8,100	48,600	10,800	64,800	12,400	74,400	15,000	90,000	26,800	160,800	40,400	242,400	51,400	308,400
	Cement Stabilized Sand Backfill	CY	25	1,660	41,500	1,800	45,000	2,270	56,750	2,390	59,750	2,640	66,000	2,810	70,250	3,600	90,000	4,510	112,750	5,240	131,000
	Backfill	CY	10	15,000	150,000	15,800	158,000	17,400	174,000	18,200	182,000	18,900	189,000	19,600	196,000	22,900	229,000	26,700	267,000	29,700	297,000
	14" Concrete Piling	VLF	45	10,500	472,500	16,920	761,400	20,420	918,900	31,500	1,417,500	31,500	1,417,500	39,100	1,759,500	74,700	3,361,500	115,500	5,197,500	148,200	6,669,000
	Concrete Culvert - CIP																				
	Floor slab	CY	300	470	141,000	755	226,500	910	273,000	1,400	420,000	1,400	420,000	1,740	522,000	3,320	996,000	5,130	1,539,000	6,590	1,977,000
	Walls	CY	600	470	281,000	625	375,000	935	561,000	1,040	624,000	1,300	780,000	1,560	936,000	2,590	1,554,000	3,890	2,334,000	4,930	2,958,000
	Roof slab	CY	750	470	352,500	755	566,250	910	682,500	1,400	1,050,000	1,400	1,050,000	1,740	1,305,000	3,320	2,490,000	5,130	3,847,500	6,590	4,942,500
	Headwalls - 2																				
	Footing	CY	300	250	75,000	280	84,000	310	93,000	345	103,500	360	108,000	390	117,000	520	156,000	680	204,000	800	240,000
	Headwalls	CY	600	310	186,000	335	201,000	345	207,000	380	228,000	380	228,000	400	240,000	510	306,000	640	384,000	740	444,000
	Gate Tower - CIP																				
	Walls	CY	600	220	132,000	295	177,000	305	183,000	435	261,000	400	240,000	480	288,000	850	510,000	1,270	762,000	1,600	960,000
	Grating - Steel - Heavy Duty	SF	75	240	18,000	420	31,500	540	40,500	880	66,000	880	66,000	1,100	82,500	2,160	162,000	3,360	252,000	4,320	324,000
	Sluice gates with motor operators																				
	500 cfs (2 - 6 x 6 Boxes)	EA	70,000	2	140,000																
	1,000 cfs (3 - 7 x 6 Boxes)	EA	81,000			3	243,000														

1588

Table L-1-9
South Bridge Diversion Culvert
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	2,000 cfs (3 - 9 x 9 Boxes)	EA	141,000					3	423,000												
	3,000 cfs (4 - 11 x 9 Boxes)	EA	150,000							4	600,000										
	4,000 cfs (4 - 11 x 10 Boxes)	EA	177,000									4	708,000								
	5,000 cfs (5 - 11 x 10 Boxes)	EA	177,000											5	885,000						
	10,000 cfs (9 - 12 x 10 Boxes)	EA	187,000													9	1,683,000				
	15,000 cfs (14 - 12 x 10 Boxes)	EA	187,000															14	2,618,000		
	20,000 cfs (18 - 12 x 10 Boxes)	EA	187,000																	18	3,366,000
	Stop Logs - 2 sets																				
	500 cfs (2 - 6 x 6 Boxes)	EA	17,000	4	68,000																
	1,000 cfs (3 - 7 x 6 Boxes)	EA	19,000			6	114,000														
	2,000 cfs (3 - 9 x 9 Boxes)	EA	27,000					6	162,000												
	3,000 cfs (4 - 11 x 8 Boxes)	EA	27,000							8	216,000										
	4,000 cfs (4 - 11 x 10 Boxes)	EA	33,000									8	264,000								
	5,000 cfs (5 - 11 x 10 Boxes)	EA	33,000											10	330,000						
	10,000 cfs (9 - 12 x 10 Boxes)	EA	35,000													18	630,000				
	15,000 cfs (14 - 12 x 10 Boxes)	EA	35,000															28	980,000		
	20,000 cfs (18 - 12 x 10 Boxes)	EA	35,000																		
	Cutoff Wall - PZ-22	SF	64	6,460	413,440	6,540	418,560	6,700	428,800	6,920	442,880	7,180	459,520	7,440	476,160	8,660	554,240	10,060	643,840	11,180	715,520
	Trash Rack/Bar Screens	SF	100	100	10,000	180	18,000	340	34,000	470	47,000	620	62,000	780	78,000	1,530	153,000	2,380	238,000	3,050	305,000
	Site Work - 6 Acres																				
	Clearing & Grubbing	AC	2,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200	6	13,200
	Strip & Stockpile topsoil - 6"	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Site Drainage																				
	Drainage swales	LF	10	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000	2,000	20,000
	Drainage pipe - 18" RCP	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Fence - 6' Chain Link w/3-strand BW	LF	33	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000	3,000	99,000
	Site road excavation and grading	CY	6	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000	2,000	12,000
	Site road fill	CY	10	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000	1,000	10,000
	Site road - gravel - 12"	SY	3	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000	2,000	18,000
	Site road - asphalt driveway	SY	40	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000	250	10,000
	Site lighting	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Place topsoil	CY	2	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000	5,000	10,000
	Seeding/turf establishment	AC	3,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000	6	18,000
	Building	LS	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000	1	30,000
	Electrical Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Instrumentation Allowance	LS	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000	1	50,000
	Utility relocations in LA 44 ROW																				
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Communication line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Overhead power line	LS	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000	1	5,000
	Dewatering																				
	Culvert	LF	100	350	35,000	350	35,000	350	35,000	350	35,000	350	35,000	350	35,000	350	35,000	350	35,000	350	35,000

Table L-1-9
South Bridge Diversion Culvert
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Inlet Canal	LF	50	170	8,500	170	8,500	170	8,500	170	8,500	170	8,500	170	8,500	170	8,500	170	8,500	170	8,500
	Site - misc. items	LF	25	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000	1,000	25,000
	SWPPP	LS	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
	LA 44 Detour - 2 lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Structural fill	CY	14	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000	1,500	21,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Pavement Demolition																				
	LA 44 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 44 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540	580	7,540
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 44 Reconstruction - 2 lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Structural fill	CY	14	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014	501	7,014
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	13	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				6,532,086		7,554,291		8,424,466		10,055,136		10,401,071		11,732,176		17,813,381		24,964,041		30,757,496
	O/H and Profit Markup		30%		1,959,626		2,266,287		2,527,340		3,016,541		3,120,321		3,519,653		5,344,014		7,489,212		9,227,249
	Subtotal				8,491,712		9,820,578		10,951,806		13,071,677		13,521,392		15,251,829		23,157,395		32,453,253		39,984,745
	Contingency		15%		1,273,757		1,473,087		1,642,771		1,960,752		2,028,209		2,287,774		3,473,609		4,867,988		5,997,712

1590

Table L-1-9
South Bridge Diversion Culvert
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Total Cost				9,765,469		11,293,665		12,594,577		15,032,428		15,549,601		17,539,603		26,631,005		37,321,241		45,982,457

1591

Table L-1-10
South Bridge Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Earthen Channel																				
	Cleaning & Grubbing	AC	2,200	83	182,600	92	202,400	112	246,400	129	283,800	145	319,000	162	356,400	251	552,200	340	748,000	426	937,200
	Strip Topsoil - 6"	CY	2	66,500	133,000	74,500	149,000	90,500	181,000	104,000	208,000	117,000	234,000	131,000	262,000	202,000	404,000	274,000	548,000	343,000	686,000
	Excavation	CY	4	392,000	1,568,000	561,000	2,244,000	923,000	3,692,000	1,225,000	4,900,000	1,527,000	6,108,000	1,899,000	7,596,000	3,459,000	13,836,000	5,049,000	20,196,000	6,659,000	26,636,000
	Fill (embankment)	CY	6	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400	55,400	332,400
	Import fill material	CY	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haul off spoils	CY	6	336,600	2,019,600	505,500	3,033,000	867,600	5,205,600	1,169,600	7,017,600	1,471,600	8,829,600	1,843,600	11,061,600	3,403,600	20,421,600	4,993,600	29,961,600	6,603,600	39,621,600
	Place topsoil	CY	2	66,500	133,000	74,500	149,000	90,500	181,000	104,000	208,000	117,000	234,000	131,000	262,000	202,000	404,000	274,000	548,000	343,000	686,000
	Seeding/Establish Turf	AC	3,000	79	237,000	79	237,000	79	237,000	79	237,000	79	237,000	79	237,000	79	237,000	81	243,000	79	237,000
	Drainage ditch at ROW	LF	10	30,050	300,500	30,200	302,000	30,500	305,000	30,800	308,000	31,000	310,000	31,300	313,000	32,600	326,000	34,000	340,000	35,300	353,000
	Drainage outfall pipes - 24" RCP	LF	50	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000	300	15,000
	Fence - 4-strand Barbed Wire	LF	15	30,050	450,750	30,200	453,000	30,500	457,500	30,800	462,000	31,000	465,000	31,300	469,500	32,600	489,000	34,000	510,000	35,300	529,500
	Stilling Basin at Culvert/Siphon Outfall																				
	Concrete channel lining - 100 LF	SY	50	1,200	60,000	1,520	76,000	2,180	109,000	2,740	137,000	3,290	164,500	3,850	192,500	6,850	342,500	9,790	489,500	12,740	637,000
	Riprap - 18" - 50 LF	SY	50	600	30,000	760	38,000	1,090	54,500	1,370	68,500	1,650	82,500	1,920	96,500	3,430	171,500	4,900	245,000	6,370	318,500
	Canadian National RR Crossing (12' x 8' CIP Box Culverts - 100 LF)																				
	Excavation	CY	6	7,000	42,000	8,000	48,000	11,000	66,000	14,000	84,000	17,000	102,000	20,000	120,000	35,000	210,000	50,000	300,000	65,000	390,000
	Culvert floor - CIP	CY	300	250	75,000	330	99,000	640	192,000	950	285,000	1,260	378,000	1,570	471,000	3,130	939,000	4,685	1,405,500	6,240	1,872,000
	Culvert walls - CIP	CY	600	180	108,000	240	144,000	420	252,000	595	357,000	770	462,000	950	570,000	1,840	1,104,000	2,730	1,638,000	3,615	2,169,000
	Culvert roof - CIP	CY	750	250	287,500	330	247,500	640	480,000	950	712,500	1,260	945,000	1,570	1,177,500	3,130	2,347,500	4,685	3,513,750	6,240	4,680,000
	Headwalls																				
	Footing	CY	300	240	72,000	275	82,500	365	109,500	460	138,000	555	166,500	645	193,500	1,120	336,000	1,580	474,000	2,045	613,500
	Wall	CY	600	175	105,000	190	114,000	240	144,000	290	174,000	340	204,000	390	234,000	630	378,000	880	528,000	1,120	672,000
	Cement Stabilized Sand Backfill	CY	25	595	14,875	645	16,125	800	20,000	960	24,000	1,120	28,000	1,270	31,750	2,045	51,125	2,820	70,500	3,600	90,000
	Backfill - excavated material	CY	10	5,100	51,000	5,400	54,000	6,400	64,000	7,400	74,000	8,400	84,000	9,300	93,000	14,300	143,000	19,200	192,000	24,100	241,000
	Haul off spoils	CY	6	1,900	11,400	2,600	15,600	4,600	27,600	6,600	39,600	8,600	51,600	10,700	64,200	20,700	124,200	30,800	184,800	40,900	245,400
	Concrete Channel Lining - 10 LF each end	SY	50	240	12,000	310	15,500	440	22,000	550	27,500	660	33,000	770	38,500	1,370	68,500	1,960	98,000	2,550	127,500
	Riprap - 10 LF each end	SY	50	240	12,000	310	15,500	440	22,000	550	27,500	660	33,000	770	38,500	1,370	68,500	1,960	98,000	2,550	127,500
	CN RR Relocation - 2,000 LF																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Embankment	LF	20	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000	2,000	40,000
	Ballast	LF	35	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000	2,000	70,000
	Railroad Track Work	LF	200	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000	2,000	400,000
	Turnout	EA	150,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000	2	300,000
	Remove temporary embankment & ballast	LF	15	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000	8,600	129,000
	Remove temporary rail	LF	15	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000	2,000	30,000
	Remove Turnout	EA	6,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000	2	12,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	CN RR Reconstruction - 200 LF																				
	Embankment	LF	20	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000	200	4,000
	Ballast	LF	35	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000	200	7,000
	Railroad Track Work	LF	200	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000	200	40,000
	Seeding	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	LA 3125 Crossing																				

Table L-1-10
South Bridge Earthen Transmission Canal
Construction Cost Estimate

Item No	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	(12' x 8' CIP Box Culverts - 300 LF)																				
	Excavation	CY	6	5,820	34,920	7,040	42,240	10,700	64,200	14,400	86,400	18,000	108,000	21,700	130,200	40,000	240,000	58,200	349,200	76,500	459,000
	Culvert floor - CIP	CY	300	330	99,000	485	145,500	960	288,000	1,430	429,000	1,910	573,000	2,375	712,500	4,740	1,422,000	7,100	2,130,000	9,465	2,839,500
	Culvert walls - CIP	CY	600	290	174,000	385	231,000	675	405,000	965	579,000	1,255	753,000	1,545	927,000	2,985	1,791,000	4,430	2,658,000	5,875	3,525,000
	Culvert roof - CIP	CY	750	330	247,500	485	363,750	960	720,000	1,430	1,072,500	1,910	1,432,500	2,375	1,781,250	4,740	3,555,000	7,100	5,325,000	9,465	7,098,750
	Headwalls																				
	Footing	CY	300	165	49,500	195	58,500	285	85,500	370	111,000	460	138,000	550	165,000	980	294,000	1,420	426,000	1,860	558,000
	Wall	CY	600	44	26,400	44	26,400	44	26,400	44	26,400	44	26,400	44	26,400	44	26,400	44	26,400	44	26,400
	Cement Stabilized Sand Backfill	CY	25	1,545	38,625	1,690	42,250	2,125	53,125	2,565	64,125	3,000	75,000	3,440	86,000	5,620	140,500	7,795	194,875	9,975	249,375
	Backfill - excavated material	CY	10	1,200	12,000	800	8,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haul off spoils	CY	6	4,620	27,720	6,240	37,440	10,700	64,200	14,400	86,400	18,000	108,000	21,700	130,200	40,000	240,000	58,200	349,200	76,500	459,000
	Concrete Channel Lining - 10 LF each end	SY	50	240	12,000	310	15,500	440	22,000	550	27,500	660	33,000	770	38,500	1,370	68,500	1,960	98,000	2,550	127,500
	Riprap - 10 LF each end	SY	50	240	12,000	310	15,500	440	22,000	550	27,500	660	33,000	770	38,500	1,370	68,500	1,960	98,000	2,550	127,500
	LA 3125 Detour - 2 Lanes - 1,000 feet																				
	Clearing & Grubbing	AC	2,200	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600	3	6,600
	Excavation & Grading	CY	10	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000	2,200	22,000
	Fill	CY	10	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000	1,500	15,000
	Lime Stabilization 12" Deep, 5% Lime	SY	6	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000	4,000	24,000
	Stone Base	CY	15	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050	670	10,050
	Bituminous Base Course 4"	SY	12	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400	2,700	32,400
	Bituminous Binder Course 3"	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	Bituminous Top Course 1"	SY	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gravel shoulders	CY	10	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600	260	2,600
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18 " RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	LA 3125 Reconstruction - 2 Lanes - 300 feet																				
	Excavation & Grading	CY	10	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890	889	8,890
	Fill	CY	10	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010	501	5,010
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802	1,467	8,802
	Stone Base	CY	15	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890	326	4,890
	Bituminous Base Course 4"	SY	12	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600	800	9,600
	Bituminous Binder Course 3"	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Bituminous Top Course 1"	SY	3	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400	800	2,400
	Gravel shoulders	CY	10	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480	148	1,480
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500	140	10,500
	Seeding/Turf Establishment	AC	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000	1	3,000
	Pavement Demolition																				
	LA 3125 Detour Pavement - 1,000 LF	SY	9	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300	2,700	24,300
	LA 3125 Pavement at Box Culvert - 300 LF	SY	9	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200	800	7,200
	Haul Demo'ed Pavement	CY	13	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670	590	7,670
	Seeding/Turf Establishment	AC	3,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000	3	9,000
	Dewatering and Water Management																				
	Earthen Canal																				
	Dewatering	LF	50	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000	15,000	750,000
	CN RR Crossing																				

Table L-1-10
South Bridge Earthen Transmission Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	500 cfs		1,000 cfs		2,000 cfs		3,000 cfs		4,000 cfs		5,000 cfs		10,000 cfs		15,000 cfs		20,000 cfs	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Dewatering	LF	50	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000	200	10,000
	LA 3125																				
	Dewatering	LF	50	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000	400	20,000
	Utility Construction																				
	Dewatering	LF	25	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500	500	12,500
					0		0		0		0		0		0		0		0		0
	Subtotal - Direct Costs				9,099,982		11,282,897		16,379,617		20,843,917		25,311,692		30,475,092		53,360,617		76,547,417		99,900,817
	O/H and Profit Markup		30%		2,729,995		3,384,869		4,913,885		6,253,175		7,593,508		9,142,528		16,008,185		22,964,225		29,970,245
	Subtotal				11,829,977		14,667,766		21,293,502		27,097,092		32,905,200		39,617,620		69,368,802		99,511,642		129,871,062
	Contingency		10%		1,182,998		1,466,777		2,129,350		2,709,709		3,290,520		3,961,762		6,936,880		9,951,164		12,987,106
	Total Cost				13,012,974		16,134,543		23,422,852		29,806,801		36,195,720		43,579,382		76,305,682		109,462,806		142,858,168

1594

Table L-1-11
North Distribution Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Area 200		Area 200 & 300 Open Cut RR & Hwy		Area 200 & 300 Tunnel RR & Hwy	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000
	Earthen Channel								
	Clearing & Grubbing	AC	2,200	141	310,200	241	530,200	241	530,200
	Strip Topsoil - 6"	CY	2	114,000	228,000	195,000	390,000	195,000	390,000
	Excavation	CY	4	729,000	2,916,000	1,225,000	4,900,000	1,225,000	4,900,000
	Fill (embankment)	CY	6	729,000	4,374,000	1,225,000	7,350,000	1,225,000	7,350,000
	Import fill material	CY	15	0	0	0	0	0	0
	Haul off spoils	CY	6	0	0	0	0	0	0
	Place topsoil	CY	2	114,000	228,000	195,000	390,000	195,000	390,000
	Seeding/Establish Turf	AC	3,000	94	282,000	132	396,000	132	396,000
	SWPPP	LS	25,000	1	25,000	1	25,000	1	25,000
	Cross-drainage								
	2 - 4' x 4' Box Culvert - Inverted Siphon	LF	300	1,750	525,000	2,700	810,000	2,700	810,000
	Headwalls	EA	5,000	14	70,000	18	90,000	18	90,000
	Release Structures to Swamp	LF	75	4,960	372,000	6,400	480,000	6,400	480,000
	Control gate	EA	5,000	124	620,000	160	800,000	160	800,000
	Transitions to Inverted Siphon								
	(U/S of KCS RR and D/S of Hwy 61)								
	Concrete Channel Lining	SY	50	0	0	1,600	80,000	1,600	80,000
	Riprap - 10 LF	SY	50	0	0	220	11,000	220	11,000
	Additional Erosion Protection - 2 locations								
	Concrete Channel Lining - 10 LF each end	SY	50	0	0	220	11,000	220	11,000
	Riprap - 10 LF each end	SY	50	0	0	220	11,000	220	11,000
	KCS RR Crossing - Tunneled								
	(3 - 10' x 6' Box Culverts - 100 LF)								
	3 - 10' x 6' Box Culverts - Tunneled - 50 LF	LF	4,000	0	0	0	0	150	600,000
	3 - 10' x 6' Box Culverts - Open Cut - 50 LF	LF	2,000	0	0	0	0	50	100,000
	Headwalls	EA	50,000	0	0	0	0	2	100,000
	KCS RR Crossing - Open-cut								
	(3 - 10' x 6' CIP Box Culverts - 100 LF)								
	Excavation	CY	6	0	0	9,200	55,200	0	0
	Culvert floor - CIP	CY	300	0	0	400	120,000	0	0

1595

Table L-1-11
North Distribution Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Area 200		Area 200 & 300 Open Cut RR & Hwy		Area 200 & 300 Tunnel RR & Hwy	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Culvert walls - CIP	CY	600	0	0	296	177,600	0	0
	Culvert roof - CIP	CY	750	0	0	400	300,000	0	0
	Headwalls								
	Footing	CY	300	0	0	244	73,200	0	0
	Wall	CY	600	0	0	83	49,800	0	0
	Cement Stabilized Sand Backfill	CY	25	0	0	680	17,000	0	0
	Backfill - excavated material	CY	10	0	0	6,100	61,000	0	0
	Haul off spoils	CY	6	0	0	3,100	18,600	0	0
	KCS RR Relocation - 2,000 LF								
	Clearing & Grubbing	AC	2,200	0	0	3	6,600	0	0
	Embankment	LF	20	0	0	2,000	40,000	0	0
	Ballast	LF	35	0	0	2,000	70,000	0	0
	Railroad Track Work	LF	200	0	0	2,000	400,000	0	0
	Turnout	EA	150,000	0	0	2	300,000	0	0
	Remove temporary embankment & ballast	LF	15	0	0	8,600	129,000	0	0
	Remove temporary rail	LF	15	0	0	2,000	30,000	0	0
	Remove Turnout	EA	6,000	0	0	2	12,000	0	0
	Seeding	AC	3,000	0	0	2	6,000	0	0
	KCS RR Reconstruction - 200 LF								
	Embankment	LF	20	0	0	200	4,000	200	4,000
	Ballast	LF	35	0	0	200	7,000	200	7,000
	Railroad Track Work	LF	200	0	0	200	40,000	200	40,000
	Seeding	AC	3,000	0	0	2	6,000	2	6,000
	Hwy 61 Crossing - Tunneled Option								
	(3 - 10' x 6' Box Culverts - 200 LF)								
	3 - 10' x 6' Box Culverts - Tunneled - 100 LF	LF	4,000	0	0	0	0	300	1,200,000
	3 - 10' x 6' Box Culverts - Open Cut - 100 LF	LF	2,000	0	0	0	0	100	200,000
	Headwalls	EA	50,000	0	0	0	0	2	100,000
	Hwy 61 Crossing - Open Cut Option								
	(3 - 10' x 6' CIP Box Culverts - 200 LF)								
	Excavation	CY	6	0	0	15,100	90,600	0	0
	Culvert floor - CIP	CY	300	0	0	363	108,900	0	0
	Culvert walls - CIP	CY	600	0	0	296	177,600	0	0
	Culvert roof - CIP	CY	750	0	0	363	272,250	0	0
	Headwalls								
	Footing	CY	300	0	0	231	69,300	0	0

1596

Table L-1-11
North Distribution Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Area 200		Area 200 & 300 Open Cut RR & Hwy		Area 200 & 300 Tunnel RR & Hwy	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Wall	CY	600	0	0	74	44,400	0	0
	Cement Stabilized Sand Backfill	CY	25	0	0	1,200	30,000	0	0
	Backfill - excavated material	CY	10	0	0	10,300	103,000	0	0
	Haul off spoils	CY	6	0	0	4,800	28,800	0	0
	Hwy 61 Detour - 2 Lanes - 500 feet								
	Detour Pavement - asphalt	SY	60	0	0	1,400	84,000	0	0
	Remove Detour	SY	9	0	0	1,400	12,600	0	0
	Dispose of demo'd material	CY	13	0	0	250	3,250	0	0
	Hwy 61 Reconstruction - 4 Lanes - 200 feet								
	Hwy 61 Pavement at Box Culvert - 200 LF	SY	9	0	0	1,800	16,200	1,800	16,200
	Haul Demo'ed Pavement	CY	13	0	0	300	3,900	300	3,900
	Excavation & Grading	CY	10	0	0	600	6,000	600	6,000
	Structural fill	CY	14	0	0	300	4,200	300	4,200
	Lime Stabilization 12" Deep, 5% Lime	SY	6	0	0	1,800	10,800	1,800	10,800
	Stone Base	CY	15	0	0	600	9,000	600	9,000
	Bituminous Base Course 4"	SY	12	0	0	1,800	21,600	1,800	21,600
	Bituminous Binder Course 3"	SY	9	0	0	1,800	16,200	1,800	16,200
	Bituminous Top Course 1"	SY	3	0	0	1,800	5,400	1,800	5,400
	Gravel shoulders	CY	10	0	0	0	0	0	0
	Painted Lines 4" Wide	LF	0.20	0	0	3,000	600	3,000	600
	Signage	LS	1,500	0	0	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	0	0	100	7,500	100	7,500
	Seeding/Turf Establishment	AC	3,000	0	0	1	3,000	1	3,000
	Utility Relocations								
	Pipe line between RR and Hwy	LS	500,000	0	0	0	0	0	0
	Communication lines - RR	EA	5,000	0	0	2	10,000	0	0
	Communication lines - Hwy	EA	5,000	0	0	2	10,000	0	0
	Dewatering and Water Management								
	Earthen Canal								
	Dewatering	LF	25	31,000	775,000	40,000	1,000,000	40,000	1,000,000
	KCS RR Crossing								
	Dewatering	LF	50	0	0	100	5,000	100	5,000
	Hwy 61								
	Dewatering	LF	50	0	0	200	10,000	200	10,000
	Utility Construction								
	Dewatering	LF	25	200	5,000	500	12,500	500	12,500

Table L-1-11
North Distribution Canal
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Area 200		Area 200 & 300 Open Cut RR & Hwy		Area 200 & 300 Tunnel RR & Hwy	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
					0		0		0
	Subtotal - Direct Costs				10,830,200		20,475,300		19,864,600
	O/H and Profit Markup		30%		3,249,060		6,142,590		5,959,380
	Subtotal				14,079,260		26,617,890		25,823,980
	Contingency		10%		1,407,926		2,661,789		2,582,398
	Total Cost				**15,487,186**		**29,279,679**		**28,406,378**

1598

Table L-1-12
Parish Ditch Widening
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	100,000	10,000
	Barge for access, operations	MON	4	60,000	240,000
	Clearing & Grubbing	AC	190	2,200	418,000
	Strip & stockpile topsoil	CY	153,000	2	306,000
	Excavation	CY	760,000	4	3,040,000
	Cast spoil behind existing spoil banks	CY	760,000	2	1,520,000
	Place topsoil	CY	153,000	2	306,000
	Seeding/establish vegetation	AC	190	3,000	570,000
	SWPPP	LS	1	25,000	25,000
	Water Control - channel	LS	1	100,000	100,000
	Water Control - misc.	LS	1	10,000	10,000
	Pipe line adjustment or accommodations	LS	1	100,000	100,000
					-
	Subtotal - Direct Costs				6,645,000
	O/H and Profit Markup			30%	1,993,500
	Subtotal				8,638,500
	Contingency			15%	1,295,775
	Total Cost				**9,934,275**

Notes:

1. Widen the existing Parish drainage channel for 1,500 cfs
2. From Lateral 3-D to South Bridge alignment
3. Use land-based excavation operations, but need a barge for supplemental access, operations
4. Access via S. Brodge alignment and existing drainage ROW's into the Swamp.

Table L-1-13
Control Structures
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Struct No. 1-2		Struct No. 1-3		Struct No. 1-4		Struct No. 1-5		Struct No. 1-6E		Struct No. 1-6S		Struct No. 1-6N		Struct No. 1-7		Struct No. 3-1		Struct No. 3-2	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Access/Work Barges	MON	60,000	4	240,000	4	240,000	4	240,000	3	180,000	4	240,000	3	180,000	3	180,000	3	180,000	4	240,000	3	180,000
	Clear work site	AC	2,200	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400	2	4,400
	Seeding/Establish Turf	AC	3,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000	2	6,000
	Coffer Dam																						
	Steel Sheet Piling - PZ-27	SF	35	19,500	682,500	26,000	910,000	25,100	878,500	13,600	476,000	20,500	717,500	11,400	399,000	11,400	399,000	12,500	437,500	39,900	1,396,500	23,000	805,000
	Dewatering interior	MON	5,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000	4	20,000
	Channel Excavation	CY	10	1,700	17,000	2,300	23,000	2,200	22,000	1,100	11,000	1,630	16,300	670	6,700	720	7,200	820	8,200	3,690	36,900	1,900	19,000
	Gate Structure																						
	Concrete floor	CY	400	180	72,000	265	106,000	225	90,000	100	40,000	215	86,000	90	36,000	90	36,000	95	38,000	410	164,000	170	68,000
	Intermediate Pedestals																						
	Walls	CY	700	100	70,000	167	116,900	136	95,200	44	30,800	89	62,300	34	23,800	34	23,800	39	27,300	245	171,500	82	57,400
	Roof	CY	850	6	5,100	10	8,500	8	6,800	3	2,550	6	5,100	2	1,700	2	1,700	3	2,550	13	11,050	4	3,400
	Retaining Walls - gate structure																						
	Walls	CY	700	80	56,000	90	63,000	110	77,000	75	52,500	75	52,500	60	42,000	60	42,000	65	45,500	125	87,500	125	87,500
	Footings	CY	400	85	34,000	90	36,000	95	38,000	85	34,000	85	34,000	80	32,000	80	32,000	80	32,000	100	40,000	100	40,000
	Retaining Walls - channel transition sections																						
	Walls	CY	700	45	31,500	45	31,500	55	38,500	40	28,000	40	28,000	30	21,000	30	21,000	35	24,500	60	42,000	60	42,000
	Footings	CY	400	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000	40	16,000
	Concrete Channel Lining	SY	50	1,600	80,000	2,270	113,500	1,745	87,000	940	47,000	2,000	100,000	940	47,000	940	47,000	940	47,000	2,940	147,000	1,200	60,000
	Riprap - 18" deep	SY	50	270	13,500	380	19,000	290	14,500	160	8,000	340	17,000	160	8,000	160	8,000	160	8,000	490	24,500	200	10,000
	Crest Gates - Gate and HPU																						
	Crest Gates	SF	450	1,200	540,000	1,820	819,000	1,650	742,500	660	297,000	1,430	643,500	560	243,000	540	243,000	600	270,000	3,230	1,453,500	1,360	612,000
	Hydraulic Power Unit (HPU)	EA	225,000	2	450,000	2	450,000	2	450,000	1	225,000	2	450,000	1	225,000	1	225,000	1	225,000	2	450,000	1	225,000
	Cylinders (operators)	EA	25,000	3	75,000	8	200,000	6	150,000	2	50,000	3	75,000	2	50,000	2	50,000	2	50,000	8	200,000	4	100,000
	Piping - HPU to Cylinders (multiple lines)	LF	25	1,300	32,500	1,500	37,500	1,400	35,000	1,100	27,500	1,400	35,000	1,100	27,500	1,100	27,500	1,100	27,500	1,600	40,000	1,200	30,000
	Safety System at crest gates	LS	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000	1	100,000
	Fence - Chain Link with 3-strand barbed wire	LF	33	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600	200	6,600
	Equipment Building																						
	Pre-fab Concrete Building	EA	25,000	2	50,000	2	50,000	2	50,000	1	25,000	2	50,000	1	25,000	1	25,000	1	25,000	2	50,000	1	25,000
	12" Prestressed Concrete Piling	VLF	50	240	12,000	240	12,000	240	12,000	120	6,000	240	12,000	120	6,000	120	6,000	120	6,000	240	12,000	120	6,000
	Electrical																						
	Generator (one per HPU)	LS	20,000	2	40,000	2	40,000	2	40,000	1	20,000	2	40,000	1	20,000	1	20,000	1	20,000	2	40,000	1	20,000
	Conduit & Wiring to Pedestals	LF	20	1,300	26,000	1,500	30,000	1,400	28,000	1,100	22,000	1,400	28,000	1,100	22,000	1,100	22,000	1,100	22,000	1,600	32,000	1,200	24,000
	Misc electrical items	LS	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000	1	20,000
	Instrumentation																						
	On-site instrumentation in equipment bldg	EA	15,000	2	30,000	2	30,000	2	30,000	1	15,000	2	30,000	1	15,000	1	15,000	2	15,000	2	30,000	1	15,000
	Subtotal - Direct Costs				2,830,100		3,608,900		3,398,000		1,870,350		2,995,200		1,703,700		1,703,200		1,784,050		6,941,450		2,702,300
	O/H and Profit Markup		30%		849,030		1,082,670		1,019,400		561,105		898,560		511,110		511,260		535,215		1,482,435		810,690
	Subtotal				3,679,130		4,691,570		4,417,400		2,431,455		3,893,760		2,214,810		2,215,460		2,319,265		6,423,885		3,512,990

1600

Table L-1-13
Control Structures
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	Struct No. 1-2		Struct No. 1-3		Struct No. 1-4		Struct No. 1-5		Struct No. 1-6E		Struct No. 1-6S		Struct No. 1-6N		Struct No. 1-7		Struct No. 3-1		Struct No. 3-2	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Contingency		15%		551,870		703,736		662,610		364,718		584,064		332,222		332,319		347,890		963,582		526,949
	Total Cost				4,231,088		5,395,306		5,080,010		2,796,173		4,477,824		2,547,032		2,547,779		2,667,155		7,387,458		4,039,939

1601

Table L-1-14
Berm Gap (20 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	5,000	5,000
	Barge for access ($60,000/Month)	Day	2	2,000	4,000
	Clearing & Grubbing	AC	0.50	5,600	2,800
	Strip & stockpile topsoil	CY	400	2	800
	Excavation	CY	200	4	800
	Disposal on site	CY	200	4	800
	Geotextile	SY	160	5	800
	Articulated Concrete Blocks	SY	160	50	8,000
	Place topsoil	CY	400	2	800
	Seeding/establish vegetation	AC	1	3,000	1,500
	SWPPP	LS	1	500	500
	Water Control	LS	1	500	500
	Subtotal - Direct Costs				26,300
	O/H and Profit Markup			30%	7,890
	Subtotal				34,190
	Contingency			15%	5,129
	Total Cost				**39,319**

Notes
1. Articulated Concrete Blocks - without cables
2. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
3. Barge time - 1 day each move-in, move-out and delivering materials. Use 2 days

Table L-1-15
Berm Gap (100 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	2	2,000	4,000
	Clearing & Grubbing	AC	0.50	5,600	2,800
	Strip & stockpile topsoil	CY	420	2	840
	Excavation	CY	700	4	2,800
	Disposal on site	CY	700	4	2,800
	Geotextile	SY	225	5	1,125
	Articulated Concrete Blocks	SY	225	50	11,250
	Place topsoil	CY	420	2	840
	Seeding/establish vegetation	AC	0.50	3,000	1,500
	SWPPP	LS	1	500	500
	Water Control	LS	1	500	500
	Subtotal - Direct Costs				38,955
	O/H and Profit Markup			30%	11,687
	Subtotal				50,642
	Contingency			15%	7,596
	Total Cost				**58,238**

Notes:

1. Extend articulated concrete block 50 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out and delivering materials. Use 2 days

Table L-1-16
Berm Gap (250 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	3	2,000	6,000
	Clearing & Grubbing	AC	0.75	5,600	4,200
	Strip & stockpile topsoil	CY	420	2	840
	Excavation	CY	700	4	2,800
	Disposal on site	CY	700	4	2,800
	Geotextile	SY	225	5	1,125
	Articulated Concrete Blocks	SY	225	50	11,250
	Place topsoil	CY	420	2	840
	Seeding/establish vegetation	AC	0.75	3,000	2,250
	SWPPP	LS	1	1,000	1,000
	Water Control	LS	1	1,000	1,000
	Subtotal - Direct Costs				44,105
	O/H and Profit Markup			30%	13,232
	Subtotal				57,337
	Contingency			15%	8,600
	Total Cost				**65,937**

Notes:

1. Extend articulated concrete block 50 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out. 1 day delivering materials. Use 4 days

Table L-1-17
Berm Gap (500 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	4	2,000	8,000
	Clearing & Grubbing	AC	2.00	5,600	11,200
	Strip & stockpile topsoil	CY	1,300	2	2,600
	Excavation	CY	2,400	4	9,600
	Disposal on site	CY	2,400	4	9,600
	Geotextile	SY	340	5	1,700
	Articulated Concrete Blocks	SY	340	50	17,000
	Place topsoil	CY	1,300	2	2,600
	Seeding/establish vegetation	AC	2	3,000	6,000
	SWPPP	LS	1	2,000	2,000
	Water Control	LS	1	2,000	2,000
	Subtotal - Direct Costs				82,300
	O/H and Profit Markup			30%	24,690
	Subtotal				106,990
	Contingency			15%	16,049
	Total Cost				**123,039**

Notes:
1. Extend articulated concrete block 50 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out. 1 day delivering materials. Use 4 days

Table L-1-18
Circulation Improvements at KCS RR and Hwy 61 Corridor
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	1 - 4x4 Box		2 - 10x5		Bridges	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Mobilization	LS	100,000	1	100,000	1	100,000	1	100,000
	Earthen Channel - 525 LF								
	Clearing & Grubbing	AC	2,200	2	4,400	2	4,400	2	4,400
	Strip Topsoil - 6"	CY	2	1,070	2,140	1,070	2,140	1,070	2,140
	Excavation	CY	4	3,300	13,200	3,300	13,200	3,300	13,200
	Fill (embankment)	CY	6	0	0	0	0	0	0
	Import fill material	CY	15	0	0	0	0	0	0
	Haul off spoils	CY	6	0	0	0	0	0	0
	Place topsoil	CY	2	1,070	2,140	1,070	2,140	1070	2,140
	Seeding/Establish Turf	AC	3,000	2	6,000	2	6,000	2	6,000
	Drainage ditch at ROW	LF	10	1,100	11,000	1,100	11,000	1100	11,000
	Drainage outfall pipes - 24" RCP	LF	25	100	2,500	100	2,500	100	2,500
	Fence - 4-strand Barbed Wire	LF	15	0	0	0	0	0	0
	KCS RR Crossing - 100 LF								
	Small Capacity Culvert								
	1 - 4' x 4' Box Culvert - tunneled - 50 LF	LF	4,000	50	200,000		0		0
	1 - 4' x 4' Box Culvert - open cut - 50 LF	LF	1,000	50	50,000		0		0
	Headwalls	EA	10,000	2	20,000		0		0
	KCS RR Moderate capacity culverts								
	4 - 5' x 5' Box Culverts - tunneled - 50 LF	LF	4,000	0	0	200	800,000	0	0
	4 - 5' x 5' Box Culverts - open cut - 50 LF	LF	2,000	0	0	100	200,000	0	0
	Headwalls	EA	20,000	0	0	2	40,000	0	0
	KCS RR Moderate capacity bridge								
	Bridge - 20' w x 50' l	LF	4,000		0		0	100	400,000
	Channel Excavation	CY	10		0		0	700	7,000
	KCS RR Channel erosion protection								
	Concrete Channel Lining - 10 LF each end	SY	50	120	6,000	120	6,000	520	26,000
	Riprap - 10 LF each end	SY	50	120	6,000	120	6,000	520	26,000
	KCS RR Reconstruction - 200 LF								
	Railroad Track Work	LF	200	200	40,000	200	40,000	200	40,000
	Subgrade	LF	20	200	4,000	200	4,000	200	4,000
	Ballast	LF	20	200	4,000	200	4,000	200	4,000

Table L-1-18
Circulation Improvements at KCS RR and Hwy 61 Corridor
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	1 - 4x4 Box		2 - 10x5		Bridges	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Hwy 61 Crossing - 200 LF								
	Hwy 61 Box Culverts								
	Excavation	CY	6	4,120	24,720	5,300	31,800		0
	Culvert floor - CIP	CY	300	55	16,500	155	46,500		0
	Culvert walls - CIP	CY	600	45	27,000	105	63,000		0
	Culvert roof - CIP	CY	750	55	41,250	155	116,250		0
	Headwalls	EA	10,000	2	20,000	2	20,000		0
	Cement Stabilized Sand Backfill	CY	20	560	11,200	750	15,000		0
	Backfill - excavated material	CY	6	3,190	19,140	3,400	20,400		0
	Haul off spoils	CY	6	930	5,580	1,900	11,400		0
	Hwy 61 Bridge								
	Bridge - 100' w x 50' l	SF	100		0		0	5000	500,000
	Channel Excavation	CY	10		0		0	1300	13,000
	Hwy 61 erosion protection								
	Concrete Channel Lining - 10 LF each end	SY	50	120	6,000	120	6,000	560	28,000
	Riprap - 10 LF each end	SY	50	120	6,000	120	6,000	560	28,000
	Hwy 61 Detour - 2 Lanes - 500 feet								
	Detour Pavement - asphalt	SY	60	1,400	84,000	1,400	84,000	1,400	84,000
	Remove Detour	SY	9	1,400	12,600	1,400	12,600	1,400	12,600
	Dispose of demo'd material	CY	13	250	3,250	250	3,250	250	3,250
	Hwy 61 Reconstruction - 4 Lanes - 200 feet								
	Hwy 61 Pavement at Box Culvert - 200 LF	SY	9	1,800	16,200	1,800	16,200	1,800	16,200
	Haul Demo'ed Pavement	CY	13	300	3,900	300	3,900	300	3,900
	Excavation & Grading	CY	10	600	6,000	600	6,000	600	6,000
	Structural fill	CY	14	300	4,200	300	4,200	300	4,200
	Lime Stabilization 12" Deep, 5% Lime	SY	6	1,800	10,800	1,800	10,800	1,800	10,800
	Stone Base	CY	15	600	9,000	600	9,000	600	9,000
	Bituminous Base Course 4"	SY	12	1,800	21,600	1,800	21,600	1,800	21,600
	Bituminous Binder Course 3"	SY	9	1,800	16,200	1,800	16,200	1,800	16,200
	Bituminous Top Course 1"	SY	3	1,800	5,400	1,800	5,400	1,800	5,400
	Gravel shoulders	CY	10	0	0	0	0	0	0
	Painted Lines 4" Wide	LF	0.20	3,000	600	3,000	600	3,000	600
	Signage	LS	1,500	1	1,500	1	1,500	1	1,500
	Drainage Pipe 18" RCP	LF	75	100	7,500	100	7,500	100	7,500
	Seeding/Turf Establishment	AC	3,000	1	3,000	1	3,000	1	3,000

1607

Table L-1-18
Circulation Improvements at KCS RR and Hwy 61 Corridor
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	1 - 4x4 Box		2 - 10x5		Bridges	
				Qty	Cost, $	Qty	Cost, $	Qty	Cost, $
	Utility Relocations								
	Pipe line between RR and Hwy	LS	500,000	1	500,000	1	500,000	1	500,000
	Communication lines - RR	EA	5,000	2	10,000	2	10,000	2	10,000
	Communication lines - Hwy	EA	5,000	2	10,000	2	10,000	2	10,000
	Dewatering and Water Management								
	Earthen Canal								
	Dewatering	LF	50	500	25,000	500	25,000	500	25,000
	CN RR Crossing								
	Dewatering	LF	50	100	5,000	100	5,000	100	5,000
	LA 3125								
	Dewatering	LF	50	200	10,000	200	10,000	200	10,000
	Utility Construction								
	Dewatering	LF	25	200	5,000	200	5,000	200	5,000
					0		0		0
	Subtotal - Direct Costs				1,419,520		2,348,480		1,988,130
	O/H and Profit Markup		30%		425,856		704,544		596,439
	Subtotal				1,845,376		3,053,024		2,584,569
	Contingency		15%		276,806		457,954		387,685
	Total Cost				**2,122,182**		**3,510,978**		**2,972,254**

1608

Table L-1-19
Instrumentation/Communications
Construction Cost Estimate

Item No.	Description	Unit	Unit Price	HU 100's Romeville Qty	HU 100's Romeville Cost, $	HU 100's & 200's South of Motiva Qty	HU 100's & 200's South of Motiva Cost, $	All HU's South of Motiva Qty	All HU's South of Motiva Cost, $	HU 100's & 200's Dual Diversion Qty	HU 100's & 200's Dual Diversion Cost, $	All HU's Dual Diversion Qty	All HU's Dual Diversion Cost, $
	Mobilization	LS	10,000	1	10,000	1	10,000	1	10,000	1	10,000	1	10,000
	Radio Towers												
	Diversion Site												
	Romeville - 150' Tower	VLF	1,000	150	150,000		0		0	150	150,000	150	150,000
	Motiva - 150' Tower	VLF	1,000		0	150	150,000	150	150,000	150	150,000	150	150,000
	Hwy 61 Corridor - 150' Tower	VLF	1,000		0	150	150,000	150	150,000	150	150,000	150	150,000
	Control Structure 1 - 150' Tower	VLF	1,000	150	150,000	150	150,000	150	150,000	150	150,000	150	150,000
	Control Structure 2 - 150' Tower	VLF	1,000	150	150,000	150	150,000	150	150,000	150	150,000	150	150,000
					0		0		0		0		0
	Control Room - at Diversion Site	LS	12,000	1	12,000	1	12,000	1	12,000	1	12,000	1	12,000
					0		0		0		0		0
	Gage Stations (stream, weather)	EA	15,000	3	45,000	5	75,000	6	90,000	5	75,000	6	90,000
					0		0		0		0		0
	Environmental Monitoring Stations				0		0		0		0		0
	HU 100 Series	EA	15,000	6	90,000	6	90,000	6	90,000	6	90,000	6	90,000
	HU 200 Series	EA	15,000	0	0	2	30,000	2	30,000	2	30,000	2	30,000
	HU 300 Series	EA	15,000	0	0	0	0	2	30,000	0	0	2	30,000
					0		0		0		0		0
	Subtotal - Direct Costs				607,000		817,000		862,000		967,000		1,012,000
	O/H and Profit Markup		30%		182,100		245,100		258,600		290,100		303,600
	Subtotal				789,100		1,062,100		1,120,600		1,257,100		1,315,600
	Contingency		15%		118,365		159,315		168,090		188,565		197,340
	Total Cost				907,465		1,221,415		1,288,690		1,445,665		1,512,940

Notes:
1. Local instrumentation not included in this estimate. See the specific project element.

1609

Table L-1-20
Conway Canal - Diversion Ditch to HU 200
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	4	2,000	8,000
	Clearing & Grubbing	AC	10	5,600	56,000
	Strip & stockpile topsoil	CY	7,800	2	15,600
	Excavation	CY	20,000	4	80,000
	Fill (berm)	CY	20,000	6	120,000
	Place topsoil	CY	7,800	2	15,600
	Seeding/establish vegetation	AC	10	3,000	30,000
	SWPPP	LS	1	10,000	10,000
	Water Control	LS	1	5,000	5,000
	Pipe line adjustment or accommodations	LS	1	100,000	100,000
	Subtotal - Direct Costs				450,200
	O/H and Profit Markup			30%	135,060
	Subtotal				585,260
	Contingency			15%	87,789
	Total Cost				**673,049**

Notes:
1. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
2. Barge time - 1 day each move-in, move-out. 1 day delivering materials. Use 4 days

Table L-1-21

Conway Canal Berm Gap (20 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	5,000	5,000
	Barge for access ($60,000/Month)	Day	2	2,000	4,000
	Clearing & Grubbing	AC	0.50	5,600	2,800
	Strip & stockpile topsoil	CY	130	2	260
	Excavation	CY	180	4	720
	Disposal on site	CY	180	4	720
	Geotextile	SY	160	5	800
	Articulated Concrete Blocks	SY	160	50	8,000
	Place topsoil	CY	130	2	260
	Seeding/establish vegetation	AC	0.5	3,000	1,500
	SWPPP	LS	1	500	500
	Water Control	LS	1	500	500
	Subtotal - Direct Costs				25,060
	O/H and Profit Markup			30%	7,518
	Subtotal				32,578
	Contingency			15%	4,887
	Total Cost				**37,465**

Notes
1. Articulated Concrete Blocks - without cables
2. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
3. Barge time - 1 day each move-in, move-out and delivering materials. Use 2 days

Table L-1-22
Conway Canal Berm Gap (100 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	2	2,000	4,000
	Clearing & Grubbing	AC	0.50	5,600	2,800
	Strip & stockpile topsoil	CY	250	2	500
	Excavation	CY	420	4	1,680
	Disposal on site	CY	420	4	1,680
	Geotextile	SY	340	5	1,700
	Articulated Concrete Blocks	SY	340	50	17,000
	Place topsoil	CY	250	2	500
	Seeding/establish vegetation	AC	0.50	3,000	1,500
	SWPPP	LS	1	500	500
	Water Control	LS	1	500	500
	Subtotal - Direct Costs				42,360
	O/H and Profit Markup			30%	12,708
	Subtotal				55,068
	Contingency			15%	8,260
	Total Cost				**63,328**

Notes:
1. Extend articulated concrete block 50 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out and delivering materials. Use 2 days

Table L-1-23
Conway Canal Berm Gap (250 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	3	2,000	6,000
	Clearing & Grubbing	AC	1.00	5,600	5,600
	Strip & stockpile topsoil	CY	480	2	960
	Excavation	CY	860	4	3,440
	Disposal on site	CY	860	4	3,440
	Geotextile	SY	340	5	1,700
	Articulated Concrete Blocks	SY	340	50	17,000
	Place topsoil	CY	480	2	960
	Seeding/establish vegetation	AC	1	3,000	3,000
	SWPPP	LS	1	1,000	1,000
	Water Control	LS	1	1,000	1,000
	Subtotal - Direct Costs				54,100
	O/H and Profit Markup			30%	16,230
	Subtotal				70,330
	Contingency			15%	10,550
	Total Cost				**80,880**

Notes:
1. Extend articulated concrete block 25 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out. 1 day delivering materials. Use 3 days

Table L-1-24
Conway Canal Berm Gap (500 feet wide)
Construction Cost Estimate

Item No.	Description	Unit	Quantity	Unit Price	Cost, $
	Mobilization	LS	1	10,000	10,000
	Barge for access ($60,000/Month)	Day	4	2,000	8,000
	Clearing & Grubbing	AC	2.00	5,600	11,200
	Strip & stockpile topsoil	CY	850	2	1,700
	Excavation	CY	1,600	4	6,400
	Disposal on site	CY	1,600	4	6,400
	Geotextile	SY	340	5	1,700
	Articulated Concrete Blocks	SY	340	50	17,000
	Place topsoil	CY	850	2	1,700
	Seeding/establish vegetation	AC	2	3,000	6,000
	SWPPP	LS	1	2,000	2,000
	Water Control	LS	1	2,000	2,000
	Subtotal - Direct Costs				74,100
	O/H and Profit Markup			30%	22,230
	Subtotal				96,330
	Contingency			15%	14,450
	Total Cost				**110,780**

Notes:
1. Extend articulated concrete block 50 feet into gap
2. Articulated Concrete Blocks - without cables
3. Multiple work sites and crews using the barges. Prorate costs, as if barges being used on this and other tasks full-time.
4. Barge time - 1 day each move-in, move-out. 1 day delivering materials. Use 4 days

Volume IV

APPENDIX L—Annex L-2

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Detailed hydrologic and hydraulic results are presented in Main Appendix L, Section L2.

Volume IV

APPENDIX L—Annex L-3

Geotechnical Engineering Data for Design Facilities

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LOG OF BORING CDM-7

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°3'46.4"
COORDINATE LON: W90°50'25.1"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lb/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CL		Firm, brown and gray lean CLAY w/ little silt, and ferrous staining		1.00					32.1				
		CH		Firm, gray fat CLAY w/ ferrous staining		0.75		0.58		81	42.1	73	21	52	
5		CH		Firm, brown and gray fat CLAY w/ ferrous staining; silty sand lenses, 4'-6'		2.25									
				- w/ some silt, 6'-7'		1.25		0.63		88	34.5				
10						1.25		0.66		89	30.6	85	25	60	
		CL		Firm, gray lean CLAY w/ some silt, and ferrous staining		1.25		0.63		96	29.2				
15															
				- w/ trace of shell fragments											
20						1.50									
				- w/ trace of calcareous nodules											
25						1.50		0.78		94	32.9				
30						2.50									
		ML		Loose, brown SILT		0.50			0.55 @10.0	91	32.9	29	25	4	
35															
		CL		Very stiff, brown lean CLAY w/ ferrous staining											
40						2.50									
		ML		Very loose, brown SILT w/ some clay											
45						<0.25									90.5
		CH		Very stiff, gray fat CLAY w/ shell fragments											
50						1.75		2.11		78	42.8	76	20	56	

DEPTH OF BORING: 100 FEET
DATE DRILLED: January 18, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
: 6 INCHES AFTER 24 HOURS

PSI *Geotechnical Consulting Services*
Baton Rouge, Louisiana

LOG OF BORING CDM-7

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°3'46.4"
COORDINATE LON: W90°50'28.1"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
55		CL		Very stiff becoming firm, brown and gray lean CLAY		2.75									
60						1.50		0.82		96	31.3				
65		CL		Very stiff, brown lean CLAY w/ ferrous staining		3.25									
70		CL		Very stiff, brown and gray lean CLAY w/ ferrous staining		3.00		2.36		94	29.7				
75		CH		Very stiff, gray fat CLAY - w/ ferrous staining, 73'-80'		2.75									
80				- w/ silt, 78'-90', calcareous nodules at 78'		2.75		0.89		81	38.9				
85				- becoming stiff		2.00									
90						1.00		1.08		80	50.2	70	22	48	
95						1.75									
100				- becoming very stiff		2.50									

DEPTH OF BORING: 100 FEET
DATE DRILLED: January 18, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
: 6 INCHES AFTER 24 HOURS

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-8

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°3'97.23"
COORDINATE LON: W90°50'9.05"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CL		Firm, brown lean CLAY w/ some fine sand				0.54		103	25.6				
		SM		Very loose, brown silty SAND w/ some clay		1.25									
		CH		Soft, brown fat CLAY		<0.25									
						0.75		0.35		79	35.0	101	26	75	99.1
5		CH		Firm, gray and brown fat CLAY; trace of fine sand @ top 4"		0.50									
				- w/ ferrous stains											
						0.75		0.68		82	40.7				
		CH		Stiff, gray fat CLAY w/ ferrous stains											
10						1.25					33.8	87	27	60	
15		CL		Soft, gray lean CLAY w/ ferrous stains		1.00		0.47		92	30.1				
20				- becoming very stiff w/ shell fragments, and trace of black and white concretions		2.25									
25				- becoming soft and mottled w/ green, tan and white spots		0.75		0.37		88	34.5				
30				- becoming very stiff		3.25									
35		CL-ML		Firm, red and brown silty CLAY w/ fine sand, and ferrous stains		0.50			0.78 @10.0	93	32.8	29	22	7	
40		SP		Medium dense, red and brown fine SAND w/ some silt	16										
				Boring terminated @ 40 feet											
45															
50															

DEPTH OF BORING: 40 FEET
DATE DRILLED: January 19, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
: 2 INCHES AFTER 24 HOURS

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-9

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°47.08'
COORDINATE LON: W90°49'54.51"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CH		Firm, brown fat CLAY; trace plant roots, 0'-2'		0.50		0.64		84	38.1	66	23	43	
						0.25									
5		CH		Firm becoming soft, gray and brown fat CLAY; ferrous stains, 4'-20'		1.00		0.59		80	40.7	83	24	59	
						0.75									
10						0.50		0.30		86	36.0				
15		CH		Stiff, red-brown and gray fat CLAY w/ trace of fine sand		1.50									
20		CH		Stiff, light gray fat CLAY		3.00		1.48		103	24.8	52	16	36	
25		CH		Soft, gray and red-brown fat CLAY w/ black stains; w/ trace of sand @ 25'		1.75									
30		SC		Very loose, red-brown fine clayey SAND w/ some silt		0.25		0.28		95	27.0				25.2
35					8										
40		CL		Very stiff, light gray lean CLAY	7	2.25		2.29		97	27.8				
				Boring terminated @ 40 feet											
45															
50															

DEPTH OF BORING: 40 FEET
DATE DRILLED: January 19, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
: 4 INCHES AFTER 24 HOURS

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-10

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'17.28"
COORDINATE LON: W90°49'39.37"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CH		Soft, brown fat CLAY; trace plant roots, 0'-2'		0.50									
				- w/ ferrous stains		1.00		0.42		68	58.5	107	28	79	
5		CH		Very soft to soft, gray fat CLAY w/ ferrous stains		0.25		0.23		65	59.2				
						0.25		0.34		66	59.1	100	30	70	
10						0.50									
		CH		Firm becoming stiff, tan and gray fat CLAY w/ ferrous stains		1.25		0.75		97	27.0				
20					8	2.00									
						2.00			1.2 @12.7	100	28.1				
		CL		Firm becoming soft, red-brown lean CLAY		3.25		0.68		94	28.1	30	20	10	
30				- w/ trace of silt, and fine sand	7	0.50		0.25		90	32.3				
		ML		Loose, red-brown SILT w/ sand and clay											
35					8							25	23	2	41.8
		CL		Firm, light gray and tan lean CLAY											
40					9	2.00									
				Boring terminated @ 40 feet											
45															
50															

DEPTH OF BORING: 40 FEET
DATE DRILLED: January 19, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
; 4 INCHES AFTER 24 HOURS

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-11

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'29.27"
COORDINATE LON: W90°49'26.44"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D3858) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CL		Firm, brown lean CLAY w/ fine sand and ferrous stains ▽		1.25		0.59		90	25.1				
		CH		Firm, brown-gray fat CLAY w/ roots and ferrous stains		0.75		0.51		78	53.4	107	26	81	
5				- w/ interbedded layers of decayed wood		0.75									
		CH		Very soft becoming stiff, gray fat CLAY		0.25		0.20		80	64.6	113	26	87	
				- w/ ferrous stains, 6'-8'											
				- w/ roots		0.75					63.3				
10															
				- w/ silt and ferrous stains		1.50									
15															
		CL		Stiff, light gray lean CLAY w/ silt and ferrous stains		1.75					22.9				
20															
		CL		Stiff, gray and red-brown lean CLAY w/ silt		1.75									
25															
		CL		Firm becoming stiff, brown lean CLAY w/ silt		0.75									
30															
				- w/ ferrous staining		2.00									
35															
		CL		Stiff, gray lean CLAY w/ ferrous staining		2.00									
40				Boring terminated @ 40 feet											
45															
50															

DEPTH OF BORING: 40 FEET
DATE DRILLED: January 21, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED
: 1.5 FEET AFTER 24 HOURS

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-12

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA PARISH

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'35.75"
COORDINATE LON: W90°49'18.11"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		ML		Loose, brown SILT w/ fine sand, clay, and plant roots		0.50		0.40		89	20.8	28	25	3	
						0.25									
5		CH		Soft, gray fat CLAY w/ ferrous stains, and roots; slickensided, 4'-6'		0.50		0.41		70	53.6	107	31	76	
						1.25									
10						1.25		0.39		60	64.1				
15						0.75									
20						1.00									
25		CL		Stiff, light gray lean CLAY w/ silt, and ferrous stains		1.75					22.2				
30		CL		Very stiff, red-brown lean CLAY w/ trace silt, and ferrous stains		2.75									
35		CL		Very stiff, mottled red-tan-gray-black lean CLAY w/ concretions		3.00									
40		CL		Very stiff, tan and gray lean CLAY w/ ferrous stains		2.75									
45						3.00									
50		CL		Very stiff, tan lean CLAY w/ some silt		2.25									

DEPTH OF BORING: 100 FEET
DATE DRILLED: January 21, 2010

DEPTH TO FREE GROUNDWATER: NOT RECORDED

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LOG OF BORING CDM-12

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'35.75"
COORDINATE LON: W90°49'18.11"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
				- becoming soft w/ some fine sand											
55						0.75									
				- becoming stiff w/ silt and sand											
60						1.25									
				- w/ interbeded silty sand layers											
65															
				- becoming very stiff to hard w/ silt and ferrous stains											
70						4.00									
		CL		Very stiff, gray lean CLAY w/ trace silt, trace fine sand, shells, ferrous stains											
75						3.50									
		CL		Stiff, gray and dark brown lean CLAY w/ decayed wood											
80						1.25									
		CL		Very stiff, gray lean CLAY w/ calcareous lenses, and ferrous stains											
85						2.25									
				- becoming stiff											
90						1.75									
		CL		Very stiff, dark gray lean CLAY w/ decayed wood layers											
95						2.25									
		CL		Very stiff, green and gray lean CLAY w/ trace of fine sand											
100						2.75									

DEPTH OF BORING: 100 FEET
DATE DRILLED: January 21, 2010

DEPTH TO FREE GROUNDWATER: NOT RECORDED

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-13

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: HOLLOW-STEM AUGER

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'40.38"
COORDINATE LON: W90°49'21.73"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		ML		Loose, brown SILT w/ some clay, sand and roots ▽		0.50									
												28	26	2	
5		CL		Stiff becoming soft, brown lean CLAY w/ silt		1.50		1.18		99	26.6				
						0.75									
						0.75		0.33		93	25.7	35	22	13	
10		CH		Soft, gray fat CLAY w/ ferrous stains and silt		0.50		0.34		57	74.8				
15				Firm becoming stiff, gray lean CLAY -w/ ferrous stains and silt, 13'-20'		0.75									
20						2.00		1.15		107	23.1	34	22	12	
25				-w/ concretions		3.25									
				Boring terminated @ 25 feet											
30															
35															
40															
45															
50															

DEPTH OF BORING: 25 FEET

DATE DRILLED: January 20, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED

: 1 FEET AFTER 24 HOURS

PSI

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LOG OF BORING CDM-14

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: HOLLOW-STEM AUGER

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'31.20"
COORDINATE LON: W90°48'14.11"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CL		Firm becoming soft, brown sandy lean CLAY w/ roots		0.50		0.50		97.7	23.4	30	22	8	
						0.25									
5		CH		Soft, gray-brown fat CLAY w/ fine sand		0.75		0.35		68.0	56.7				
		CH		Very soft, gray fat CLAY; w/ ferrous stains, 6'-8'		0.75									
				-w/ fine sand at 8'											
10				-w/ wood fragments, 8'-15'		0.75		0.23		61.1	59.6	86	32	54	
		CL		Soft becoming stiff, gray lean CLAY w/ ferrous nodules		0.50		0.26		94.4	29.1				
15															
						1.25									
20															
25						2.50		1.37		97.8	30.6				
				Boring terminated @ 25 feet											
30															
35															
40															
45															
50															

DEPTH OF BORING: 25 FEET

DATE DRILLED: January 20, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED

: 3 FEET AFTER 24 HOURS

psi
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Baton Rouge, Louisiana

LOG OF BORING CDM-18

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°5'3.34"
COORDINATE LON: W90°48'21.49"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		OH		**Very soft, dark gray and black ORGANIC CLAY**		0.05					145.9	139	55	84	
				-w/ calcareous nodules											
				*** 0.17@3 psi; 0.17@5 psi; 0.15@10 psi											
				* average unit weight of 53.6		0.05			***	*	143.7				
5				-wood fragments @ 4'											
					WOH										
		CH		**Very soft, gray fat CLAY**		0.50					44.8	52	14	38	
		CL		**Very soft, gray lean CLAY**; silt, 8'-10'											
10				*** 0.21@4 psi; 0.27@8 psi; 0.32@15 psi		0.25			***	*	29.7				
				* average unit weight of 85.0											
				-w/ calcareous nodules											
15						1.25		0.16			26.6	45	19	26	
		CH		**Soft to firm, gray fat CLAY w/ calcareous nodules**											
20				-wood fragements @ 20'		1.75					31.0				
25						0.75		0.25		83	33.7				
		CH		**Firm to soft, light gray fat CLAY w/ calcareous nodules**		2.25					35.5				
30															
35				* large (1") calcareous nodules present in sample		1.75		0.25		77	38.7				
40						0.75					46.7				
45															
		CL		**Firm to soft, tan lean CLAY**	25	2.25					38.2				
				-w/ silt and calcareous nodules											
50						2.00		0.89		98	25.9	38	22	16	

DEPTH OF BORING: 100 FEET — DEPTH TO MUDLINE: 3 FEET
DATE DRILLED: January 28, 2010

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Baton Rouge, Louisiana

LOG OF BORING CDM-18

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°6'3.34"
COORDINATE LON: W90°48'21.49"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
55				-w/ silt and ferrous stains		2.00					25.9				
60						2.50									
65				-w/ ferrous nodules and trace of shell fragments		0.75		0.37		84	25.3				
70		CH		Firm, gray fat CLAY		0.75					28.7				
75						1.25									
80				- slickensided		1.25		0.93		85	36.9	92	22	70	
85				-w/ decayed wood @ 85'		1.50					31.6				
90				-w/ decayed wood @ 88'		1.00									
95				-w/ decayed wood @ 93' and slickensided		2.25		0.96		87	34.4				
100		SC-SM		Very dense, gray silty, clayey SAND		4.50					25.5				59

DEPTH OF BORING: 100 FEET
DATE DRILLED: January 28, 2010

DEPTH TO MUDLINE: 3 FEET

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Baton Rouge, Louisiana

LOG OF BORING CDM-19

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'44.75"
COORDINATE LON: W90°45'3.24"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (,%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		OH		Very soft, gray ORGANIC CLAY w/ root fragments and silt	WOH						212.4				
					WOH										
5		CL		Very soft, gray lean CLAY w/ root fragments and some silt	WOH						26.9	46	18	28	
		CH		Firm becoming stiff, gray fat CLAY; root fragments 6'-8'		1.25		0.66		74	25.5	50	19	31	
10				-w/ silt and organics		2.00					25.4				
		CH		Firm, tan and gray fat CLAY w/ silt lenses											
15				*** 0.21@5psi; 0.29@10psi; 0.26@19psi * average unit weight of 82.0		0.75			***	*	34.9				
				-becoming soft w/ calcareous nodules and little fine sand		0.25					33.5	58	18	40	
25		CL		Stiff, tan and gray lean CLAY w/ silt lenses; fine sand @ bottom 6"		1.25		1.85		98	26.4				
		SM		Very dense, tan silty fine SAND	58						26.4				65
35		CH		Firm, tan fat CLAY w/ calcareous nodules		0.75					47.9				
		CH		Stiff, gray fat CLAY w/ silt lenses		1.50		1.51		85	34.2	62	27	35	
		CH		Firm, tan fat CLAY w/ calcareous nodules											
40						1.00					49.7				
		CL		Stiff, gray lean CLAY; large amount of shell, 43'-45'											
45						1.75					21.3				
				-w/ calcareous nodules											
50						1.25		1.80		101	25.2				

DEPTH OF BORING: 100 FEET — DEPTH TO MUDLINE: 8 FEET
DATE DRILLED: January 30, 2010

psi
Geotechnical Consulting Services
Baton Rouge, Louisiana

LOG OF BORING CDM-19

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°4'44.76"
COORDINATE LON: W90°45'3.24"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CL		Stiff, gray lean CLAY											
				becoming very stiff											
55						2.75									
60				w/ silt, silt lenses and ferrous stains		2.50					25.3				
		CH		Stiff, gray fat CLAY; w/ sand pockets and ferrous nodules											
65						1.75		2.31		90	31.6	67	26	41	
70						3.25									
75				w/ sand pockets		2.75					41.5				
80				becoming firm w/ silt lenses, clay and fine sand @ top 8"		1.00		0.92		84	34.3	65	23	42	99
85				becoming very stiff w/ wood fragements at 83'		2.50									
90				w/ sand pockets		2.75					21.5				
95				becoming very stiff and slickensided w/ silt lenses failure at 2.1% stain		4.25		*1.84		100	24.1				
100				becoming very stiff		3.50					26.2				

DEPTH OF BORING: 100 FEET

DEPTH TO MUDLINE: 6 FEET

DATE DRILLED: January 31, 2010

psi

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LOG OF BORING CDM-21

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY — PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°6'9.30"
COORDINATE LON: W90°44'19.68"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
		CH		**Stiff, dark brown fat CLAY w/ grass roots and peat pockets**		1.50					53.0				
				- becoming soft		0.50		0.40		59	86.8				
5		CH		**Soft, gray fat CLAY, slickensided**		0.50		0.27		59	67.2	123	39	84	
				- becoming very soft w/ small pieces of roots,6'-15' and large root (1" dia) running through sample,6'-10'		<0.25					78.0				
10				-organic fat clay		<0.25					193.0				
15				-w/ small pieces of roots		0.50		0.18		83	37.8	54	18	36	
20				- becoming firm		1.25					25.3				
25		CL		**Stiff, gray lean CLAY w/ ferrous stains**		1.25		0.68		91	32.3				
30				w/ some fine sand		2.00					30.0				
35		CH		**Firm, light gray fat CLAY w/ some fine sand** -slickensided and jointed		0.75		0.32		83	34.0	58	23	35	
		SP		**Loose, red and brown fine SAND**											
40					5						27.8				
45				- becoming medium dense w/ interbedded sandy clay layer	11						36.9				
50		CH		**Firm to stiff gray fat CLAY w/ silt**	8						37.5				

DEPTH OF BORING: 100 FEET
DATE DRILLED: February 8, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED

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LOG OF BORING CDM-21

MISSISSIPPI RIVER DIVERSION

ST. JAMES PARISH, LOUISIANA

TYPE OF BORING: WET ROTARY

PROJECT NUMBER: 0193124-01

COORDINATE LAT: N30°6'9.30"
COORDINATE LON: W90°44'19.60"
SURFACE ELEVATION: NOT RECORDED
BORING LOCATION PLAN: APPENDIX SHEET NO. 2

DEPTH, FEET	SOIL	USCS GROUP SYMBOL	SAMPLES	SOIL DESCRIPTION	SPT-N (BLOWS/FOOT)	Hand Pen. (tsf)	Torvane tsf	UC (tsf) (D2166)	UU (tsf) (D2850) @ Confining Pressure (psi)	UNIT DRY WT. (lbs/ft³)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING NO. 200
				Stiff, dark brown fat CLAY w/ grass roots and peat											
				- becoming stiff											
55						1.50		1.00		84	35.7	65	23	42	
				- becoming very soft w/ little fine sand											
60						<0.25					43.8				87
				- becoming stiff											
65						1.25		1.33		75	45.7	58			
				- w/ little silt											
70						2.00					26.4				
		CH		Soft, tan and gray fat CLAY w/ large silt pockets											
75						1.25		0.34		86	34.0				
		CH		Stiff, gray fat CLAY; w/ 4" layer of shells (gravel size) @ 78'											
80						3.00					32.8				
85						2.25		1.08		85	34.0	51	20	31	
				- w/ shells (gravel size)											
90						1.50					53.5				
		CL		Very stiff, green-gray lean CLAY, slickensided											
95						3.25		2.63		99	25.7				
100						3.25					23.1				

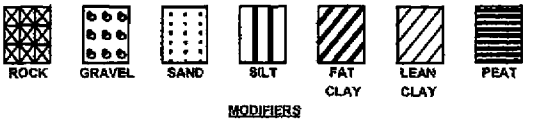
DEPTH OF BORING: 100 FEET
DATE DRILLED: February 8, 2010

DEPTH TO FREE GROUNDWATER: NOT ENCOUNTERED

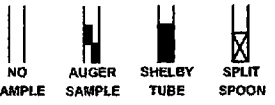
PSI
Geotechnical Consulting Services
Baton Rouge, Louisiana

KEY TO TERMS AND SYMBOLS USED ON LOGS

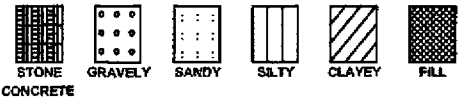
SOIL TYPE

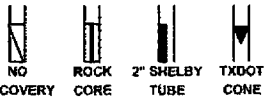


SAMPLER TYPE



MODIFIERS





UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487 (1980)

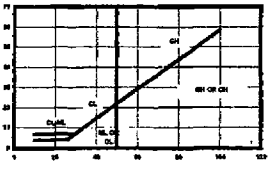
MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL & GRAVELLY SOILS	CLEAN GRAVEL	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVEL WITH FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS	CLEAN SANDS	SW	WELL GRADED SAND, GRAVELLY SAND LITTLE FINES
			SP	POORLY GRADED SANDS, GRAVELLY SAND (LITTLE FINES)
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS W/ LOW PI
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, LEAN CLAY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MED TO HIGH PL, ORGANIC SILT
HIGHLY ORGANIC SOIL			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS				ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS AND MAN-MADE SOIL MIXTURES

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH IN TONS/FT²
VERY SOFT	0.0 TO 0.25
SOFT	0.25 TO 0.50
MEDIUM STIFF	0.50 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	> 4.0 OR 4.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0-4
LOOSE	4-8
MEDIUM DENSE	10-29
DENSE	30-49
VERY DENSE	> 50 OR 50+



ABBREVIATIONS

HP - HAND PENETROMETER
TV - TORVANE
MV - MINIATURE VANE
UC - UNCONFINED COMPRESSION TEST
UU - UNCONSOLIDATED UNDRAINED TRAXIAL
CU - CONSOLIDATED UNDRAINED

▼ GROUNDWATER FIRST ENCOUNTERED
▽ 24-HOUR GROUNDWATER READING

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

6"	3"	3/4"	4	10	40	200

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	2.0	0.42	0.074		0.002

GRAIN SIZE IN MM

psi Geotechnical Consulting Services
Baton Rouge, Louisiana

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CDM

Memorandum

To: *Jamie Bartel, P.G.*

From: *Mohammad Tavassoli, Ph.D., P.E.*
Albert Ayenu-Prah, Ph.D., E.I.

Date: *March 10, 2010*

Subject: *Blind River Freshwater Diversion*
St. James Parish, Louisiana
- Geotechnical Field Investigations

Introduction

The State of Louisiana, together with the Louisiana Coastal Authority (LCA) and the United States Army Corps of Engineers (USACE) New Orleans District, is conducting a feasibility study to restore part of the Maurepas Swamp in St. James Parish, Louisiana. CDM was retained to conduct the feasibility study for the proposed project.

Project Description

The Maurepas Swamp (Swamp) is one of the largest coastal fresh water swamps in the State of Louisiana, covering an area of approximately 233,000 acres. Since the construction of the Mississippi River flood control levees in the region, the swamp has been cut off from freshwater infusion, as well as sediments and nutrients hitherto provided by the Mississippi River. As a result, the swamp has undergone considerable degradation of its ecosystem, together with continual local subsidence.

The proposed project involves designing and constructing a small freshwater diversion canal from the Mississippi River to the Swamp. The proposed flow rate in the diversion canal would be less than 5000 cubic feet per second, discharging into the Blind River, which is located within the Swamp.

Purpose and Scope

This report presents geotechnical field investigations being undertaken at the project location.

The investigations consist of drilling and sampling 21 test borings, and installing seven (7) piezometers within the project area. **Figures 1A** and **1B** show the boring location plan.

Results of laboratory testing of the soil samples, and water level readings from the piezometers will furnish information pertinent to the geotechnical design of the diversion canal.

Existing Site Conditions

Terrain

The project area is relatively flat, with elevations within the Swamp ranging from 1 to 3 feet, gradually increasing to about 10 feet near the Mississippi River levees south of the Swamp. The Swamp is wooded with cypress trees and other vegetation. The Blind River runs through the Swamp along with connected canals. The Interstate 10 corridor and Airline Highway also cross the Swamp.

Existing soil survey information from the United States Department of Agriculture (USDA) indicates that soils in the area are predominantly clay with occasional layers of silt; the top six inches is mostly peat. Soil information was only available to approximately 6.5 feet below ground surface.

Geology

St James Parish lies on Alluvium and Natural Levees. Sediments underlying this region are of the Holocene Epoch, overlying Pleistocene formations. The Alluvium consists of gray to brownish gray clay and silty clay, reddish brown in the Red River Valley, with some sand and gravel. Natural Levees are gray and brown silt, and silty clay, with some very fine sand, reddish brown along the Red River. The natural levees lie near the Mississippi River, with point bars and backswamps further inland. In general, on the concave sides of the river are fine-grained natural levee deposits, undifferentiated deltaic plain swamp, and marsh materials. On the convex sides of the river bends are accretionary and point bar deposits. The alluvial deposits are fluvial sediments deposited by a rise in sea level in this region between 4000 and 6000 years ago.

Subsurface Investigations

Field Exploration

As mentioned earlier, the geotechnical field investigation consisted of drilling a total of 21 test borings and installing seven (7) piezometers. The test borings consisted of sixteen 3-inch diameter, and five 5-inch diameter borings. **Table 1** presents some information for the test borings.

Borings B-7 through B-14 and B-18 through B-21 have been completed, with the samples at the laboratory testing stage. Borings B-1 through B-6, which are close to the Mississippi River levee, will be drilled once the Pontchartrain Levee District approves the drilling permit application. Borings B-15 through B-17 will be drilled upon permit approval by the Louisiana

Office of Coastal Restoration and Management. The completed borings were drilled and sampled between January 18 and March 5, 2010.

Before drilling, the borings were located and staked in the field using a handheld GPS device. The boring locations are shown on **Figures 1A** and **1B**.

Table 1.

Boring	Boring Depth (ft)	Boring Diameter (in.)	GPS Coordinates		Groundwater Depth (ft)
			Easting	Northing	
B1	100	5	-90.84506	30.05966	
B2	130	5	-90.84457	30.06000	
B3	100	5	-90.84423	30.06023	
B4	25	3	-90.84461	30.06070	
B5	25	3	-90.84380	30.05975	
B6	40	3	-90.84380	30.05975	
B7	100	3	-90.84021	30.06295	0.5
B8	40	3	-90.83585	30.06590	0.2
B9	40	3	-90.83181	30.06863	0.3
B10	40	3	-90.82760	30.07147	0.3
B11	40	3	-90.82401	30.07492	1.5
B12	100	3	-90.82170	30.07660	Not Recorded
B13	25	3	-90.82270	30.07788	1.0
B14	25	3	-90.82059	30.07533	3.0
B15	40	3	-90.81817	30.07917	
B16	40	3	-90.81438	30.08193	
B17	40	3	-90.81071	30.08463	
B18*	100	5	-90.80545	30.08434	3**
B19*	100	5	-90.75086	30.07906	8**
B20	100	3	-90.71677	30.08507	
B21	100	3	-90.73893	30.10262	

*Drilled in Blind River
**Depth to mudline

The borings were drilled using a track-mounted drilling rig, except borings B-18 and B-19 in the Blind River, which were drilled with a pontoon-mounted drilling rig. Each boring was sampled with the solid stem auger technique until groundwater was first encountered and recorded; the wet rotary sampling technique was used thereafter.

Split spoon samples, typically taken in cohesionless soils, and Shelby tube samples, typically taken in cohesive soils, were collected continuously to a depth of 10 feet below existing ground surface, and then at 5-foot intervals thereafter until boring termination. Shelby tube sampling was conducted in general accordance with ASTM D 1587, *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*. The Shelby tubes were extruded on-site for visual classification and storage. Split-spoon sampling was conducted in general accordance with ASTM D 1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. For the 24-inch split-spoon sampler used, the sampler was driven 18 inches into the ground at 6-inch increments. The number of blows required to drive the sampler each 6-inch increment was recorded, and the Standard Penetration Resistance (N-value) was determined as the sum of the blows over the 2nd and 3rd increments. Representative soil samples were taken from each split-spoon or Shelby tube sample, stored in moisture proof containers, and securely transported to the laboratory for later review and geotechnical laboratory testing. The borings were backfilled with cement-bentonite slurry after final groundwater readings were recorded. Borings drilled in the Blind River were backfilled immediately after drilling.

Field logs were prepared by a CDM geotechnical engineer, who also observed the test borings in the field. Final boring logs will be prepared upon receiving test results back from the laboratory. Drilling and laboratory testing are being performed by Professional Service Industries, Inc. (PSI). Completed boring logs are provided in the **Appendix**.

Laboratory Testing Program

The laboratory testing program for undisturbed and disturbed samples obtained from the borings consisted of the following:

- Moisture Content
- Atterberg Limits
- Unit Weight
- Sieve Analysis (percent passing #200)
- Unconfined Compression Test
- Triaxial Test (UU test- 3 point)

The preceding laboratory tests, conducted according to ASTM standards, will provide the necessary geotechnical parameters for design and construction purposes. Available laboratory test results are shown on the completed boring logs in the **Appendix**.

Subsurface Conditions

Final boring logs from completed sample testing indicate that subsurface soils are mostly brown and gray stiff clay with occasional loose silt and fine sand lenses and layers. The silt and sand layers were usually encountered between 30 and 50 feet below ground surface.

Some soft clay was encountered in some of the borings, usually between 0 and 25 feet below ground surface. In boring B-18, the soft clay extended to 65 feet, and in B-21 soft clay was encountered at 73 to 78 feet.

In most of the borings, soil color changed to red-brown between 25 and 50 feet.

Groundwater

Final groundwater levels were usually measured 24 hours after drilling. Groundwater generally varied between 0.2 and 3 feet below ground surface.

Variation in Subsurface Conditions

The interpretation of general soil conditions is based on soil and groundwater conditions observed at the test boring locations. However, subsurface conditions may vary at locations other than the subsurface exploration locations.

Groundwater levels are expected to fluctuate with season, temperature, river stage, and other factors.

Closure

This geotechnical field investigation report has been prepared for the proposed Blind River Freshwater Diversion canal in St. James Parish, Louisiana. This report presented geotechnical field investigations, including available results of laboratory testing on selected soil samples. The methods and procedures used in this report are in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

A final geotechnical report including recommendations for slope stability, foundation support for various diversion structures and other relevant design requirements for the proposed diversion project will be issued once the final alignment, depth, hydraulic modeling and other design features have been completed.

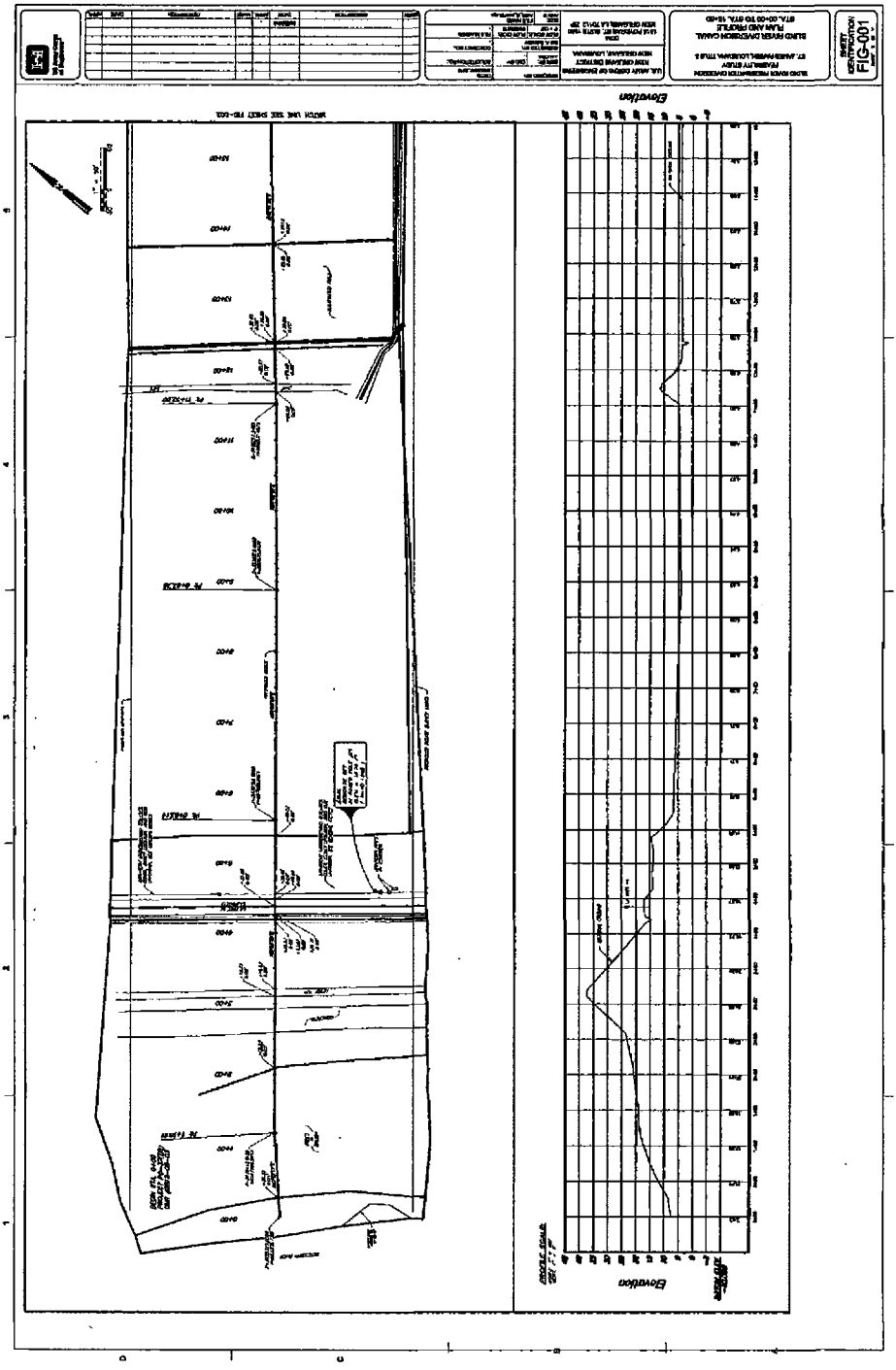
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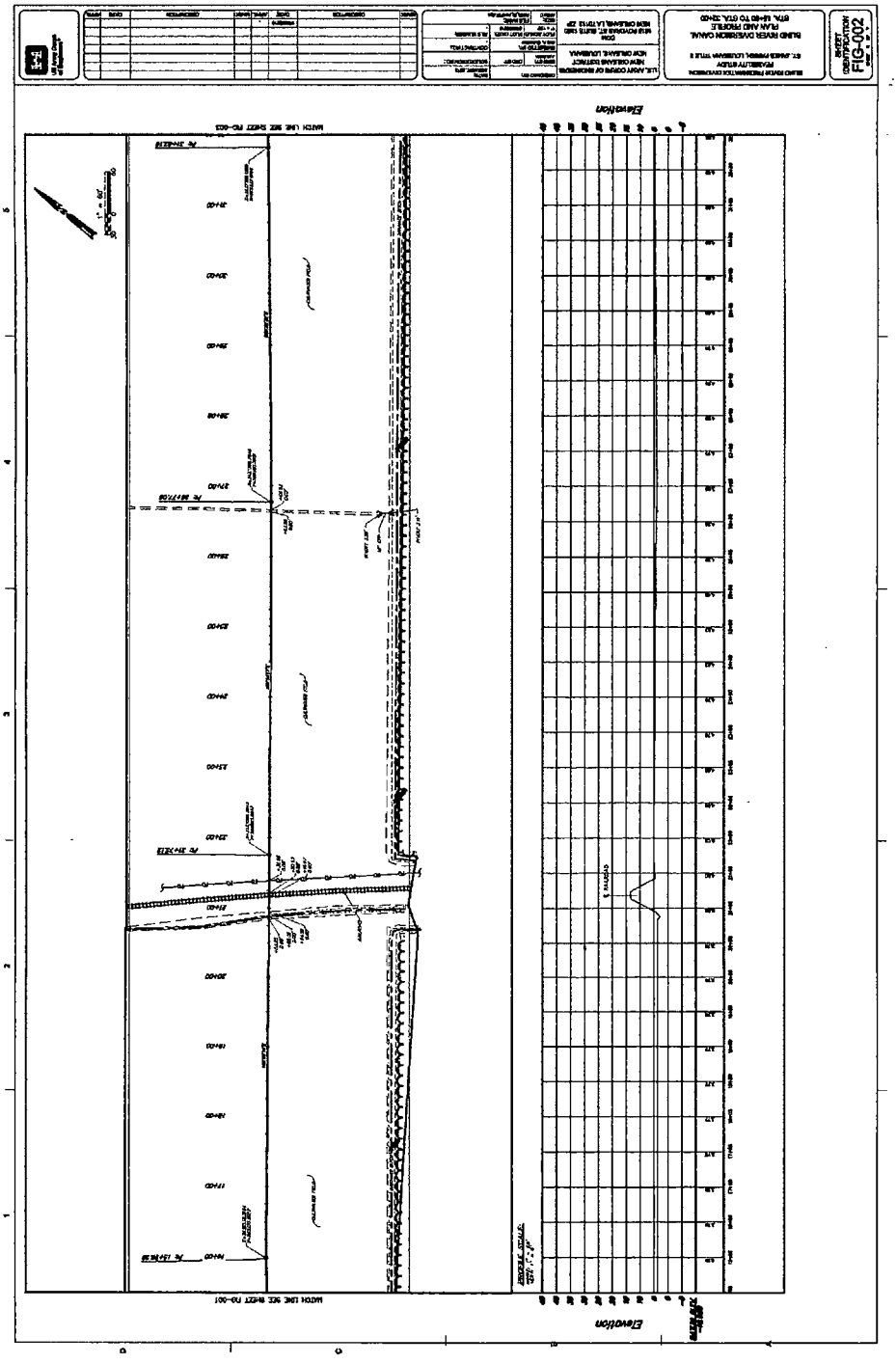
Volume IV

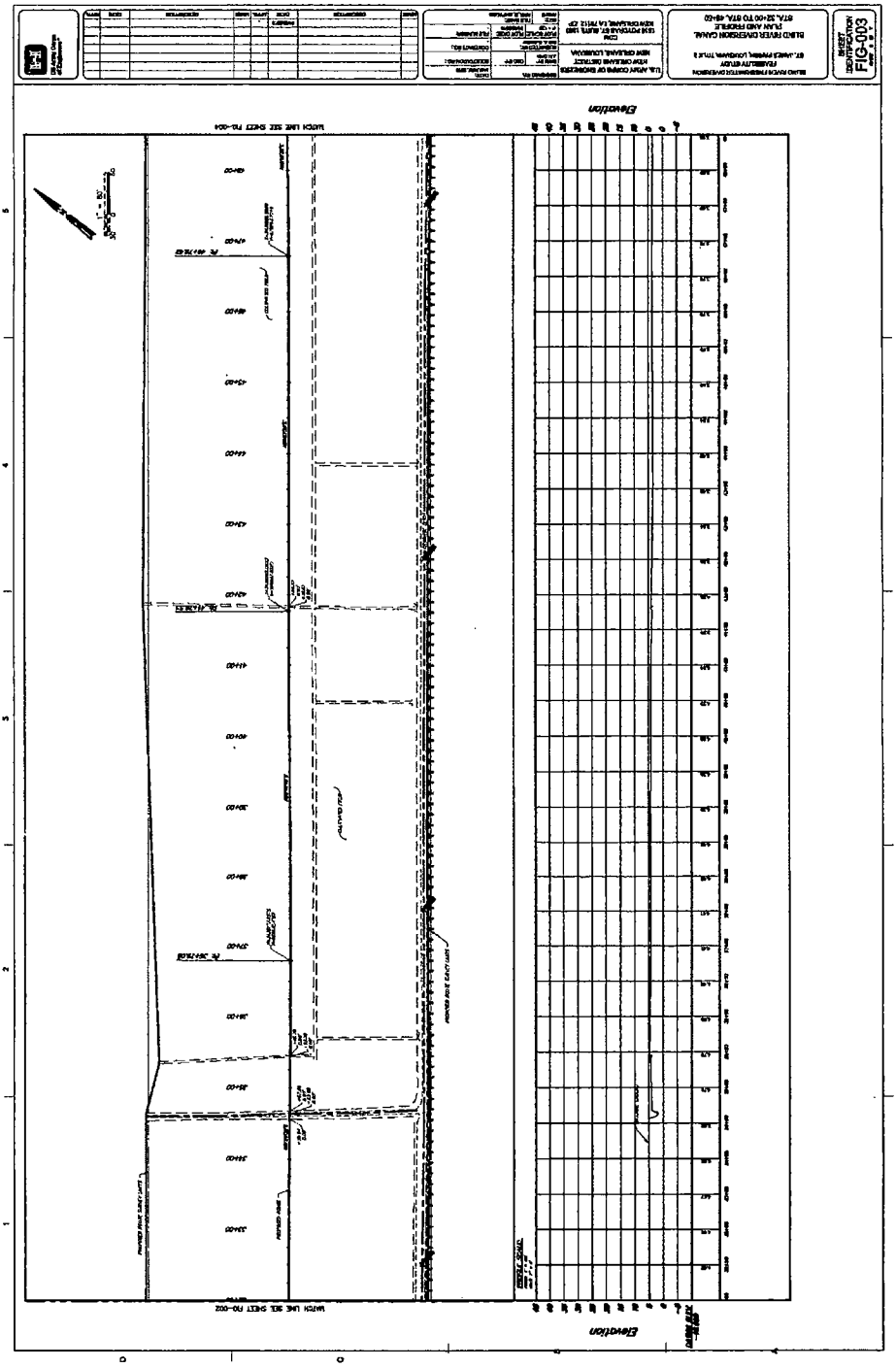
APPENDIX L—Annex L-4 through L-6

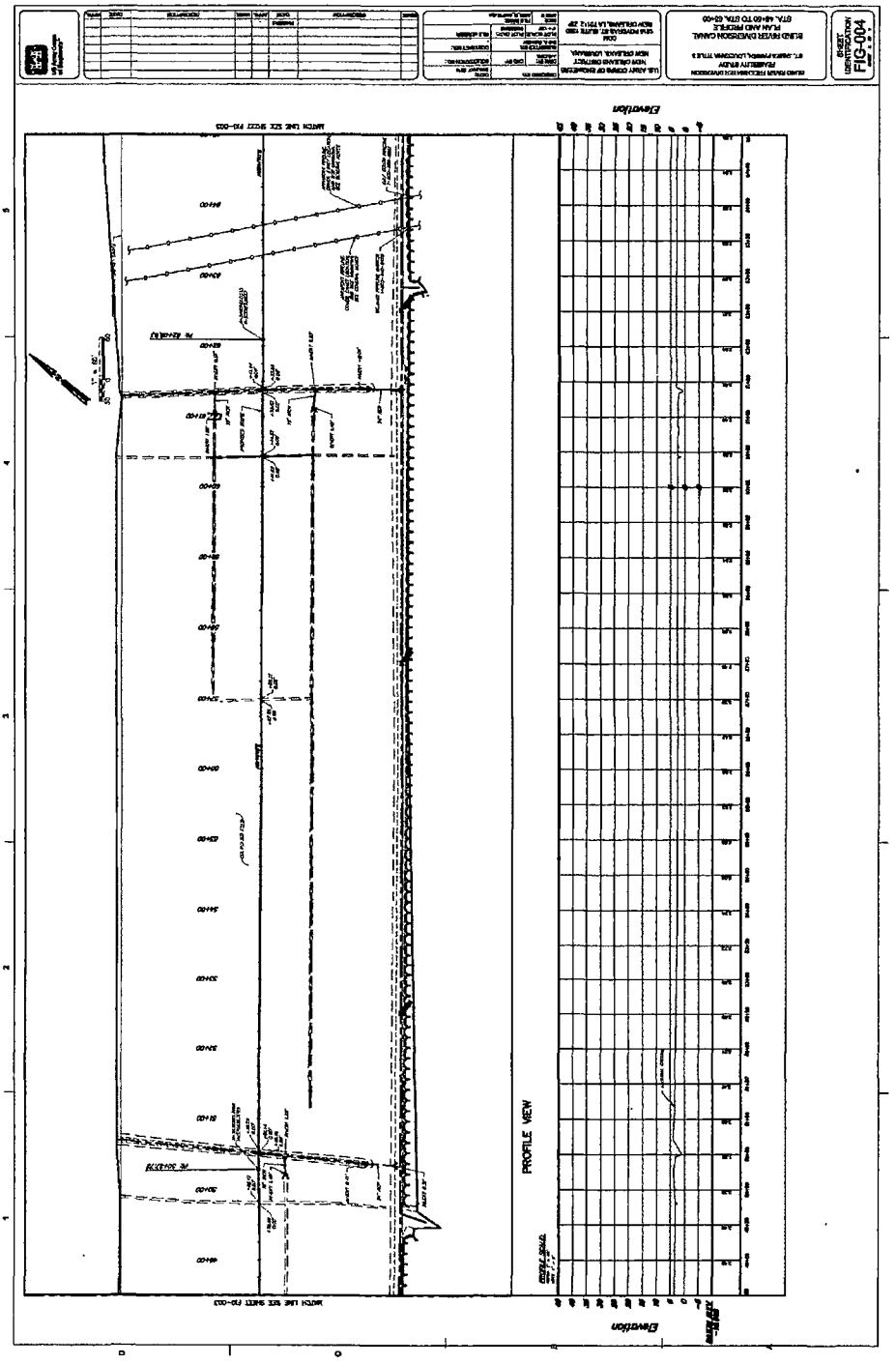
Survey Data, Engineering Plates, Control Structure Memorandum

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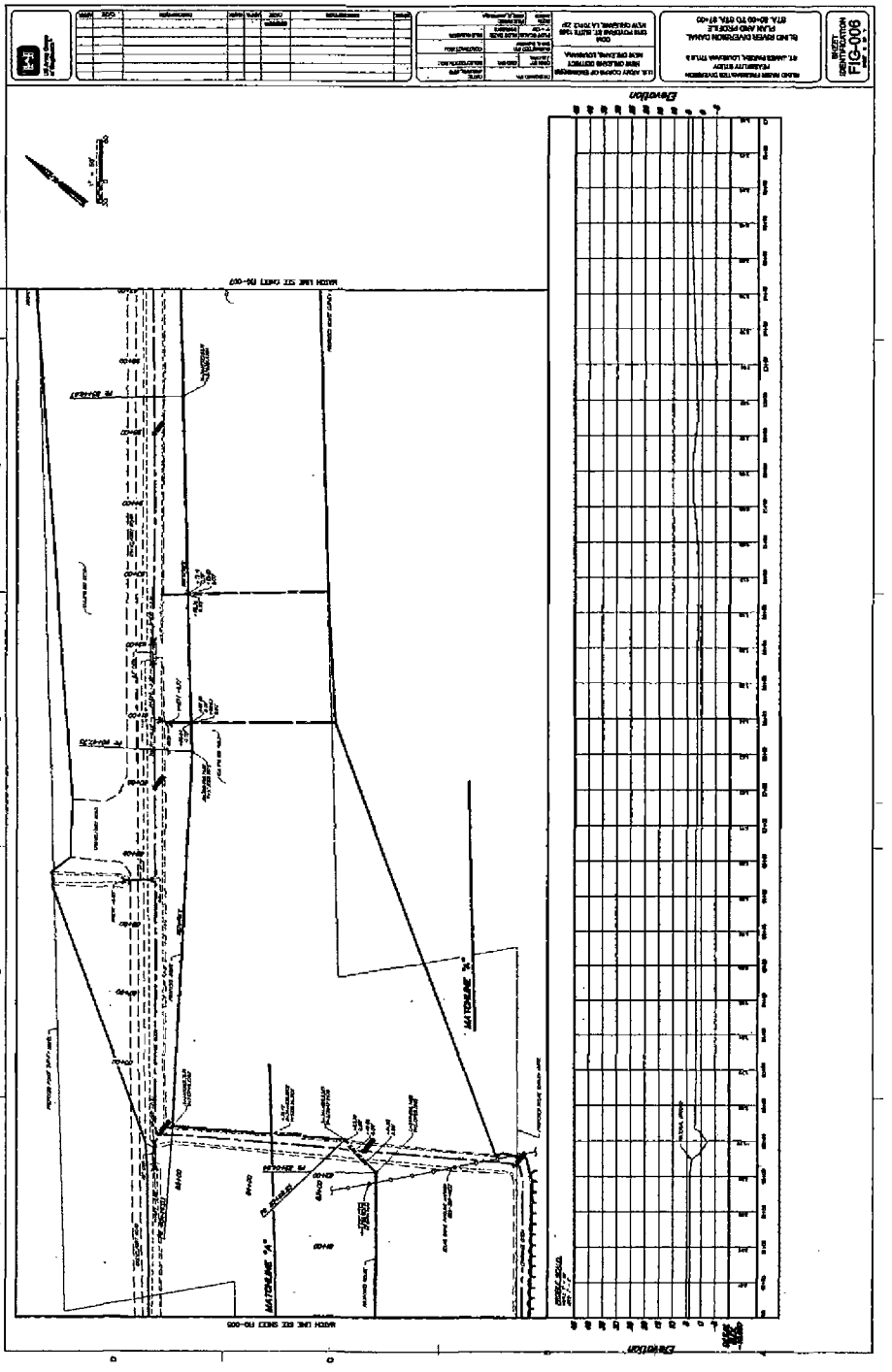


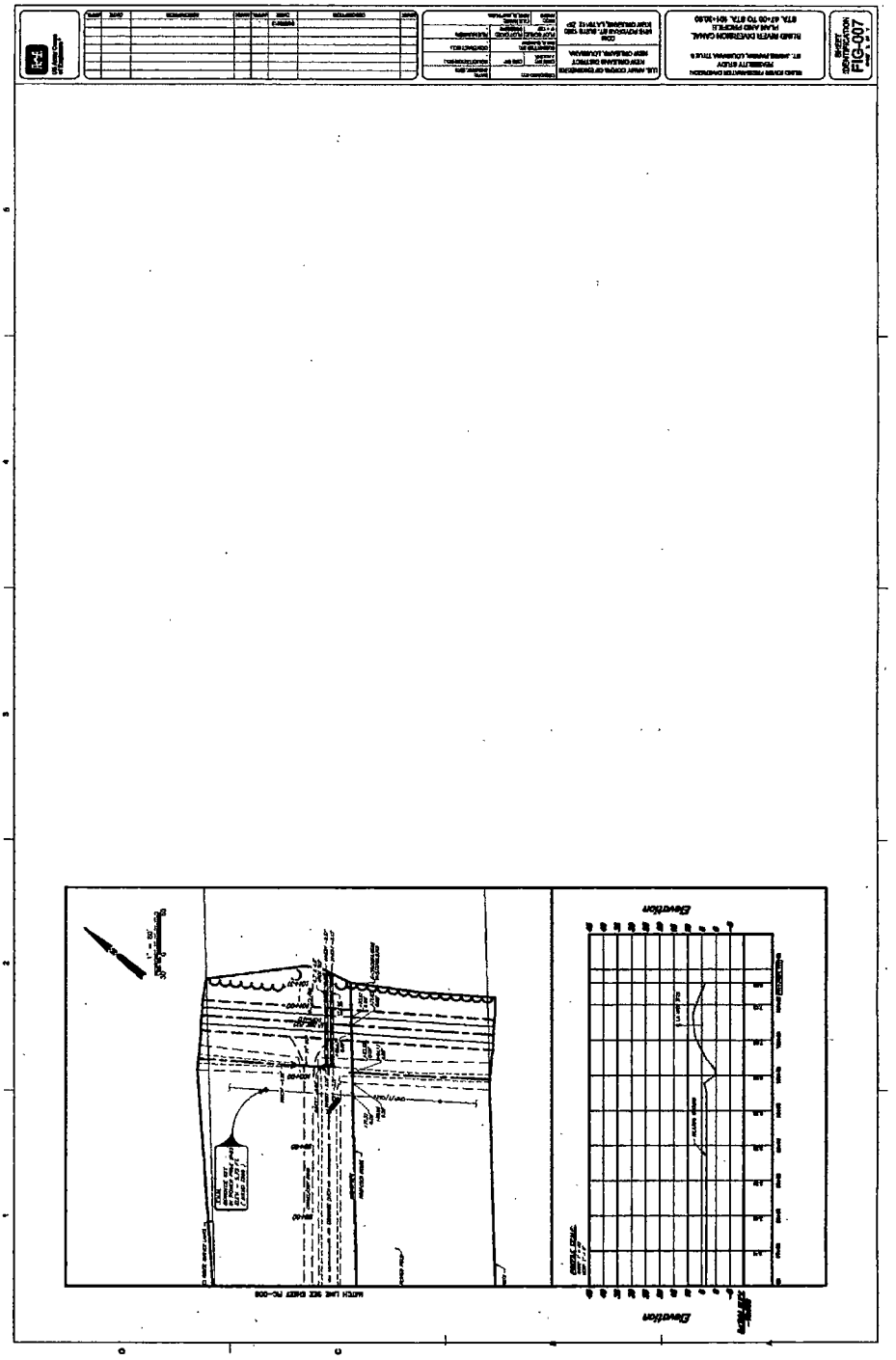

FIG-002
Elevation
Plan




PROFILE VIEW
Elevation
Elevation

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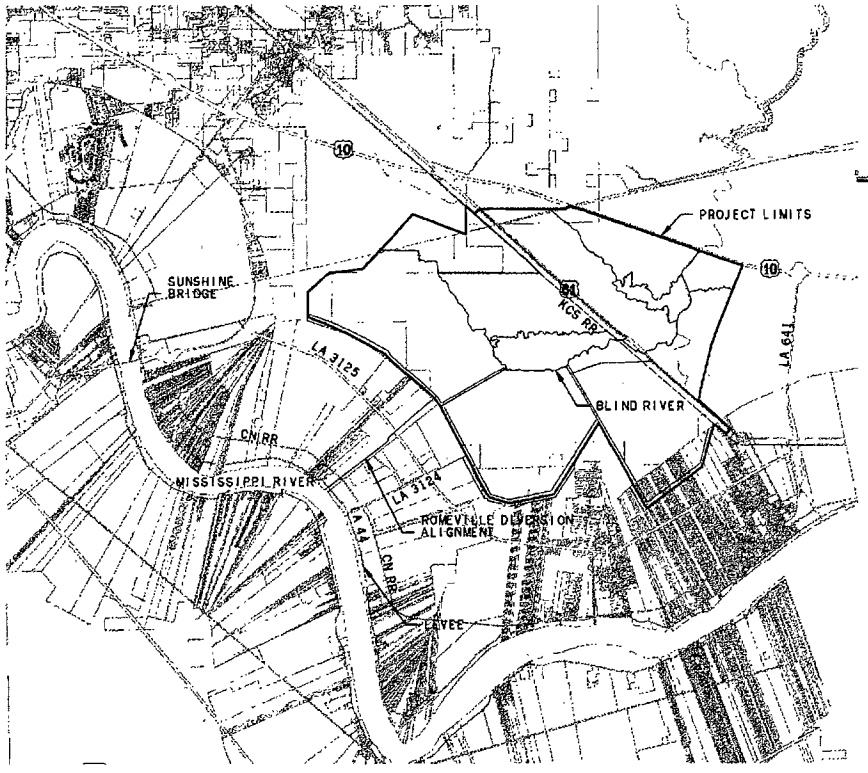

Elevation
MATCHLINE "A"
MATCHLINE "B"
MATCH LINE SEE SHEET FD-005
MATCH LINE SEE SHEET FD-007



US Army Corps
of Engineers®
New Orleans District

BLIND RIVER FRESHWATER DIVERSION
FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA

MARCH 2010



VICINITY MAP

INDEX

GENERAL SHEETS
G-1 COVER SHEET
G-2 VIVINITY MAP & INDEX
G-3 ROMEVILLE DIVERSION ALTERNATIVE

ROMEVILLEDIVERSION ALIGNMENT
C-1 ROMEVILLE DIVERSION ALIGNMENT
C-2 ROMEVILLE CULVERT PLAN AND PROFILE
C-3-5 ROMEVILLE TRANSMISSION CANAL PLAN AND PROFILE
C-6 LA 44 DETOUR SHEET

DIVERSION STRUCTURE DETAILS
C-7 CULVERT DETAILS SECTIONS AND ELEVATIONS
C-8 CULVERT DETAILS LEVEE RELOCATION

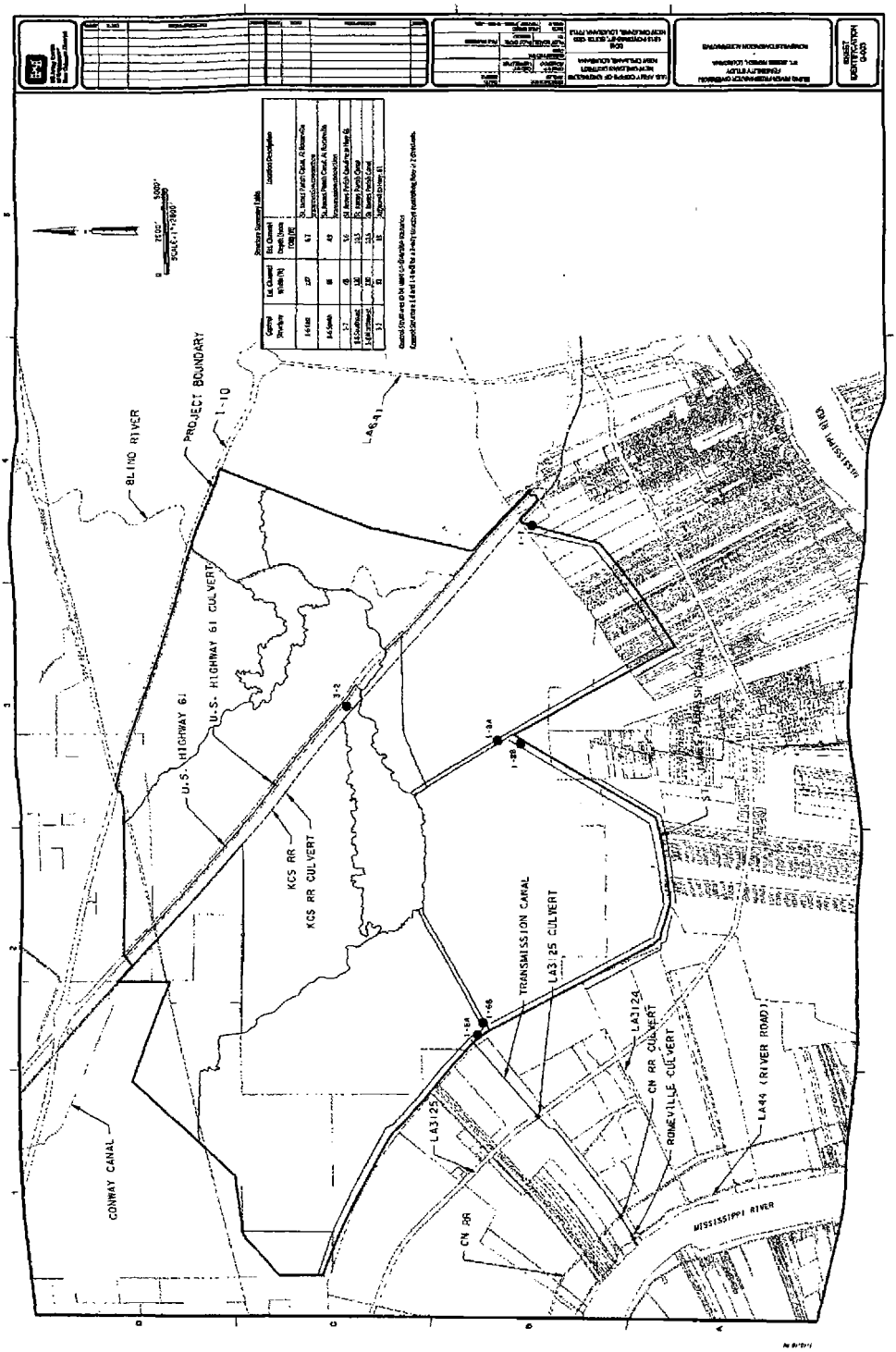
TRANSMISSION CANAL DETAILS
C-9 TYPICAL SECTIONS
C-10 CN R.R. CROSSING
C-11 CN R.R. DETOUR SHEET
C-12 LA 3125 CROSSING
C-13 LA 3125 DETOUR SHEET

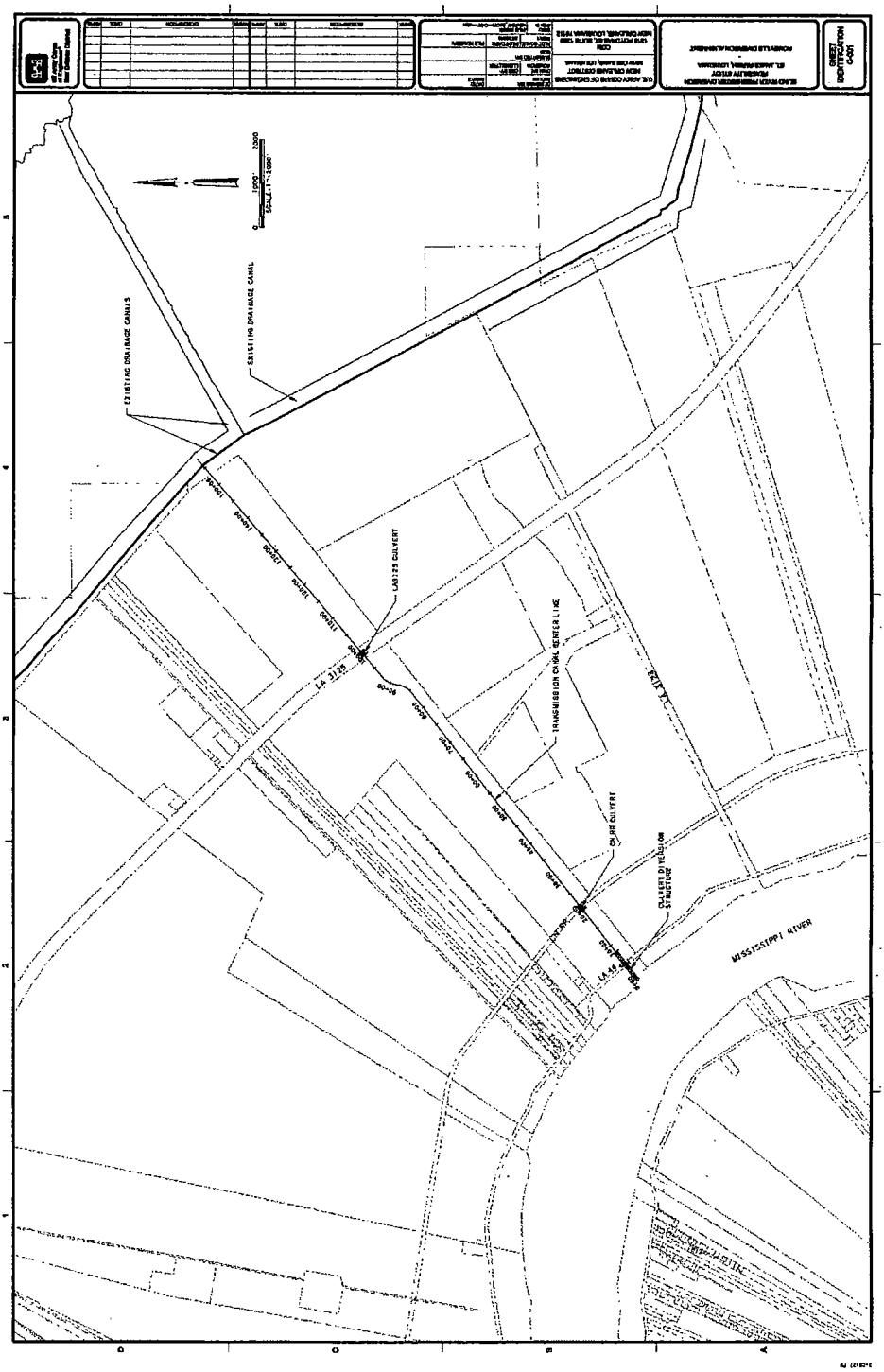
C-14 WATER MANAGEMENT IN SWAMP
C-15 CONTROL STRUCTURE PLAN AND DETAILS
C-16 BERM CUTS LAYOUT
C-17-31 BERM CUT PLAN SHEET
C-32 CULVERT CROSSING LOCATION
C-33 KCS R.R. & HIGHWAY 61 CROSSING

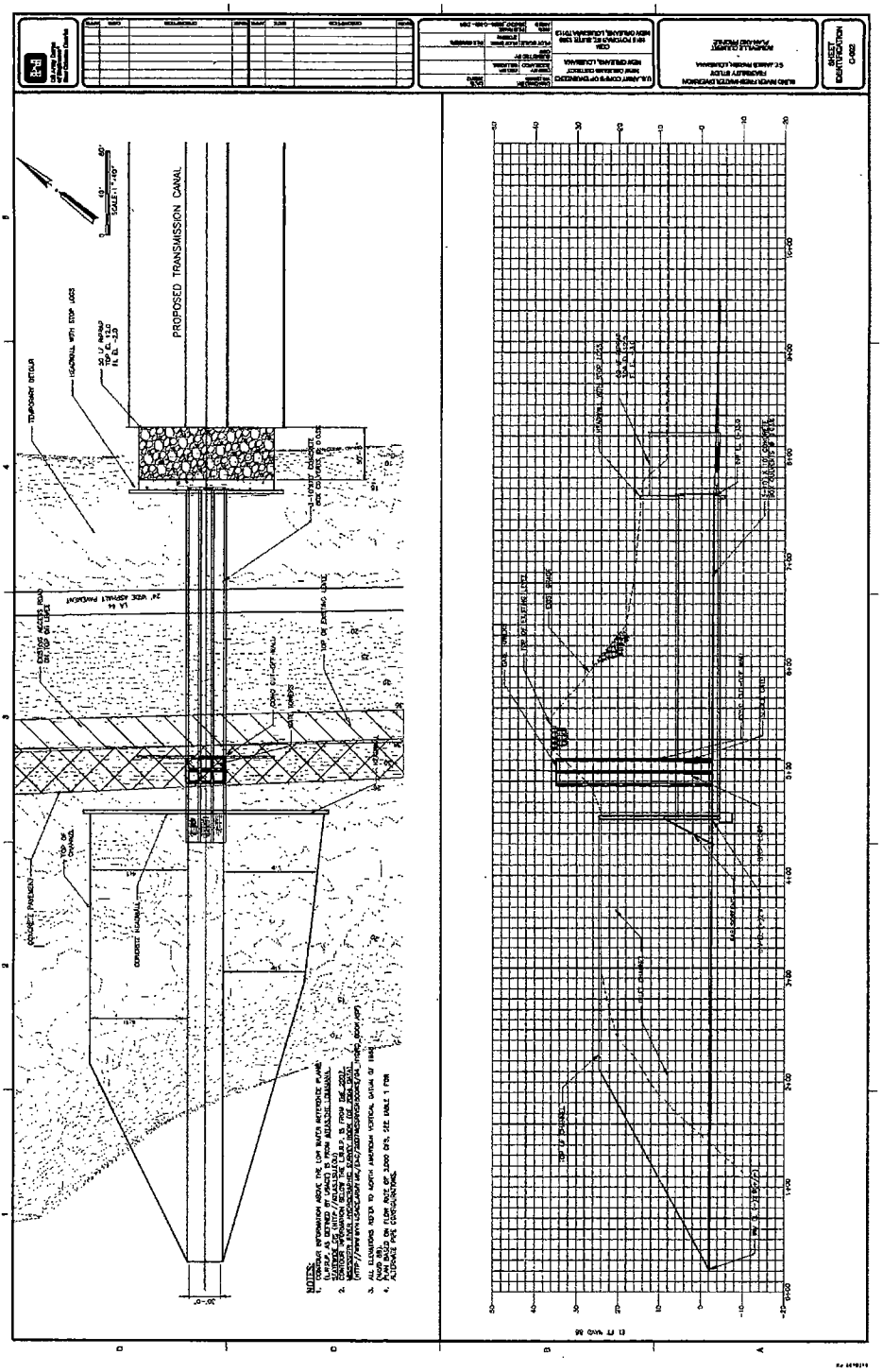
INSTRUMENTATION & CONTROLS
I-31 PROCESS & INSTRUMENTATION DIAGRAM SWAMP CONTROL STRUCTURE
I-32 PROCESS & INSTRUMENTATION DIAGRAM ROMEVILLE DIVERSION CULVERT PANEL DETAILS

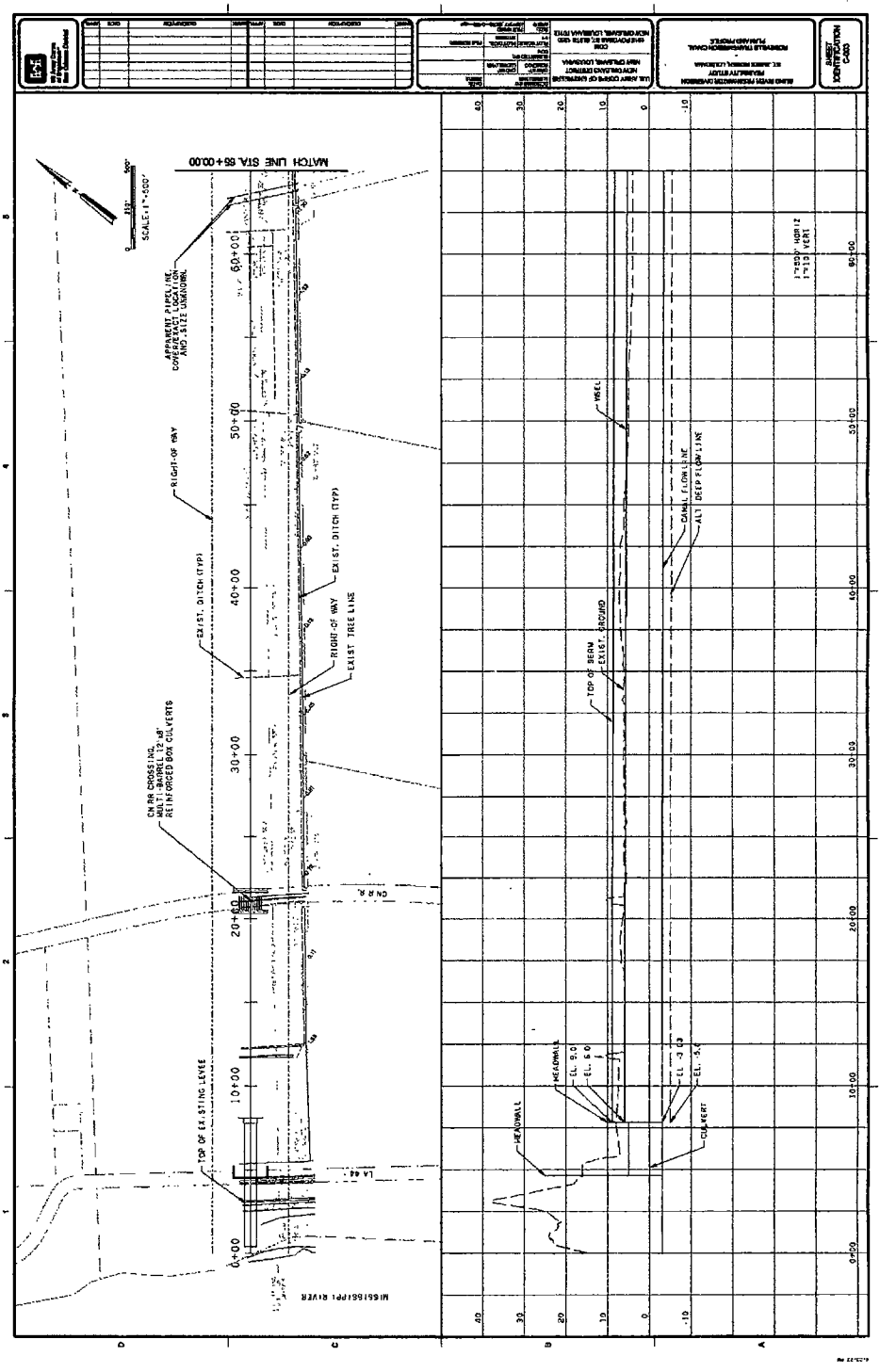
SHEET IDENTIFICATION G-002

1652


PROJECT BOUNDARY
I-10
BLIND RIVER
U.S. HIGHWAY 61
U.S. HIGHWAY 61 CULVERT
KCS RR
KCS RR CULVERT
CONWAY CANAL
TRANSMISSION CANAL
LA3125 CULVERT
LA3125
LA3124
CN RR CULVERT
ROMEVILLE CULVERT
LA44 (RIVER ROAD)
MISSISSIPPI RIVER
CN RR
LA44
I-1
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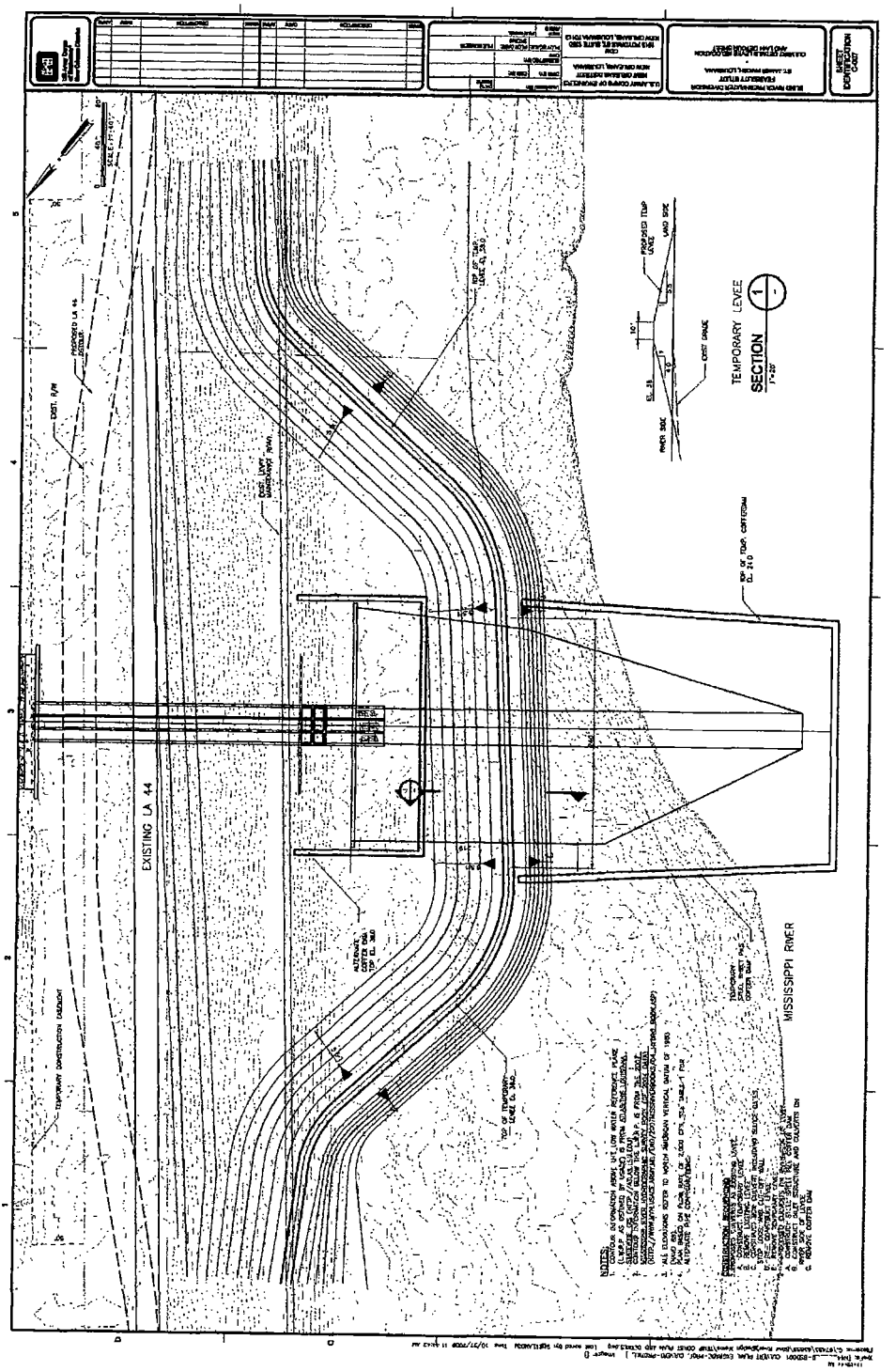

EXISTING DRAINAGE CANALS
EXISTING DRAINAGE CANAL
LA 3125
LA3125 CULVERT
TRANSMISSION CANAL CENTER LINE
LA 15
LA 46
MISSISSIPPI RIVER

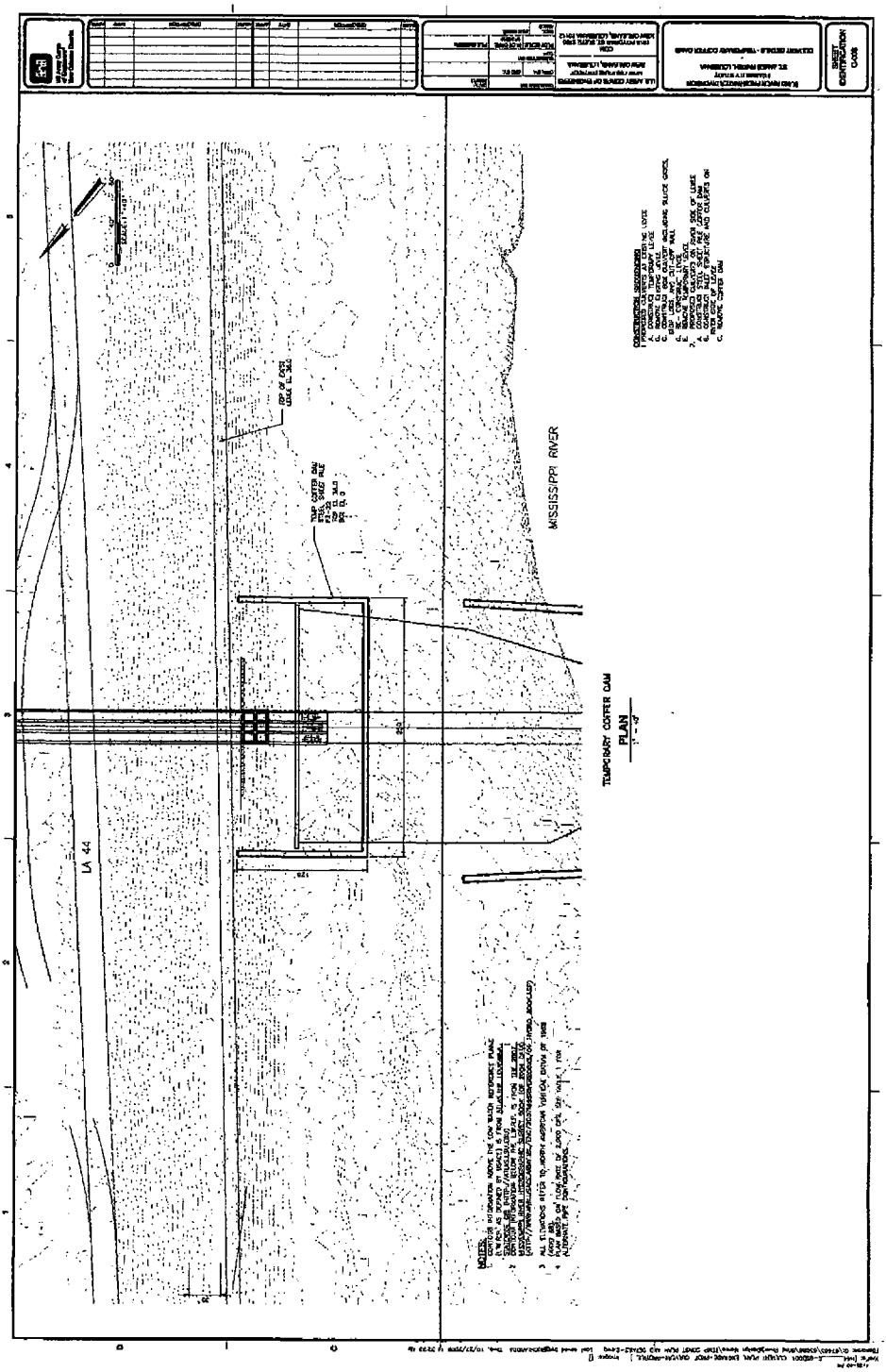

PROPOSED TRANSMISSION CANAL
TEMPORARY BERM
ISOLATION WITH STOP LOGS
24" VCP INFLOW
EL 6.0
EL 4.33
24" VCP OUTFLOW
EL 6.0
EL 4.33
CONCRETE ACCESS ROAD
TOP OF BANK
CONCRETE HEADWALL
TOP OF CHANNEL
CONCRETE PAVEMENT
TOP OF EXISTING LEVEE
TOP OF EXISTING LEVEE
EXISTING TERRAIN
EXISTING TERRAIN
EXISTING TERRAIN

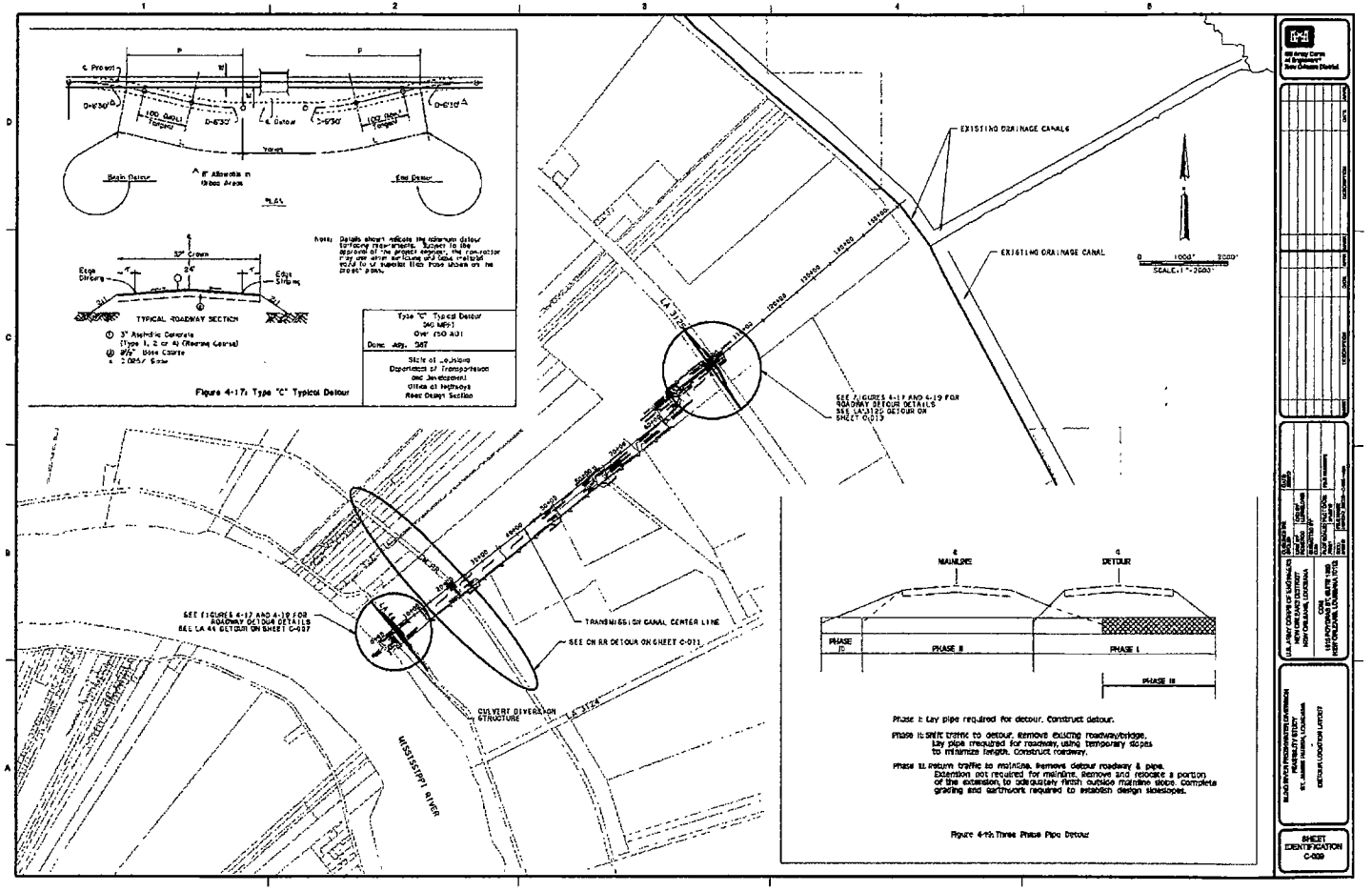

MATCH LINE STA. 55+00.00
APPARENT PIPELINE CONFIGURATION LOCATION AND SIZE UNKNOWN
RIGHT-OF-WAY
EXIST. DITCH (TYP.)
EXIST. DITCH (TYP.)
RIGHT-OF-WAY
EXIST. TREE LINE
CN RR CROSSING, MULTI-BARREL 12'x8' REINFORCED BOX CULVERTS
CN R.R.
TOP OF EXISTING LEVEE
MISSISSIPPI RIVER
WELL
CANAL FLOW LINE
ALT DEEP FLOW LINE
TOP OF BERM
EXIST. GROUND
HEADWALL
HEADWALL
CULVERT
EL. 9.0
EL. 6.0
EL. -3.0
EL. -5.0
1"=50' HORIZ
1"=10' VERT

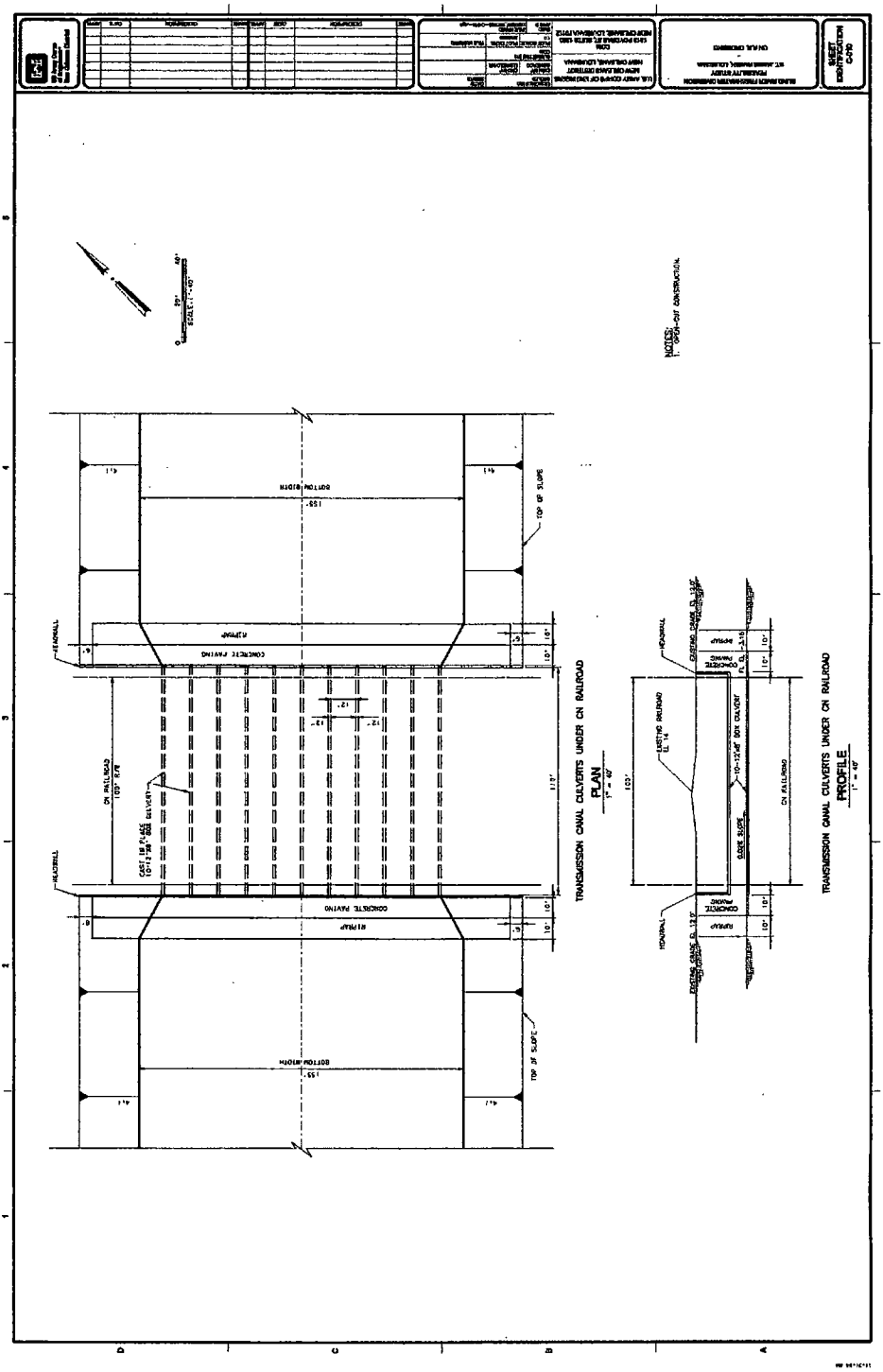
MATCH LINE STA. 65+00.00
70+00
80+00
APPARENT PIPELINE, COVER, EXACT LOCATION AND SITE UNKNOWN
EXIST. TREE LINE
EXIST. DITCH (TYP)
GRAVEL/DIRT ROAD
RIGHT-OF-WAY
LA 3125
LA 3125 CROSSING, MULTI-BARREL 12'-0" REINFORCED BOX CULVERTS
110+00
120+00
130
SCALE: 1"=50'-0"
MATCH LINE STA. 130+00.00
TOP OF BLDG
EXIST. GROUND
CANAL FLOW LINE
ALT DEEP FLOW LINE
70+00
80+00
90+00
100+00
110+00
120+00
130+00
BLIND RIVER FRESHWATER DIVERSION FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA
ROMEVILLE TRANSMISSION CANAL PLAN AND PROFILE
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
SHEET IDENTIFICATION NO.

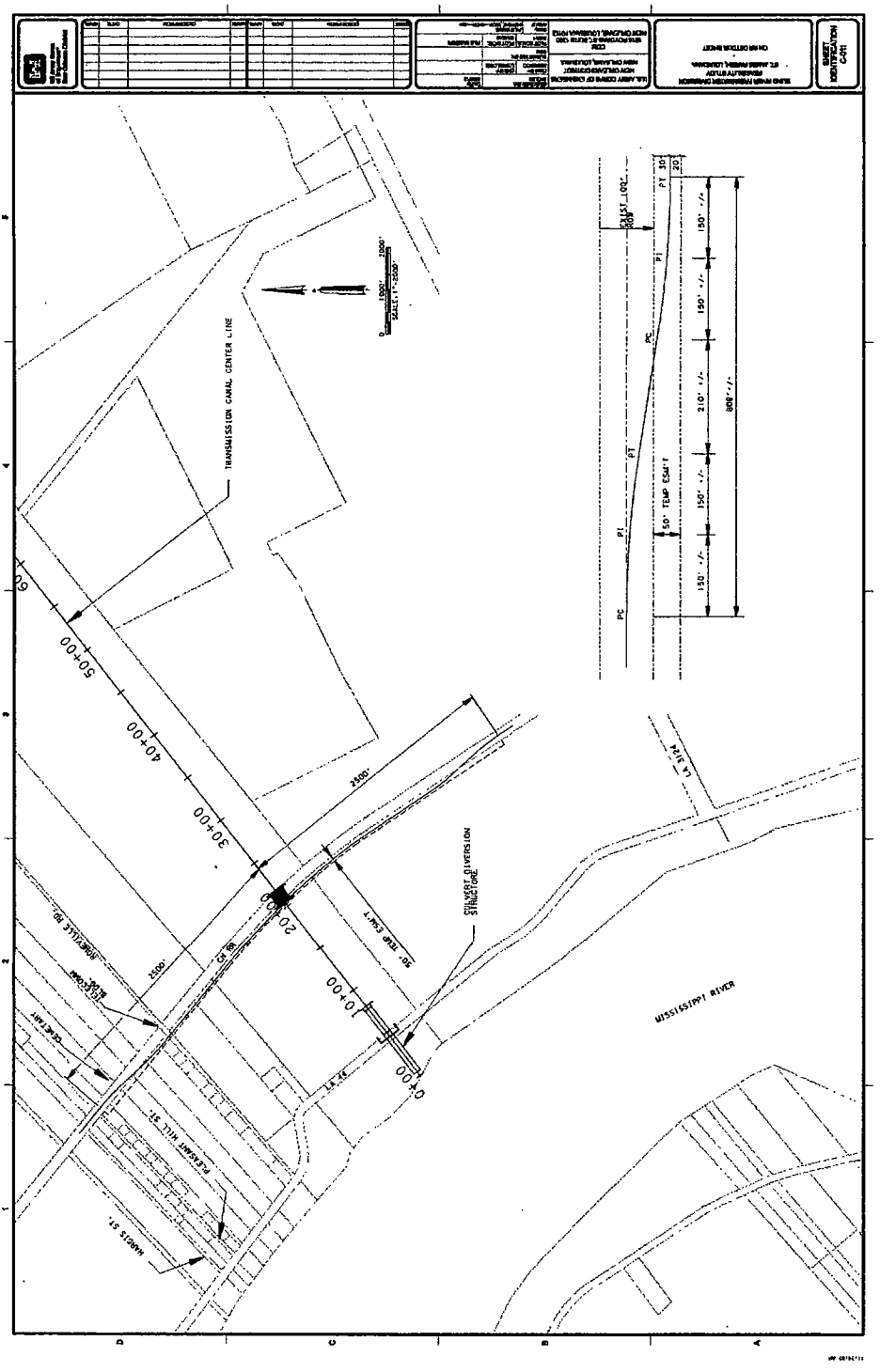
MATCH LINE STA. 130+00.00
130+00
140+00
150+00
RIGHT-OF-WAY
RIGHT-OF-WAY
CENTER OF EXISTING DRAINAGE CANAL
R.C.B.M.
EXIST. GROUND
TOP OF BERM
CANAL FLOW LINE
ALT. GRED FLOW LINE
EL. 1.0
EL. 1.0
EL. -4.5
EL. -6.5
SCALE: 1"=500'
500'
0
500'
1000'
A
B
C
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1300+00
1400+00
1500+00
BUREAU OF RECLAMATION
C-005
BUREAU OF RECLAMATION
LOWER MISSISSIPPI REGION
MEMPHIS, TENNESSEE
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
MISSISSIPPI RIVER DIVERSION CANAL
FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA
MORGANZA TO AMERICA CANAL
PLAN AND PROFILE
CDM
1414 ROYAL ST., SUITE 1200
NEW ORLEANS, LOUISIANA 70112
DESIGNED
DRAWN
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APPROVED

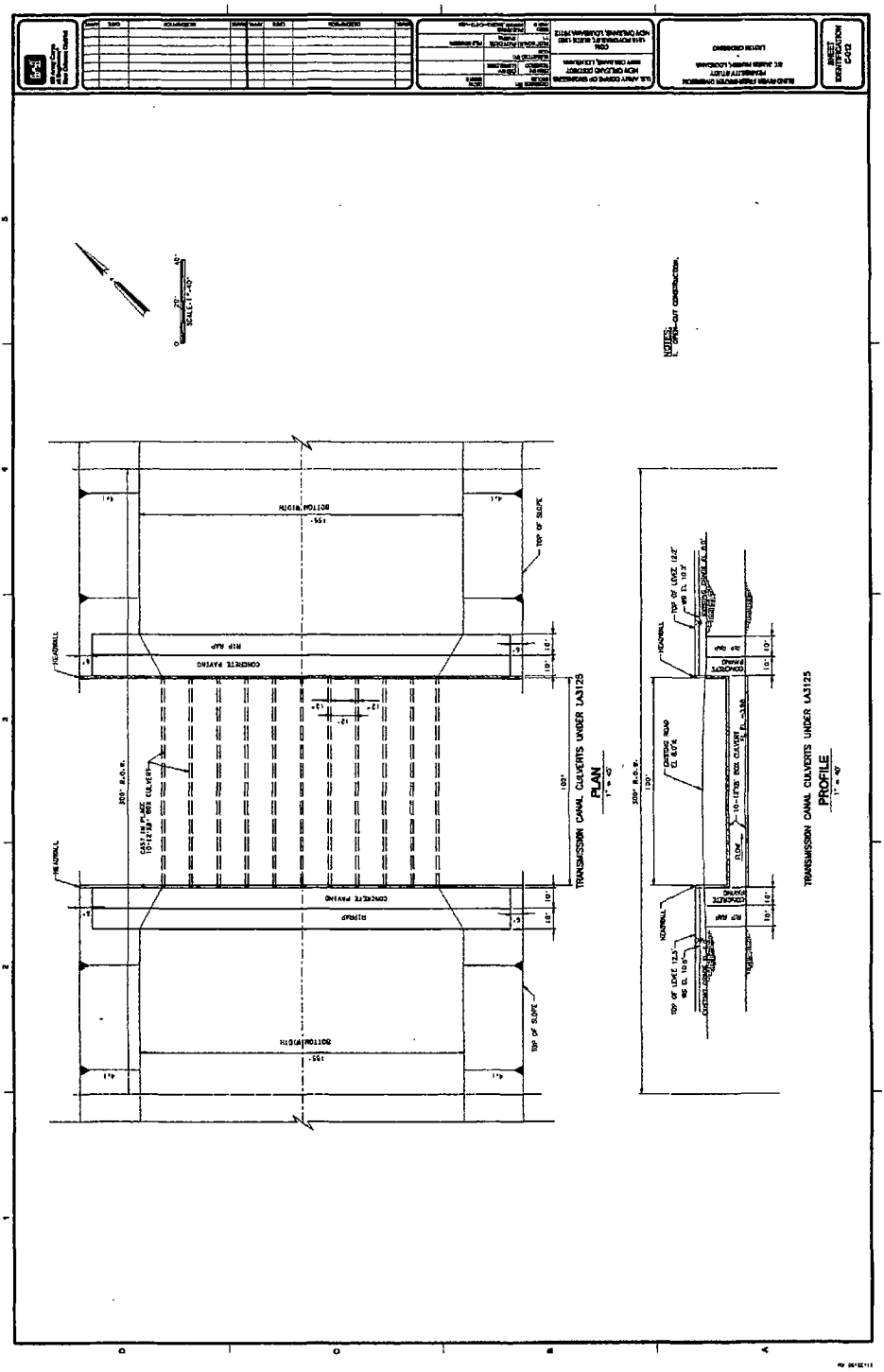

EXISTING LA 44
MISSISSIPPI RIVER
TEMPORARY LEVEE
SECTION
TEMPORARY CONSTRUCTION EASEMENT
DIST. R/W
PROPOSED LA 44
TOP OF TEMPORARY LEVEE EL. 34.0
TOP OF TEMPORARY LEVEE EL. 34.0
TOP OF TEMPORARY LEVEE EL. 31.0
PROPOSED TEMP LEVEE
LAND SIDE
RIVER SIDE
DIST DRAIN
EL. 28
10'
3:1
3:1
2.5
1.0
1
1"=20'
NOTES:
1. CONTROL ELEVATION FROM 1ST LOW WATER REFERENCE PLANE
2. ALL ELEVATIONS REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988
3. ALL COORDINATES REFER TO NORTH AMERICAN DATUM OF 1983
4. ALL DIMENSIONS ARE IN FEET AND DECIMALS THEREOF UNLESS OTHERWISE NOTED.
5. FOR SITE PLAN, STRUCTURE AND CULVERTS SEE
6. REMOVE CENTER DAM
CONSTRUCTION SEQUENCE
REMOVE EXISTING LEVEE
REMOVE EXISTING STRUCTURES
REMOVE EXISTING CULVERTS
CONSTRUCT TEMPORARY LEVEE
CONSTRUCT TEMPORARY ACCESS ROAD
CONSTRUCT TEMPORARY CULVERTS
CONSTRUCT TEMPORARY GATES
CONSTRUCT TEMPORARY PUMP STATION
CONSTRUCT TEMPORARY DRAINAGE DITCHES
CONSTRUCT TEMPORARY SILT FENCE
CONSTRUCT TEMPORARY SEDIMENT BASIN
CONSTRUCT TEMPORARY SEDIMENT TRAP
CONSTRUCT TEMPORARY SEDIMENT DAM
CONSTRUCT TEMPORARY SEDIMENT DAM
CONSTRUCT TEMPORARY SEDIMENT DAM

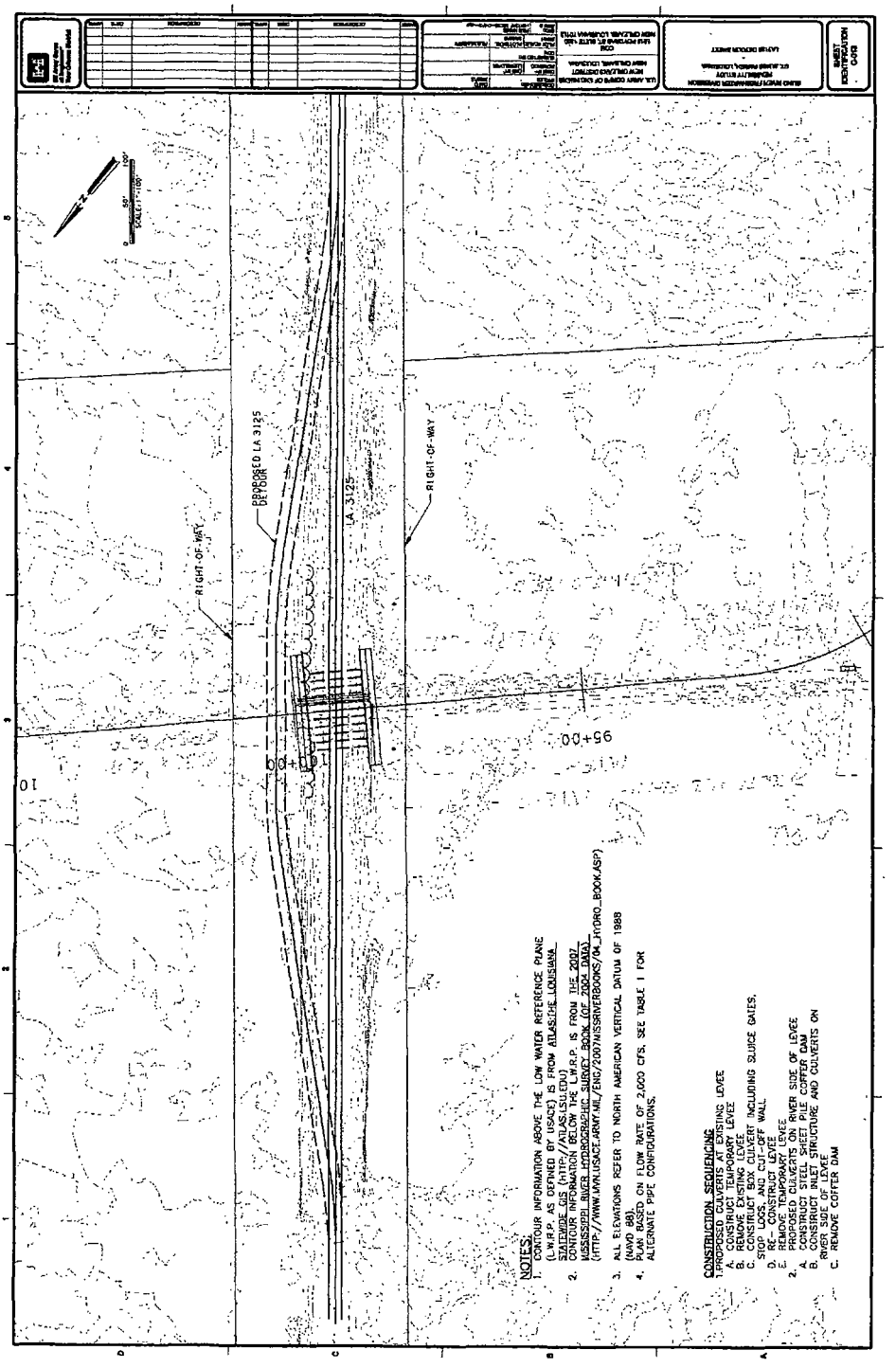

MISSISSIPPI RIVER
LA 44
TEMPORARY COFFER DAM
PLAN
1" = 40'

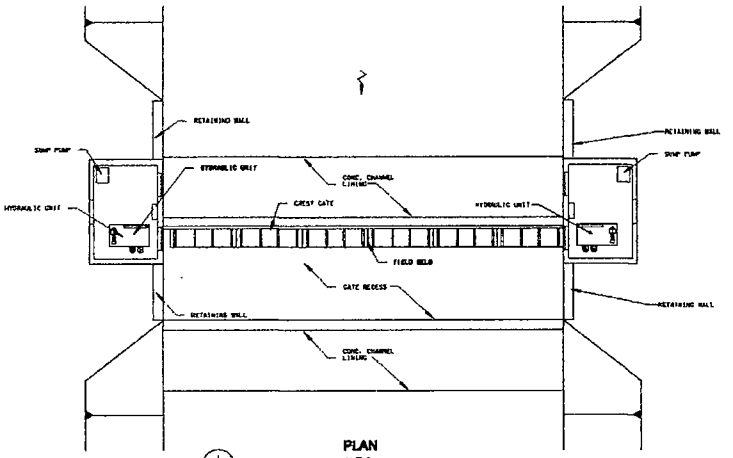

EXISTING DRAINAGE CANAL
EXISTING DRAINAGE CANAL
SCALE: 1" = 2000'
SEE FIGURES 4-17 AND 4-19 FOR ROADWAY DETOUR DETAILS SEE LA 3125 DETOUR ON SHEET C-009
SEE FIGURES 4-17 AND 4-19 FOR ROADWAY DETOUR DETAILS SEE LA 44 DETOUR ON SHEET C-007
TRANSMISSION CANAL CENTER LINE
SEE ON RR DETOUR ON SHEET C-011
CULVERT DIVERSION STRUCTURE
LA 3124
MISSISSIPPI RIVER
MAINLINE
DETOUR
PHASE I
PHASE II
PHASE III
Phase I: Lay pipe required for detour. Construct detour.
Phase II: Shift traffic to detour. Remove existing roadway/bridge. Lay pipe required for roadway, using temporary slopes to minimize length. Construct roadway.
Phase III: Return traffic to mainline. Remove detour roadway & pipe. Excavation not required for mainline. Remove and relocate a portion of the excavation to adequately finish outside mainline slope. Complete grading and earthwork required to establish design slopesides.
Figure 4-19: Three Phase Pipe Detour
Figure 4-17: Type "C" Typical Detour
TYPICAL ROADWAY SECTION
Type "C" Typical Detour
SAG MP91
Over ISO AD1
Done: July, 1987
State of Louisiana
Department of Transportation and Development
Office of Highways
Area Design Section
Note: Details shown indicate the minimum detour surfacing requirements. Subject to the approval of the project engineer, the contractor may use other surfacing and base materials equal to or superior than those shown on the project plans.
SHEET IDENTIFICATION C-009

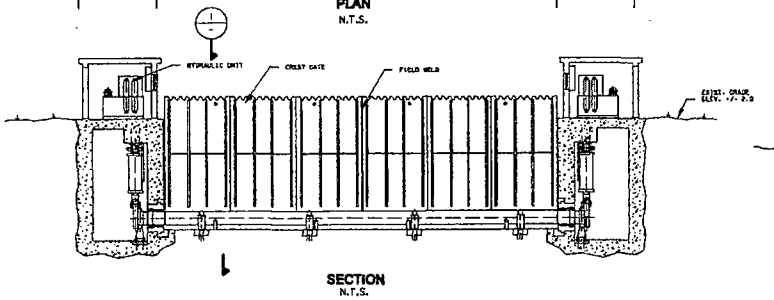

NOTES:
1. OPEN-CUT CONSTRUCTION
TRANSMISSION CANAL CULVERTS UNDER CN RAILROAD
PLAN
1" = 40'
TRANSMISSION CANAL CULVERTS UNDER CN RAILROAD
PROFILE
1" = 40'
CN RAILROAD
HEADWALL
RIPRAP
CONCRETE PAVING
BOTTOM WIDTH
TOP OF SLOPE
EXISTING GRADE EL 113.0
EXISTING RAILROAD EL 114
10'-12'x8' BOX CULVERT
SIDE SLOPE


TRANSMISSION CANAL CENTER LINE
50+00
40+00
30+00
20+00
10+00
0+00
2500'
50' TEMP ESMT
STILWELL DIVERSION STRUCTURE
MISSISSIPPI RIVER
PC
PI
PT
50' TEMP ESMT
150' +/-
210' +/-
1,808' +/-


PLAN
1" = 40'
PROFILE
1" = 40'
TRANSMISSION CANAL CULVERTS UNDER LA3125
NOTES:
1. OPEN-CUT CONSTRUCTION.
CONCRETE PAVING
RIP RAP
HEADWALL
BOTTOM WIDTH
100' OF SLOPE
100' R.O.W.
CANTOR ROAD
EL. 6.0'±
10'-10'X8' BOX CULVERT
TOP OF LEVEE 12.5'
EL. 10.5'


RIGHT-OF-WAY
PROPOSED LA 3125 REMOVAL
LA 3125
RIGHT-OF-WAY
95+00
NOTES:
1. CONTOUR INFORMATION ABOVE THE LOW WATER REFERENCE PLANE (L.W.R.P. AS DEFINED BY USACE) IS FROM ATLAS:THE LOUISIANA STATEWIDE GIS (HTTP://ATLAS.LSU.EDU)
2. CONTOUR INFORMATION BELOW THE L.W.R.P. IS FROM THE 2007 MISSISSIPPI RIVER HYDROGRAPHIC PROGRAM - 2007 DATA (HTTP://WWW.MVK.USACE.ARMY.MIL/ENG/2007MISSRIVERBOOKS/04_HYDRO_BOOK.ASP)
3. ALL ELEVATIONS REFER TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
4. PLAN BASED ON FLOW RATE OF 2,000 CFS. SEE TABLE 1 FOR ALTERNATE PIPE CONFIGURATIONS.
CONSTRUCTION SEQUENCING
1.PROPOSED CULVERTS AT EXISTING LEVEE
A. CONSTRUCT TEMPORARY LEVEE
B. REMOVE EXISTING LEVEE
C. CONSTRUCT BOX CULVERT INCLUDING SLUICE GATES, STOP LOGS, AND CUT-OFF WALL
D. RE-CONSTRUCT LEVEE
E. REMOVE TEMPORARY LEVEE
2. PROPOSED CULVERTS ON RIVER SIDE OF LEVEE
A. CONSTRUCT STEEL SHEET PILE COFFER DAM
B. CONSTRUCT INLET STRUCTURE AND CULVERTS ON PROTECTED SIDE OF LEVEE
C. REMOVE COFFER DAM





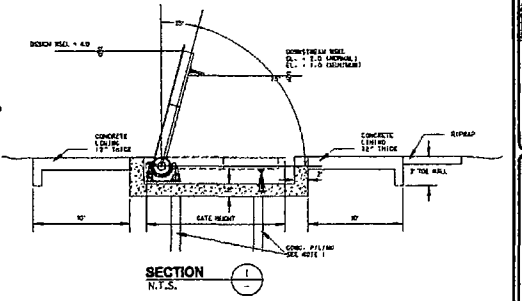
NOTES:

1. PILING SIZING, SPACING AND DEPTH SHALL BE DETERMINED FROM GEOTECHNICAL DATA.
2. CONTROL BUILDING: (NOT SHOWN) PRE-FAB CONCRETE STRUCTURE 10'X20' (PLAN) ELEVATED ON CONCRETE PILINGS PILING-4-14" SQUARE, EACH 35' LONG

Structure Summary Table

Control Structure	Est. Channel Width (ft)	Est. Channel Depth (from TOB) (ft)	Location Description
1-3	164	6.6	St. James Parish Canal
1-3 East	142	6.7	St. James Parish Canal, At Romeville transaction connection
1-3 South	155	4.8	St. James Parish Canal, At Romeville transaction connection
1 & 1 North	85	4.7	St. James Parish Canal, At Romeville transaction connection
1-7	65	5.5	St. James Parish Canal (near Hwy 61
1-8 Southwest	330	8.1	St. James Parish Canal
1-8 Southeast	330	10.5	St. James Parish Canal
1-8 Northwest	330	10.5	St. James Parish Canal
2-6	65	0	Adjacent to Hwy 61
3-1	253	12.3	Bayway Canal

Control Structures to be used on diversion scenarios.
Control Structure 1-6 and 1-8 will be a 3-way structure controlling flow in 3 directions.



U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA

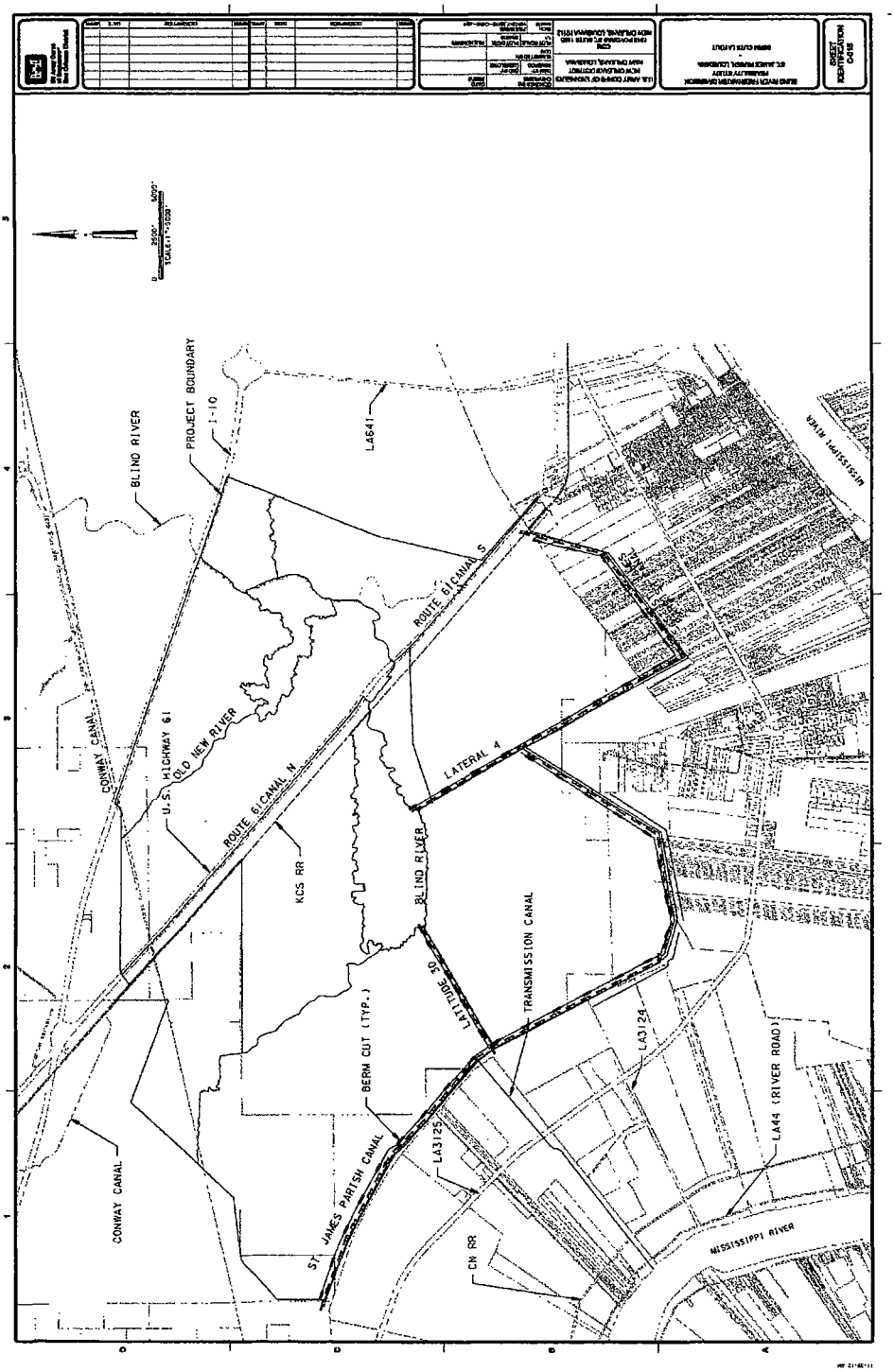
CCSE GATE SIZE
NEW ORLEANS, LOUISIANA 70118

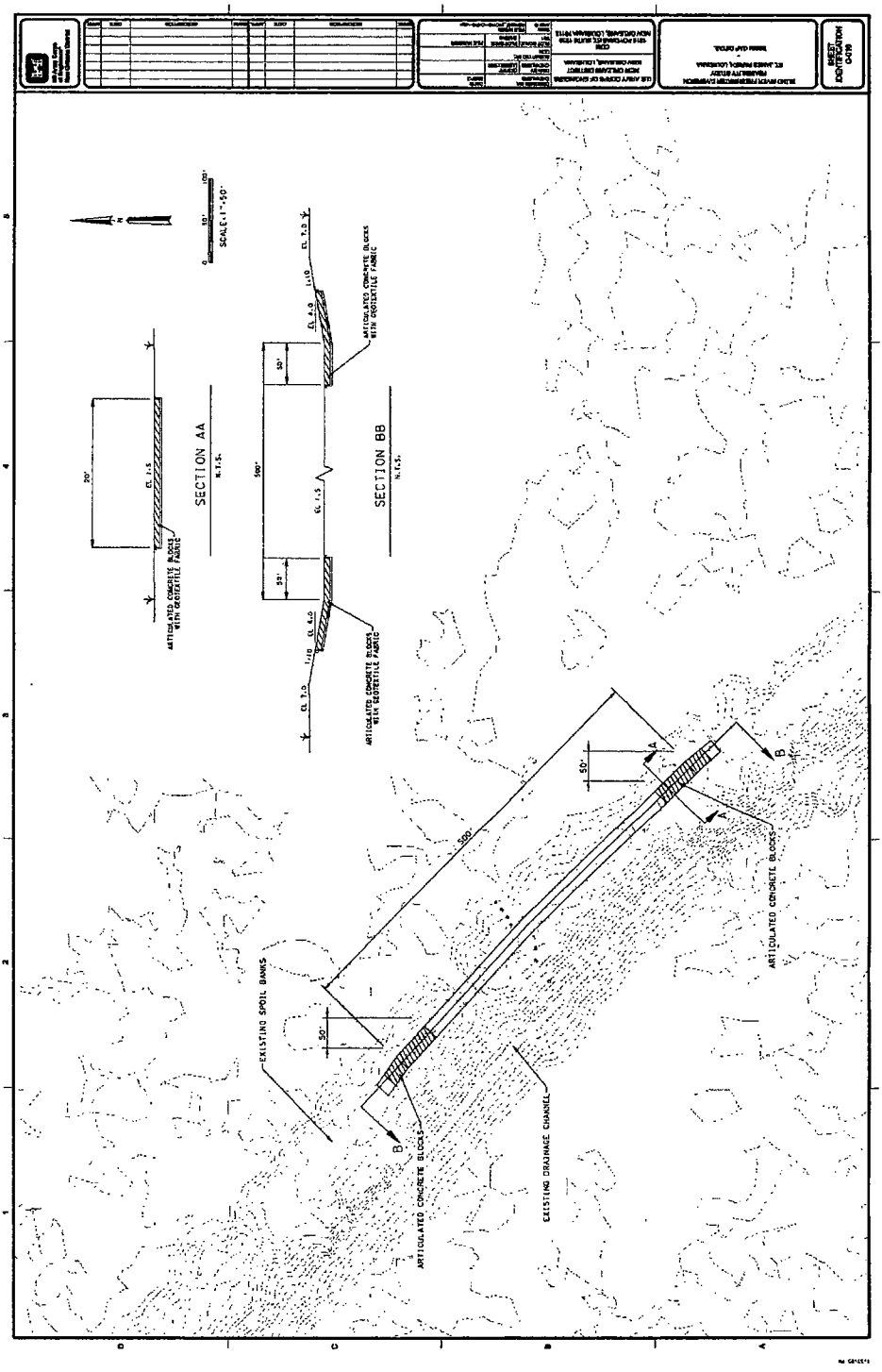
BAND PASS PROTECTION EXPANSION
FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA

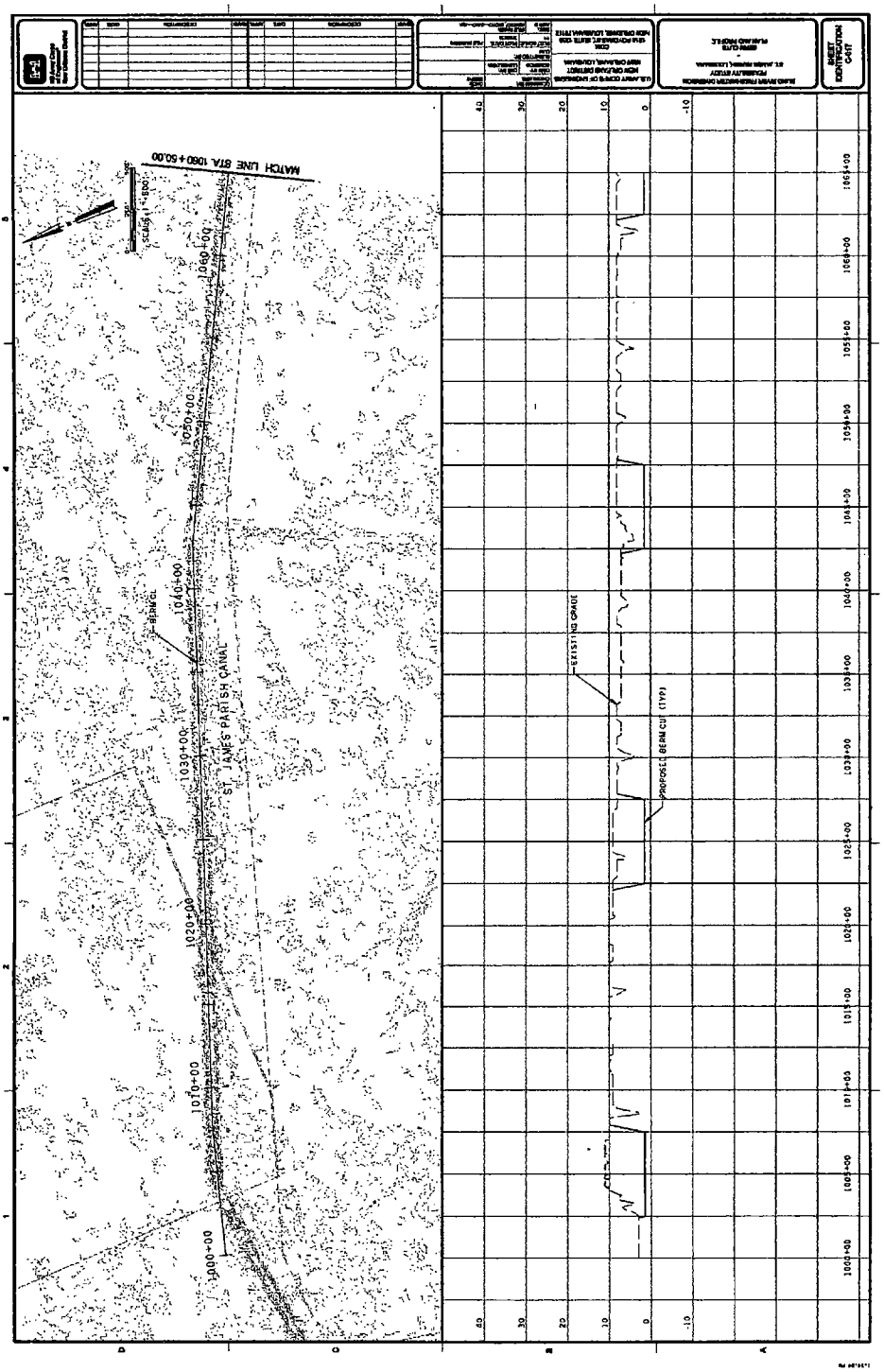
CONTROL STRUCTURE PLAN & SECTIONS

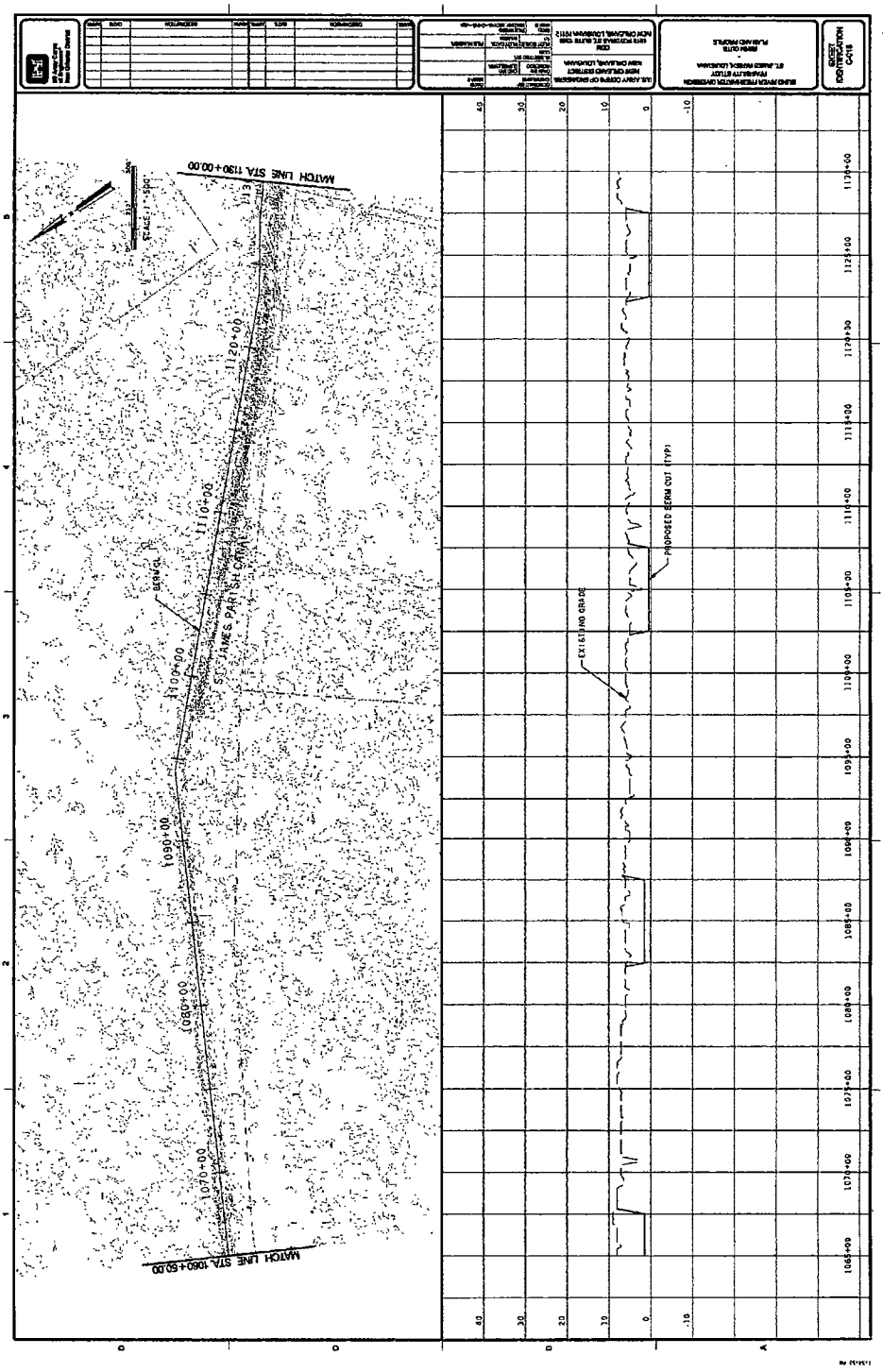
SHEET IDENTIFICATION
C-014

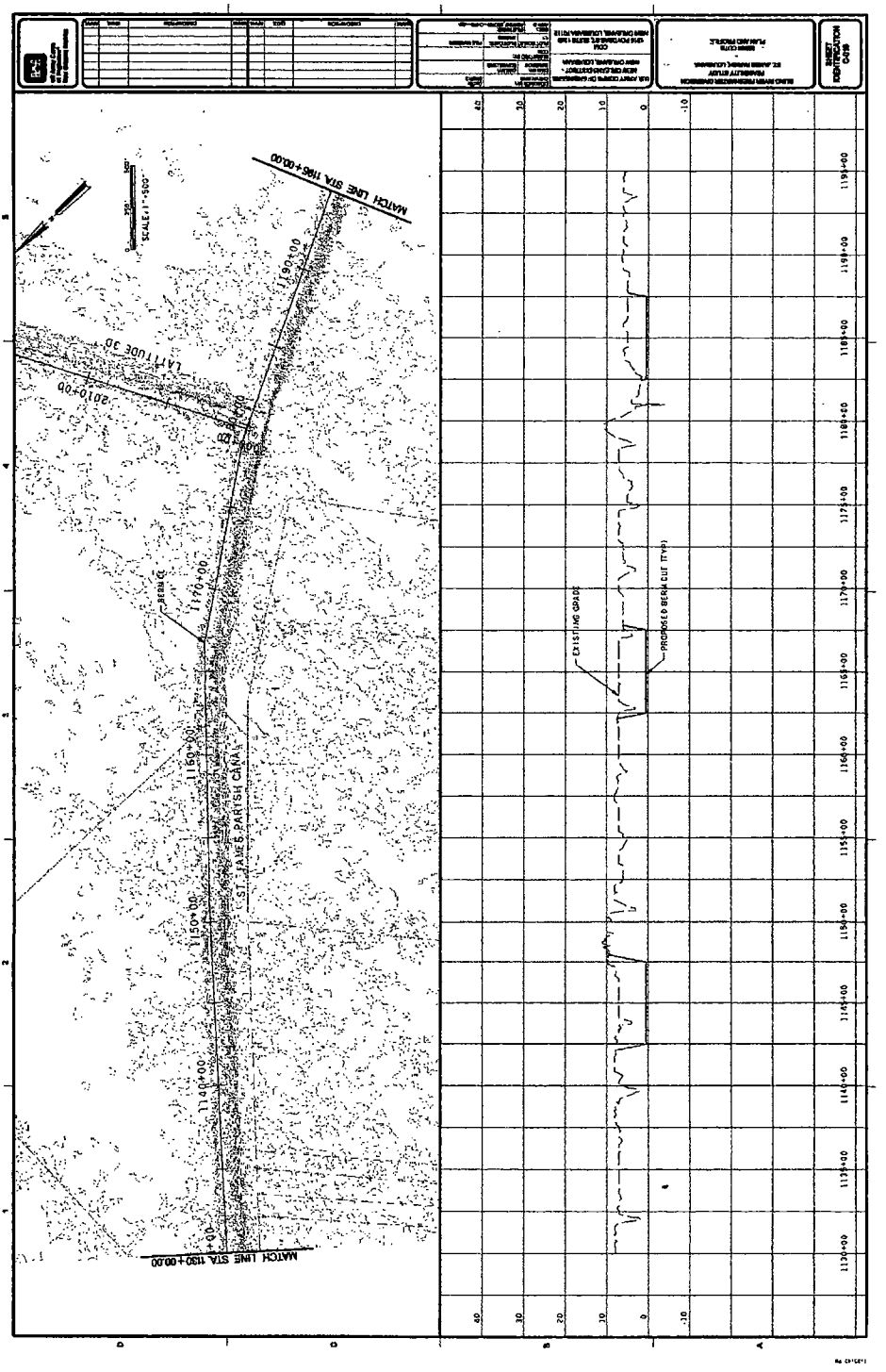
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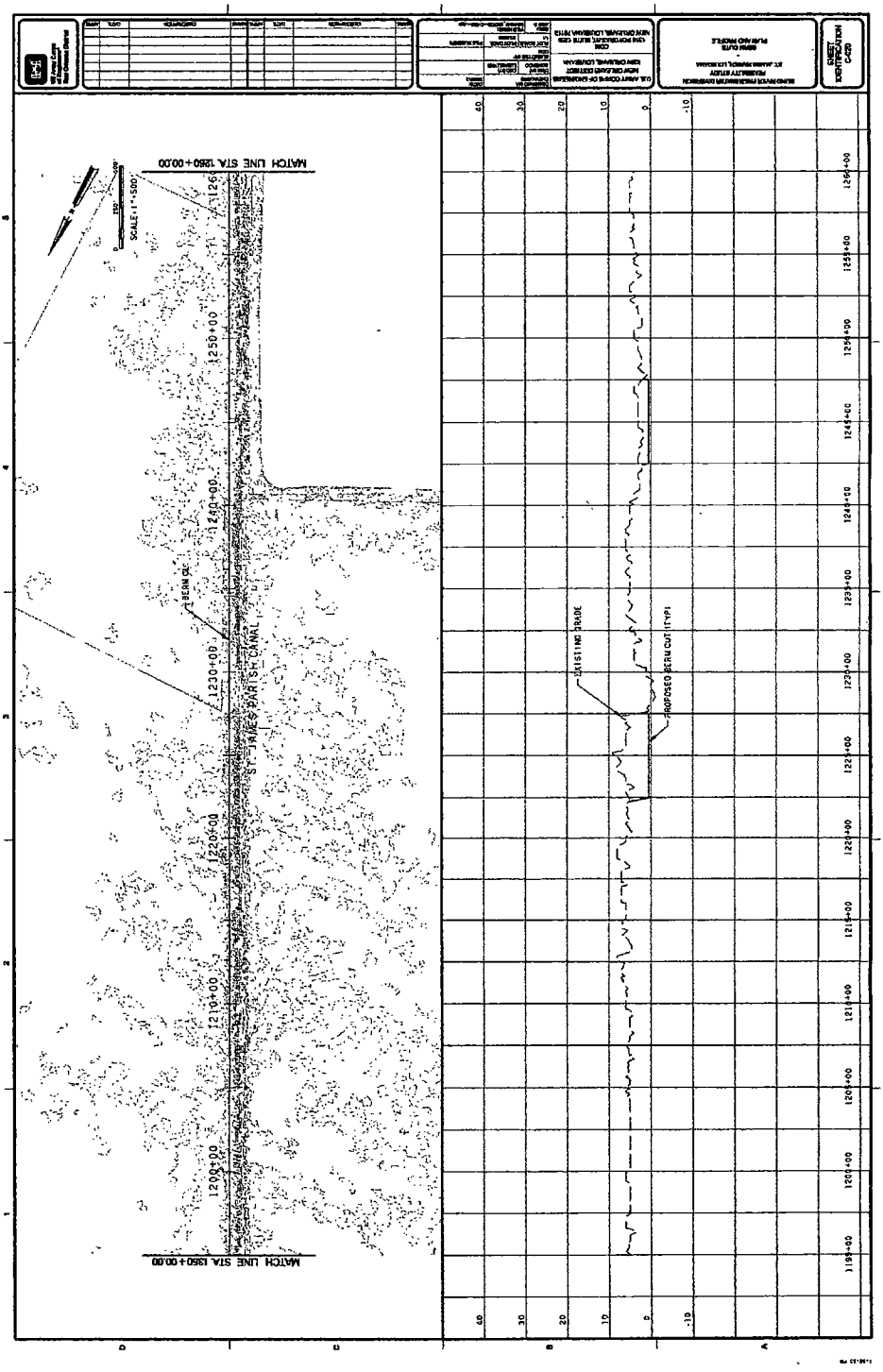

BLIND RIVER
PROJECT BOUNDARY
I-10
L4641
ROUTE 61 CANAL S
MISSISSIPPI RIVER
CONWAY CANAL
U.S. HIGHWAY 61
OLD NEW RIVER
ROUTE 61 CANAL N
LATERAL 4
KCS RR
BLIND RIVER
LAFFITTE SD
TRANSMISSION CANAL
LA3124
BERM CUT (TYP.)
ST. JAMES PARISH CANAL
LA3125
LA44 (RIVER ROAD)
CONWAY CANAL
CW RR
MISSISSIPPI RIVER

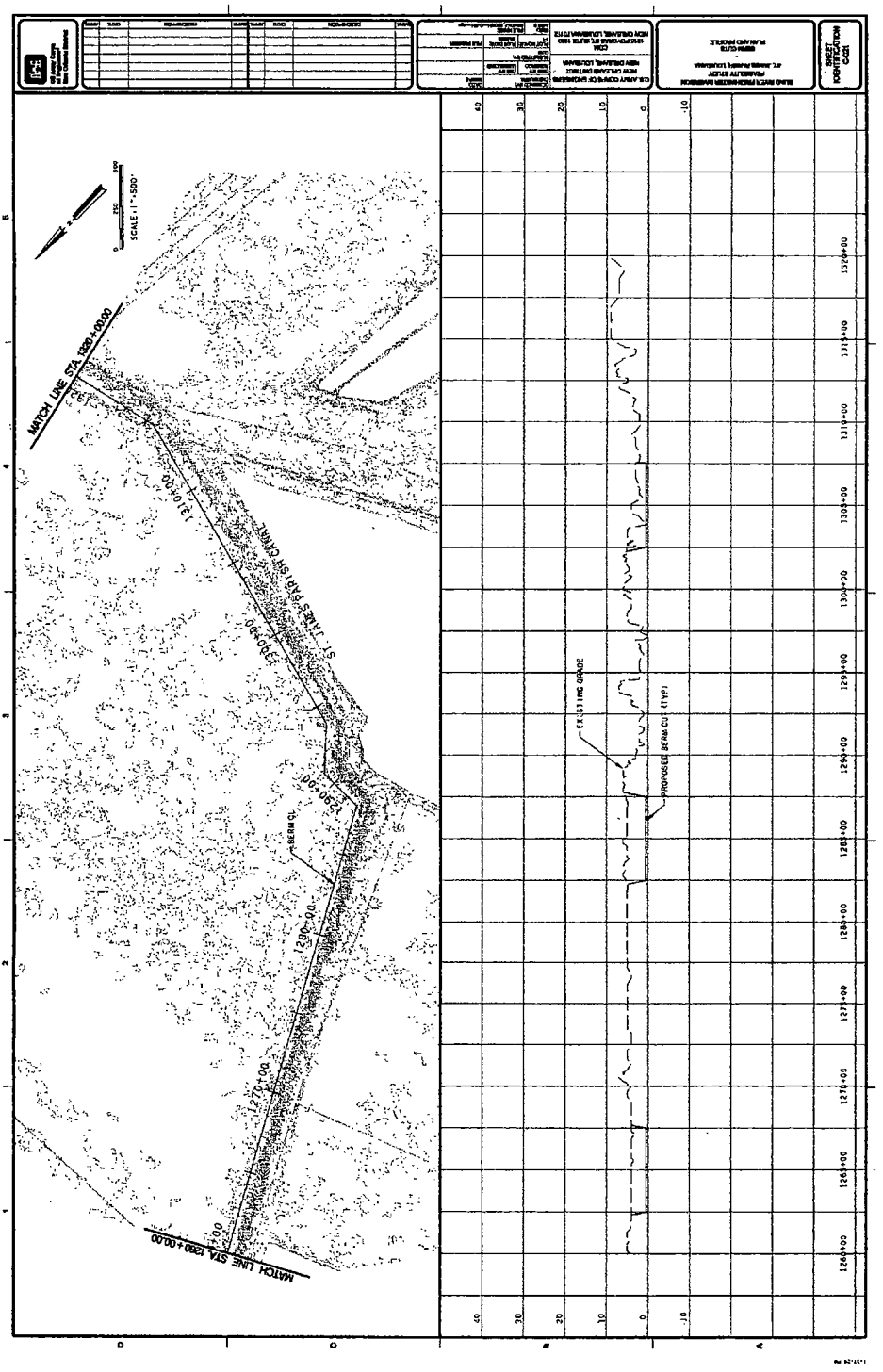

SECTION AA
SECTION BB
ARTICULATED CONCRETE BLOCKS WITH GEOTEXTILE FABRIC
EXISTING SPOIL BANKS
EXISTING DRAINAGE CHANNEL
ARTICULATED CONCRETE BLOCKS
500'
50'
70'
150'
50'
50'
SCALE: 1" = 50'

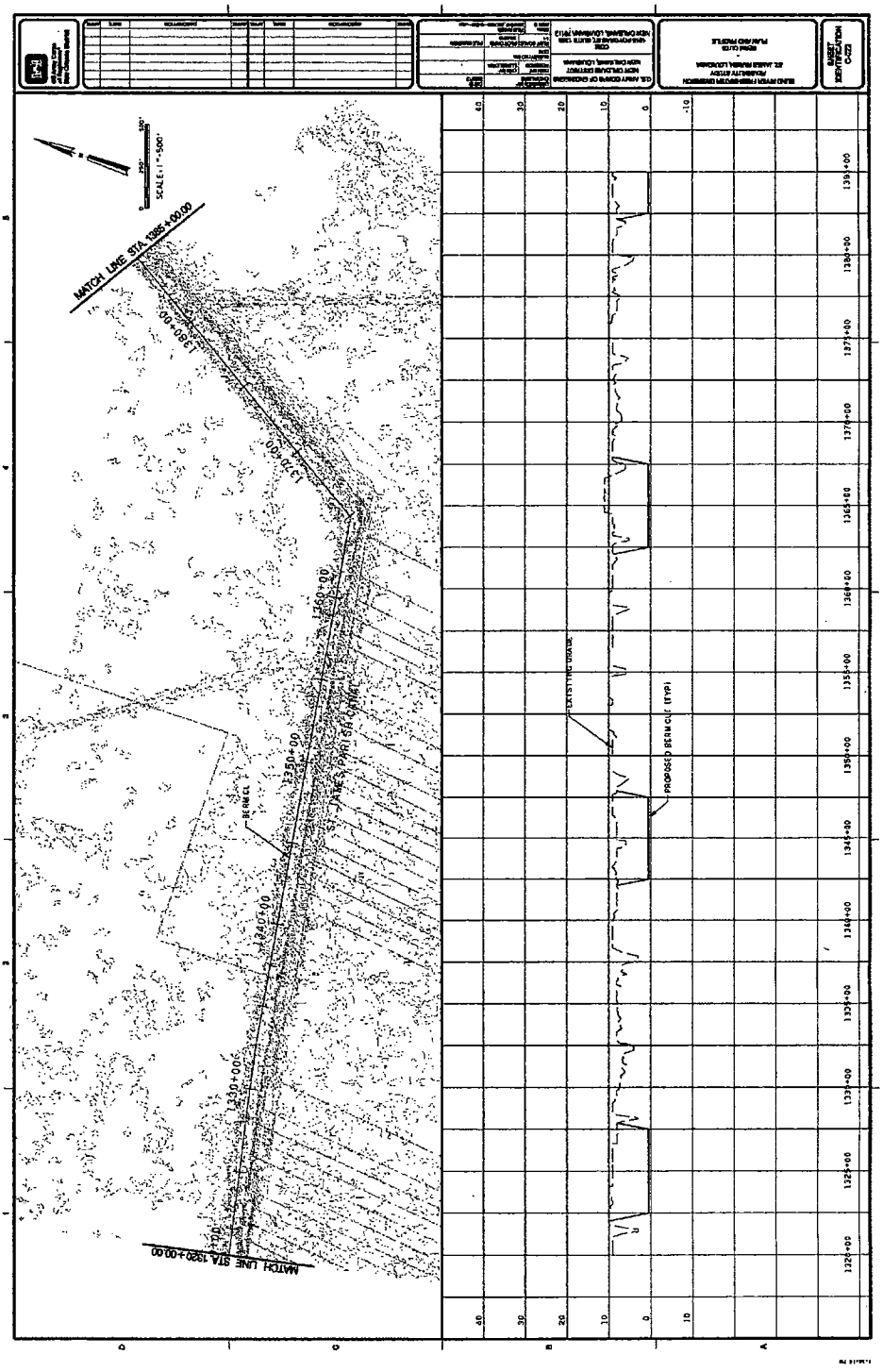

MATCH LINE STA 1060+50.00
ST. JAMES PARISH CANAL
EXISTING GRADE
PROPOSED BERM CUT (1V:2H)
1000+00
1010+00
1020+00
1030+00
1040+00
1050+00
1060+00
1069+00

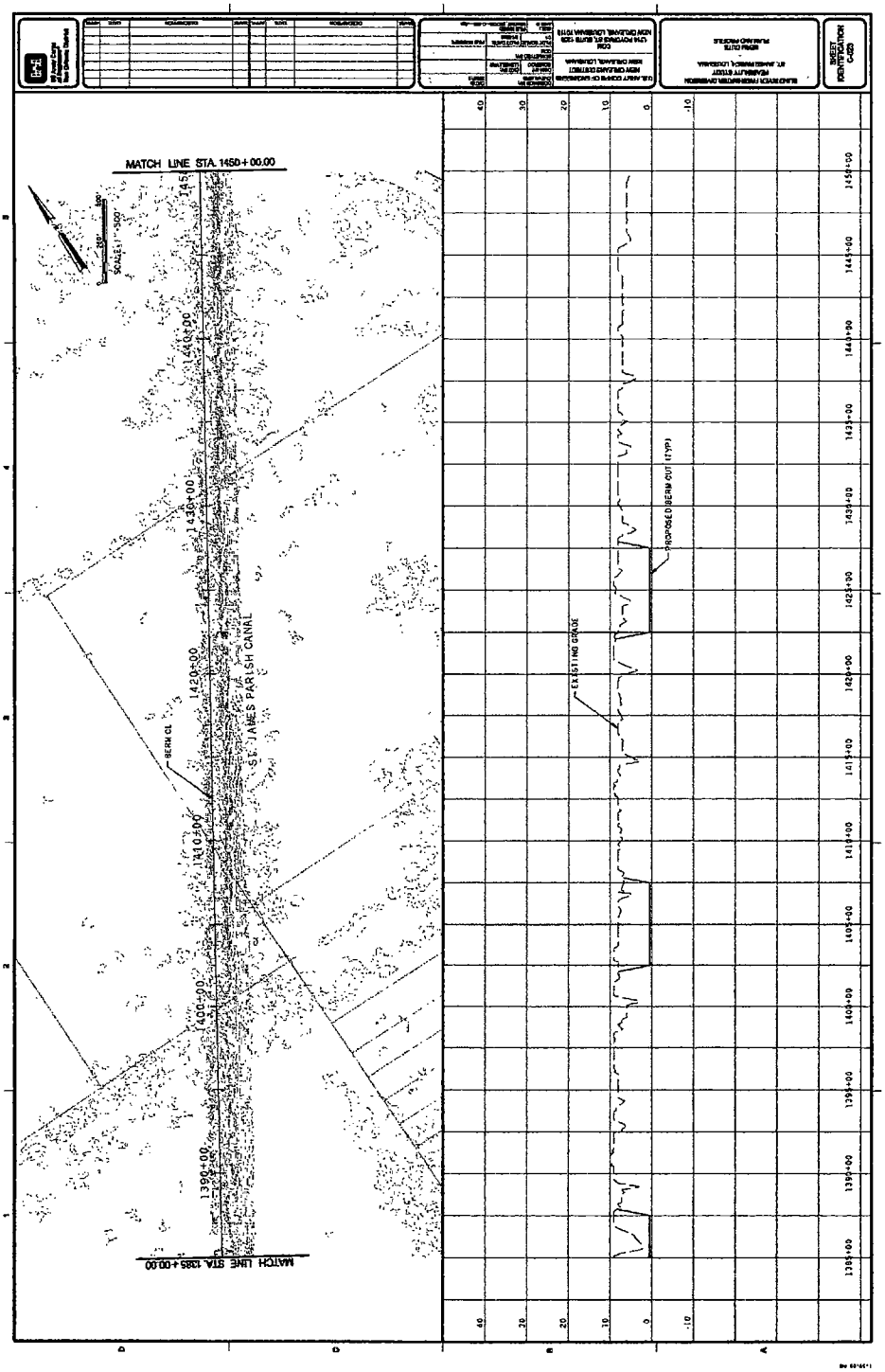

MATCH LINE STA 1130+00.00
MATCH LINE STA 1060+50.00
ST. JAMES PARISH CANAL
BERM CUT
PROPOSED BERM CUT (TYP)
EXISTING GRADE
1130+00
1120+00
1110+00
1100+00
1090+00
1080+00
1070+00
1060+00

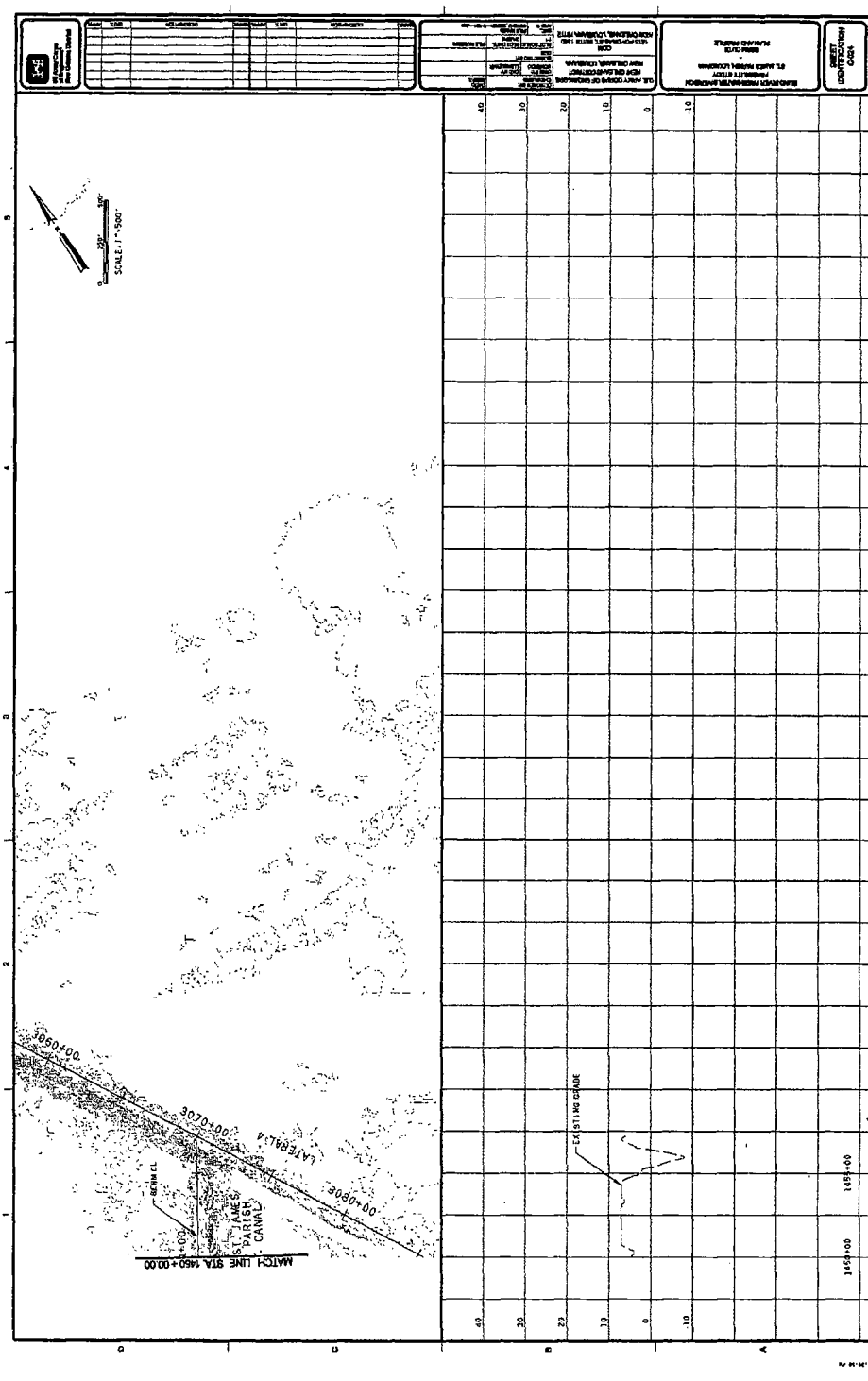

MATCH LINE STA 1150+00.00
MATCH LINE STA 1186+00.00
SCALE: 1" = 100'
LAFITTE'S BLACKSMITH SHOP
ST. JAMES PARISH CANAL
EXISTING GRADE
PROPOSED BERM CUT (TYP)
BERM CL

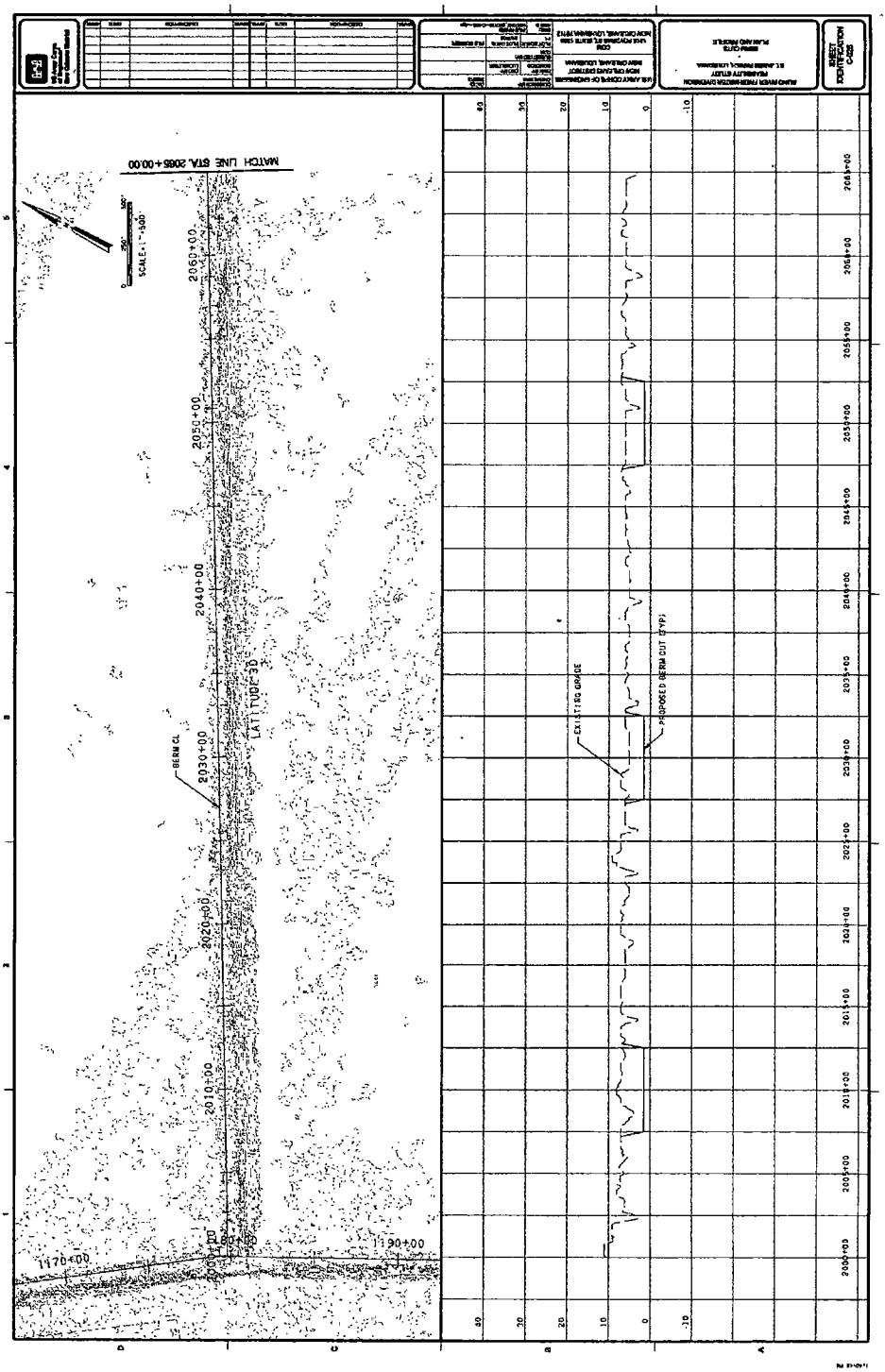

MATCH LINE STA 1350+00.00
MATCH LINE STA 1350+00.00
SCALE: 1" = 500'
EXISTING GRADE
PROPOSED BERM CUT TYP.
1200+00
1210+00
1220+00
1230+00
1240+00
1250+00
1260+00
1270+00
1280+00
1290+00
1300+00
1310+00
1320+00
1330+00
1340+00
1350+00

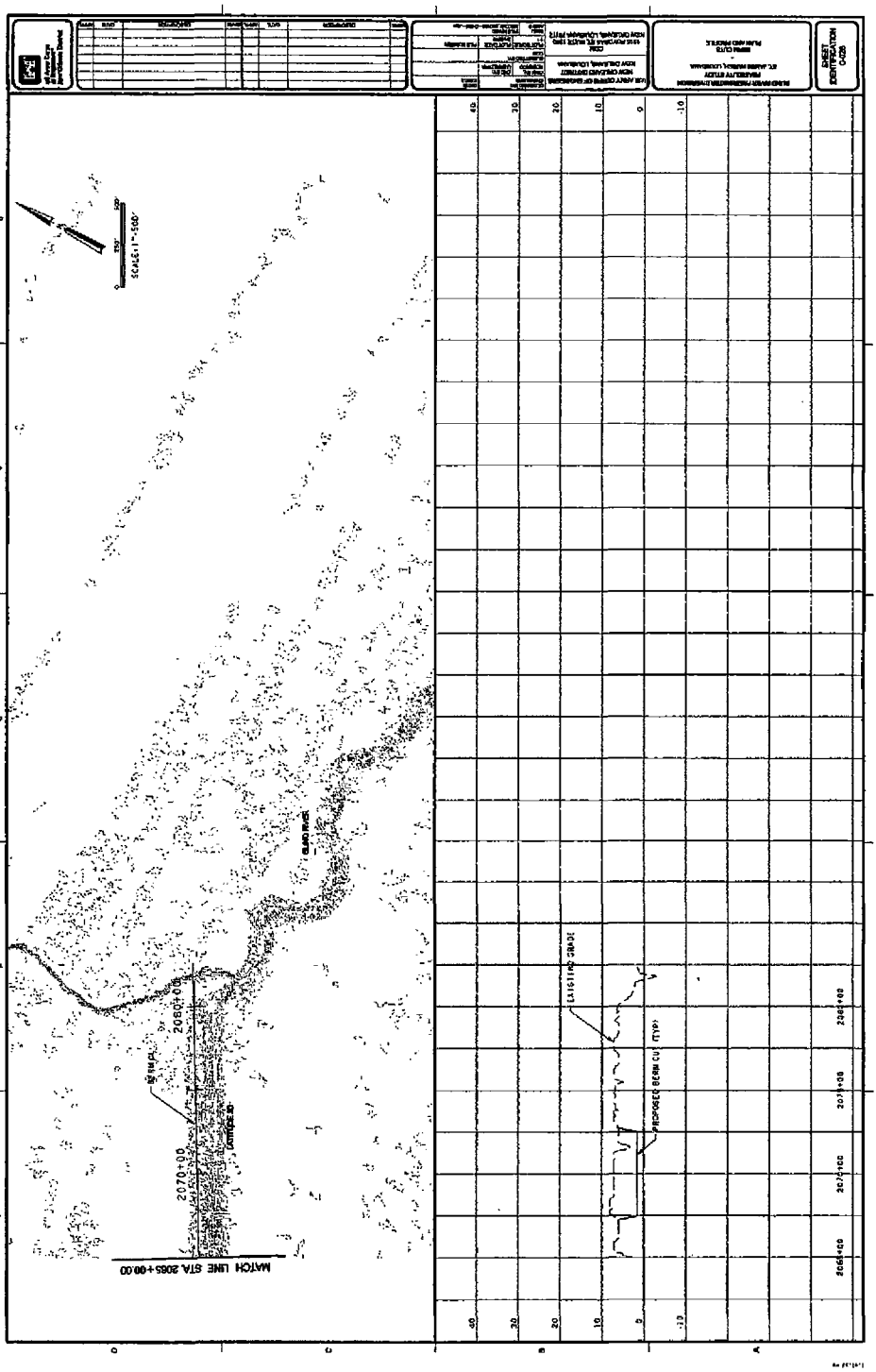

MATCH LINE STA 1260+00.00
MATCH LINE STA 1300+00.00
SCALE: 1"=500'
BERM CL
PROPOSED BERM CUT (TYP)
EXISTING GROUND

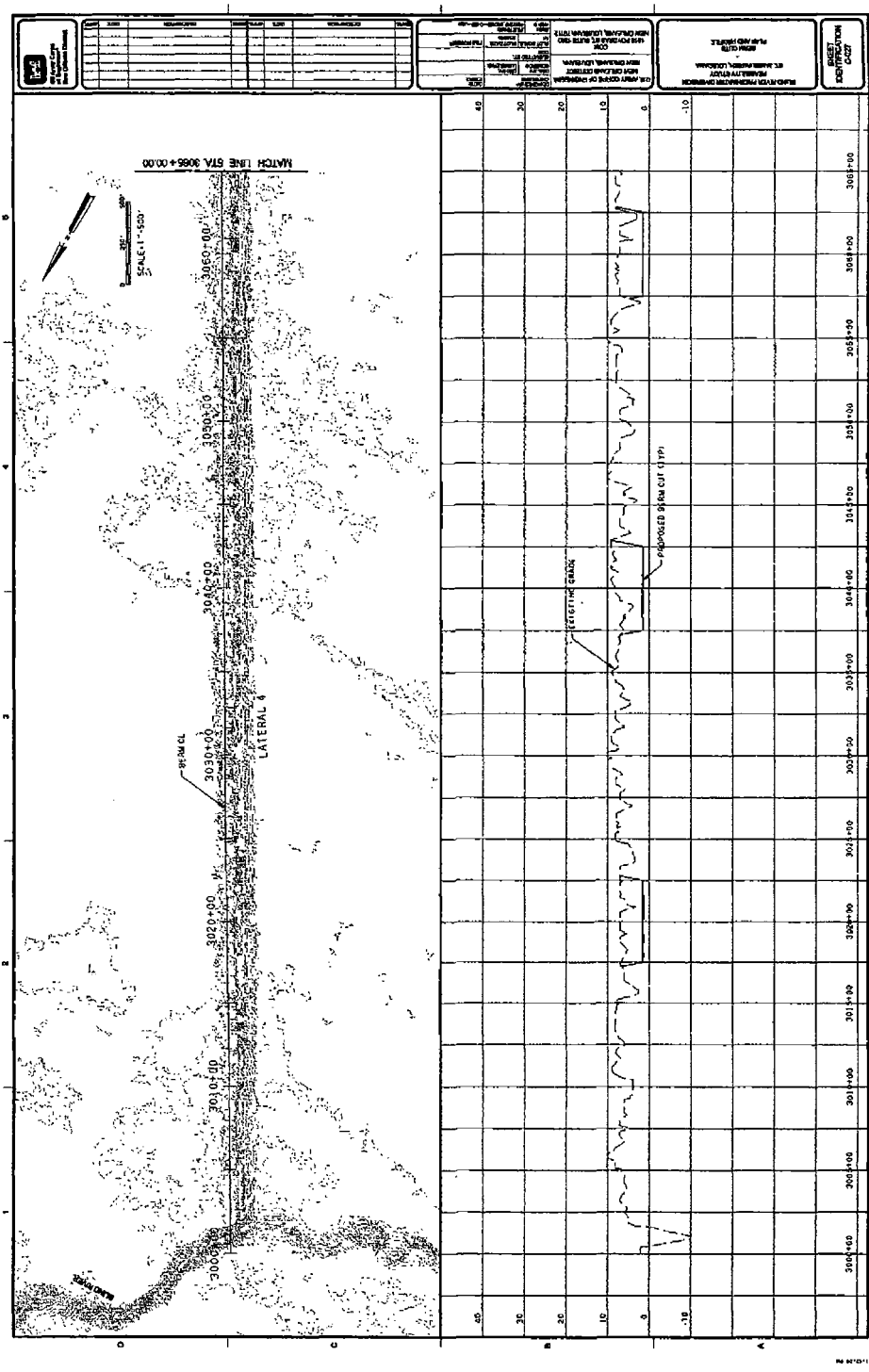

MATCH LINE STA 1385+00.00
MATCH LINE STA 1320+00.00
SCALE: 1" = 500'
1380+00
1370+00
1360+00
1350+00
1340+00
1330+00
1320+00
1310+00
BERM CL
ST. JAMES PARISH CANAL
EXISTING GROUND
PROPOSED BERM CL (TYP)
1220+00
1225+00
1230+00
1235+00
1240+00
1245+00
1250+00
1255+00
1260+00
1265+00
1270+00
1275+00
1280+00
1285+00
1290+00

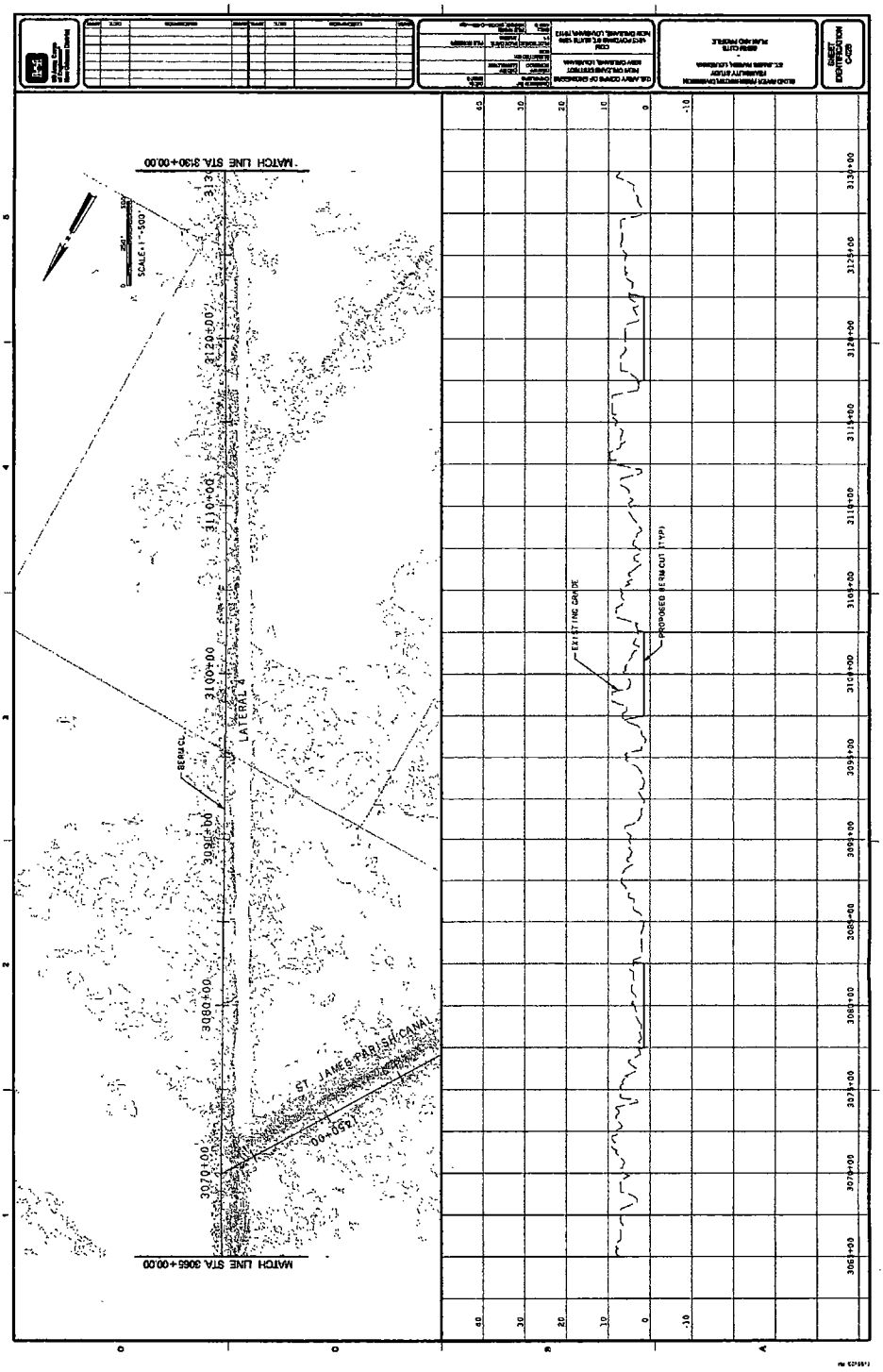

MATCH LINE STA. 1450+00.00
MATCH LINE STA 1385+00.00
1450+00
1440+00
1430+00
1420+00
1410+00
1400+00
1390+00
BERM CL
ST. JAMES PARISH CANAL
PROPOSED BERM CUT (TYP.)
EXISTING GRADE
1450+00
1445+00
1440+00
1435+00
1430+00
1425+00
1420+00
1415+00
1410+00
1405+00
1400+00
1395+00
1390+00
1385+00

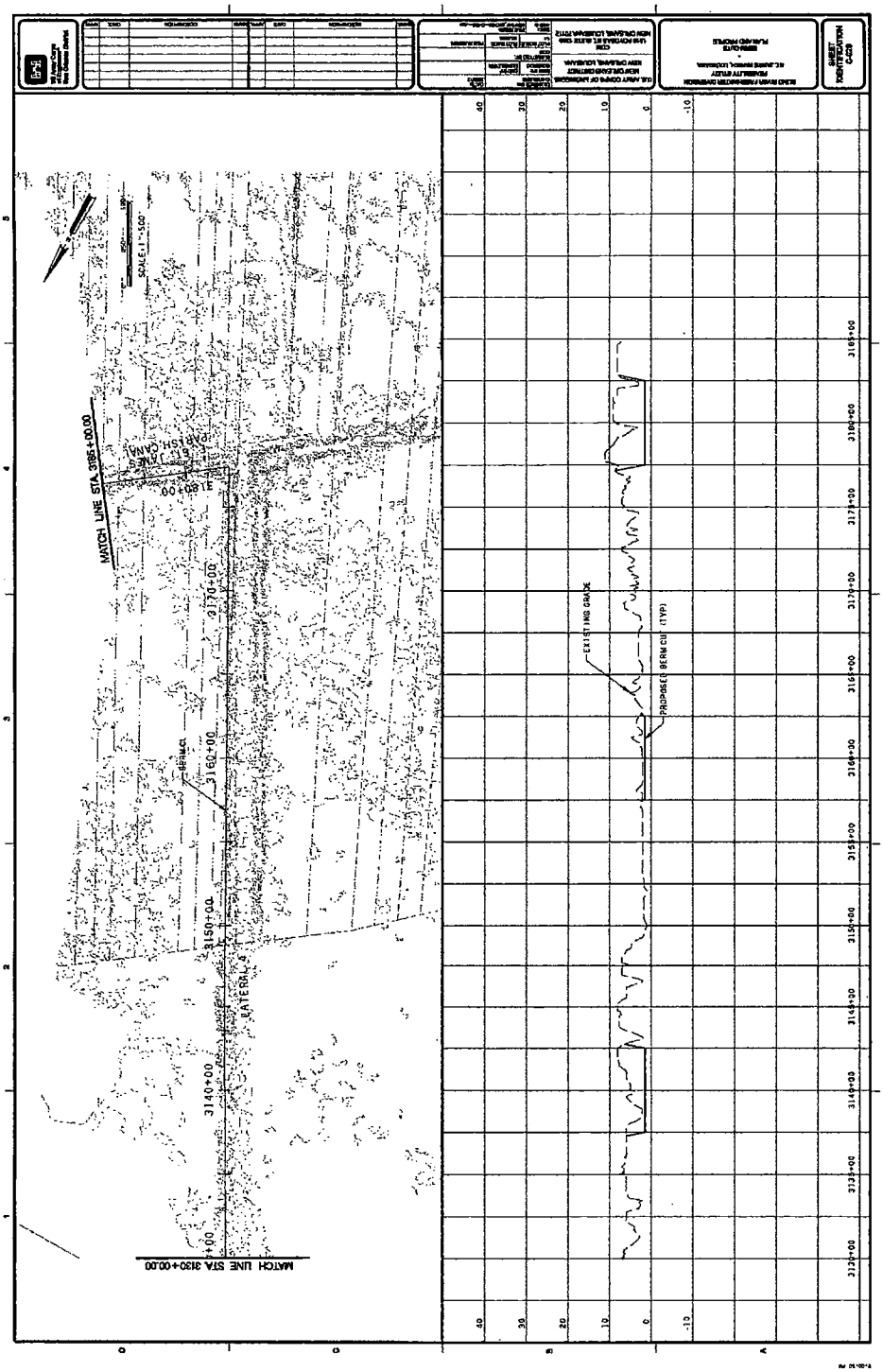

SCALE: 1" = 500'
MATCH LINE STA 1460+00.00
ST. JAMES PARISH CANAL
LATERAL 4
EXISTING GRADE
3050+00
3070+00
3080+00
1460+00
1455+00

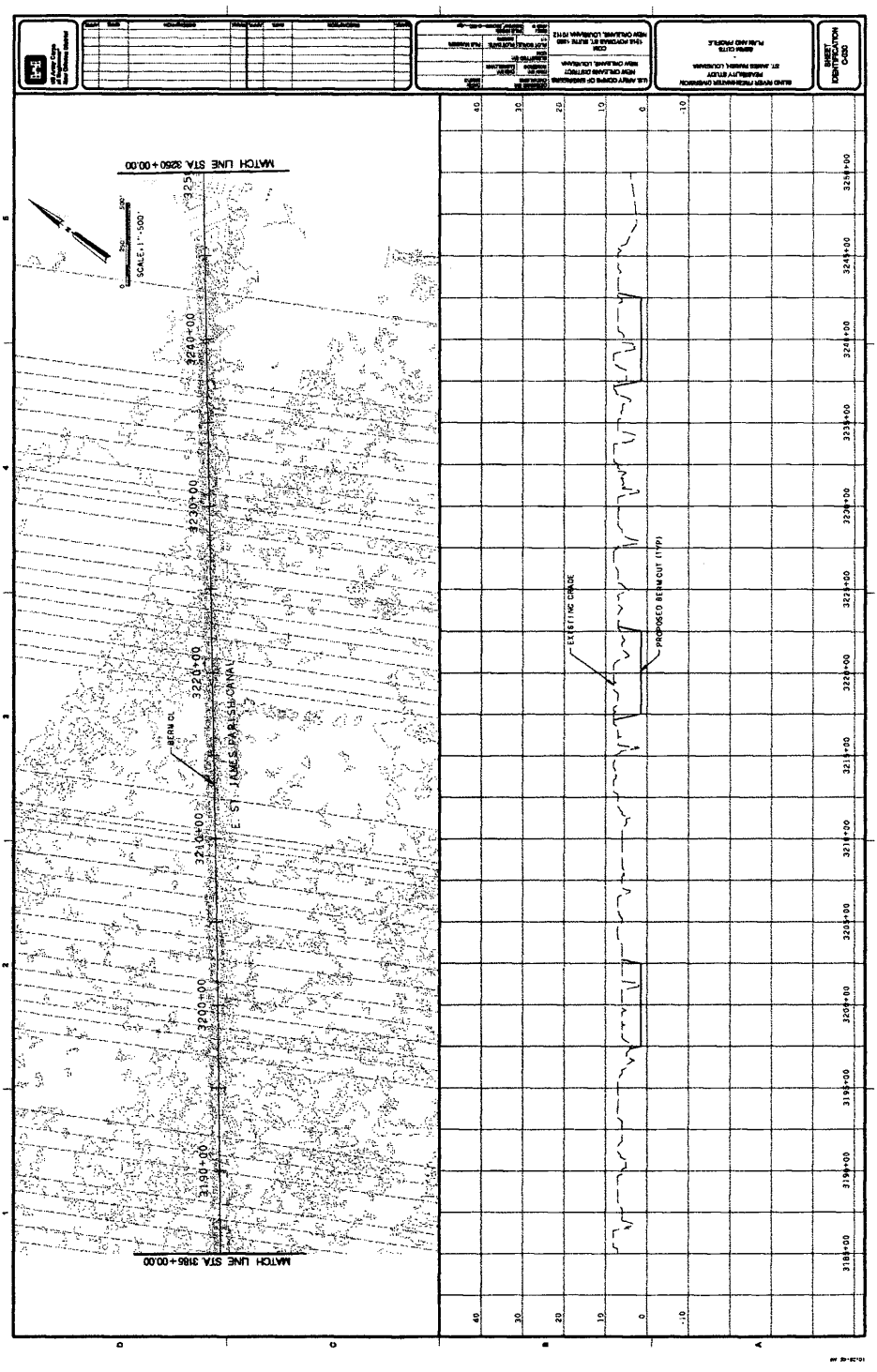

MATCH LINE STA. 2065+00.00
SCALE: 1" = 500'
BERM CL
LATITUDE 30
2060+00
2050+00
2040+00
2030+00
2020+00
2010+00
2000+00
1990+00
1980+00
1970+00
EXISTING GRADE
PROPOSED BERM CUT (TYP)
2065+00
2060+00
2055+00
2050+00
2045+00
2040+00
2035+00
2030+00
2025+00
2020+00
2015+00
2010+00
2005+00
2000+00

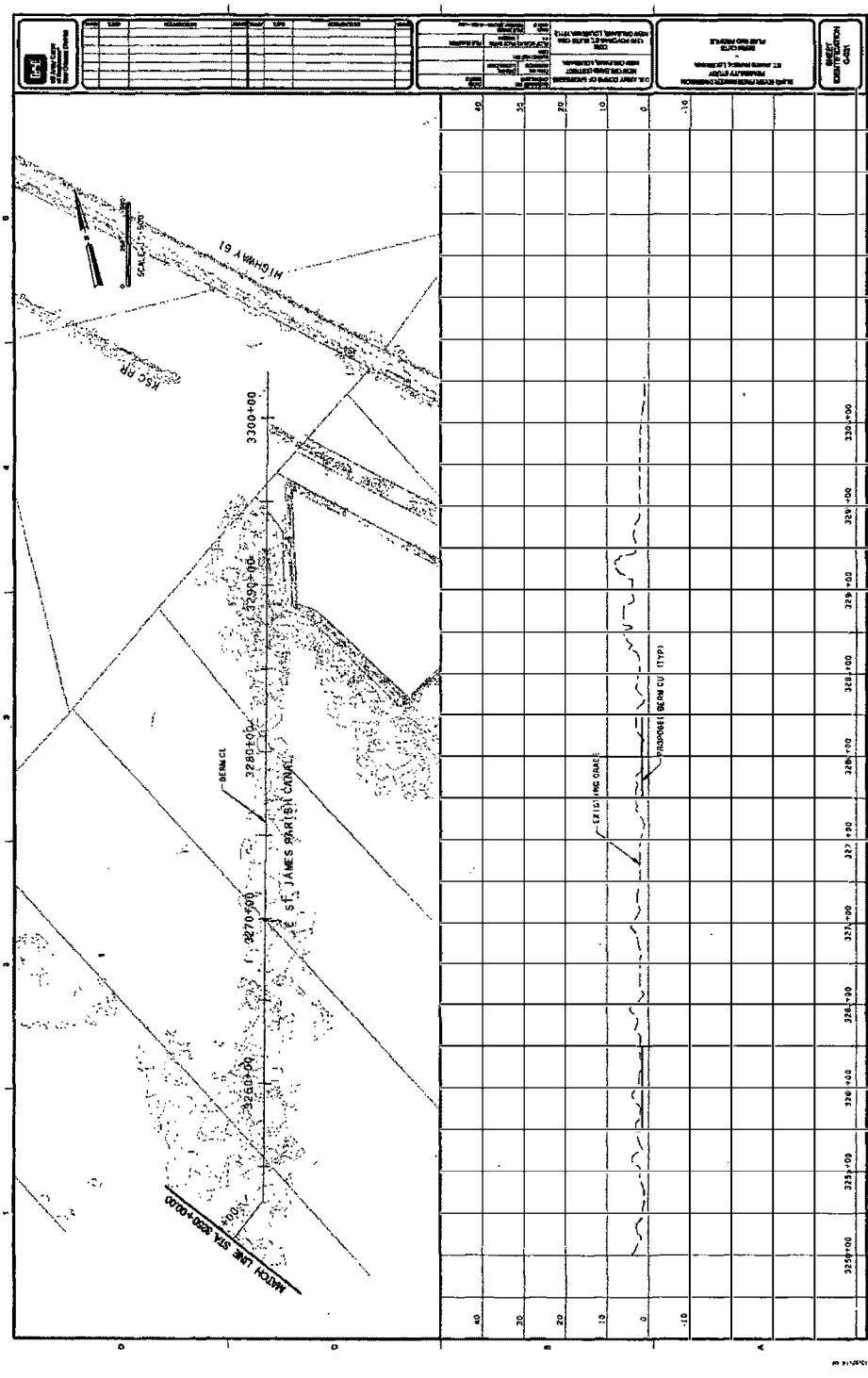

MATCH LINE STA. 2085+00.00
2070+00
2060+00
2050+00
2040+00
2030+00
2020+00
2010+00
2000+00
1990+00
EXISTING GROUND
PROPOSED BERM (TYP.)
SCALE: 1"=500'


MATCH LINE STA 3086+00.00
SCALE: 1" = 500'
LATERAL 6
PROPOSED 9' Rw CUT (TYP)
EXISTING GRADE
3030+00
3040+00
3050+00
3060+00
3070+00
3080+00
3090+00
3100+00
3110+00
3120+00
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9990+00
10000+00

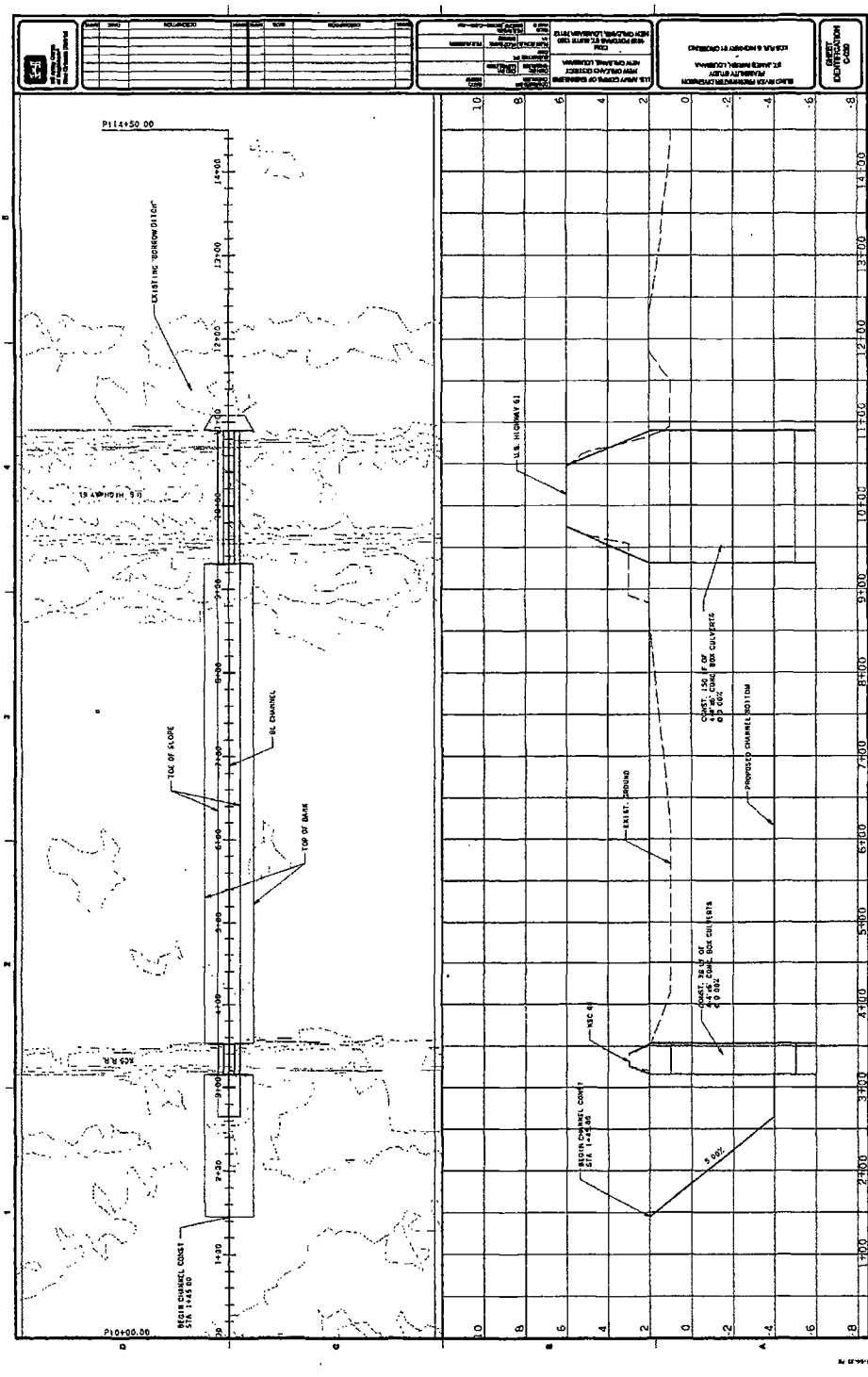

MATCH LINE STA. 3130+00.00
MATCH LINE STA. 3065+00.00
SCALE: 1"=500'
3130+00
3120+00
3110+00
3100+00
3090+00
3080+00
3070+00
3065+00
BERM CL
LATERAL
ST. JAMES PARISH CANAL
EXISTING GRADE
PROPOSED BERM CUT (TYP)

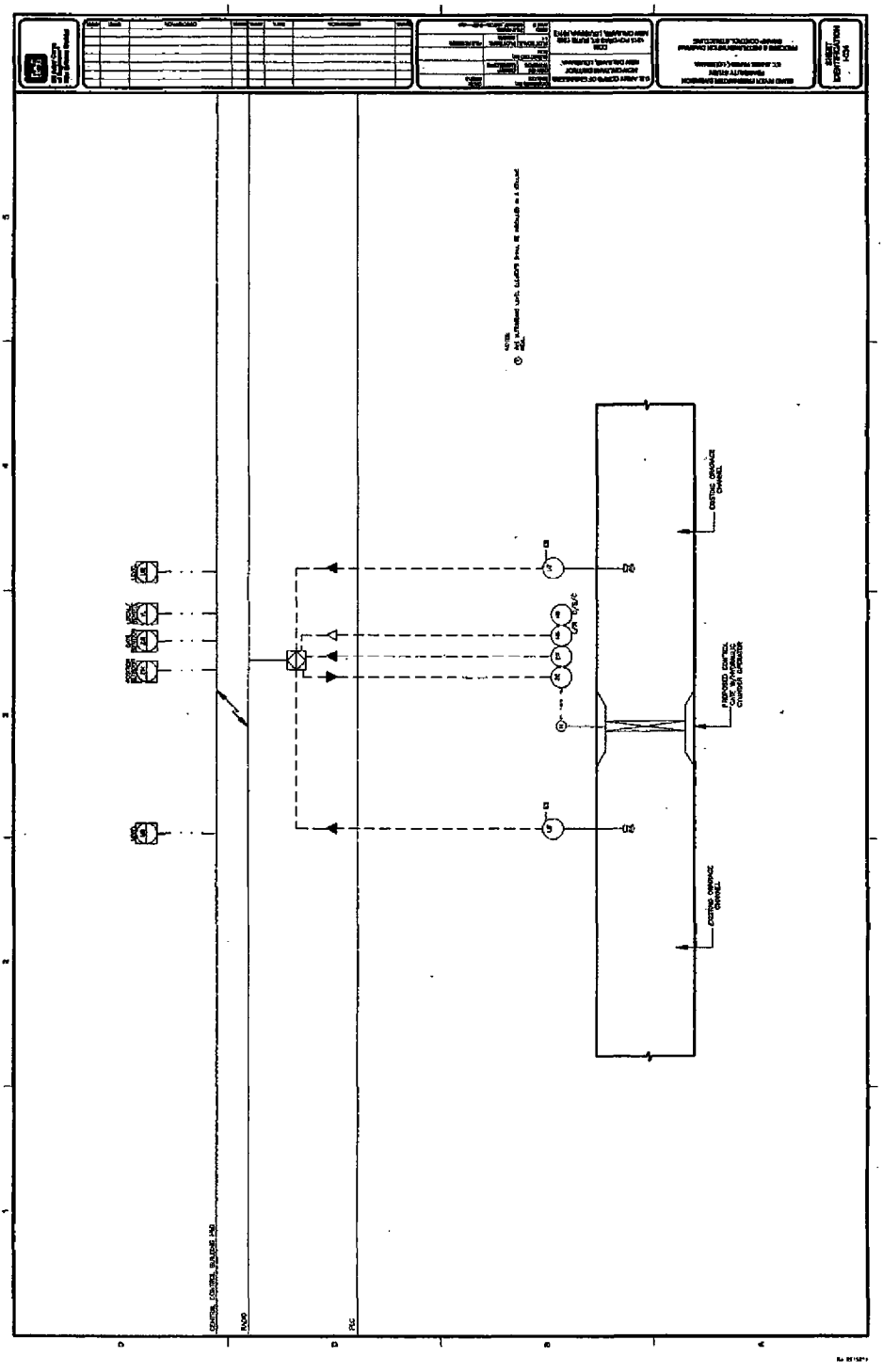

MATCH LINE STA 3135+00.00
MATCH LINE STA 3185+00.00
SCALE 1" = 500'
3140+00
3150+00
3160+00
3170+00
3180+00
EXISTING GRADE
PROPOSED BERM CUT (TYP)

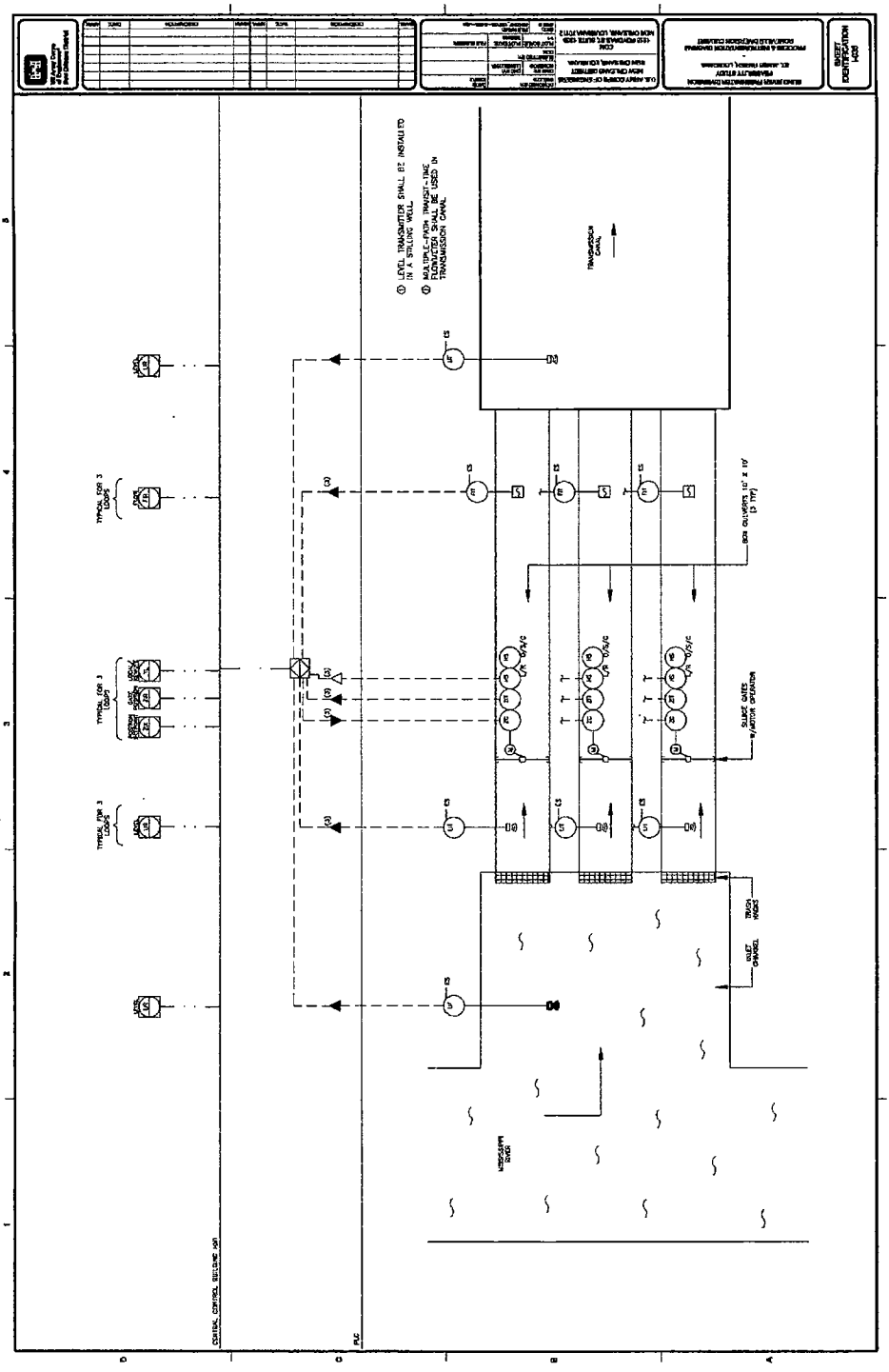

MATCH LINE STA 3250+00.00
MATCH LINE STA 3186+00.00
3240+00
3230+00
3220+00
3210+00
3200+00
3190+00
BERM CL
ST JAMES PARISH CANAL
EXISTING GRADE
PROPOSED BERM CUT (TYP)
SCALE, 1" = 500'
3250+00
3240+00
3230+00
3220+00
3210+00
3200+00
3190+00
3180+00
40
30
20
10
0
10

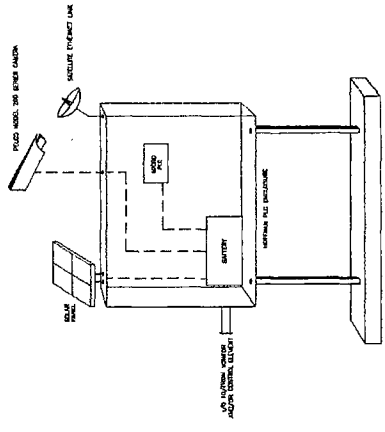

HIGHWAY 61
ASC RR
3300+00
3290+00
3280+00
3270+00
3260+00
MATCH LINE STA. 3250+00.00
BENCL
EXISTING GRADE
PROPOSED BERM CU (TYP)
3256+00
3257+00
3258+00
3259+00
3260+00
3261+00
3262+00
3263+00
3264+00
3265+00
3266+00
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3293+00
3294+00
3295+00
3296+00
3297+00
3298+00
3299+00
3300+00

BLIND RIVER
PROJECT BOUNDARY
I-10
LA 641
CULVERT CROSSING (TYP.)
U.S. HIGHWAY 61
KCS RR
CONWAY CANAL
LA 3125
CN RR
HOMEVILLE DIVERSION CANAL
LA 3124
DIVERSION STRUCTURE
LA 44 (RIVER ROAD)
MISSISSIPPI RIVER
MISSISSIPPI RIVER


BLIND RIVER WATERSHED DRAINAGE
FEASIBILITY STUDY
ST. JAMES PARISH, LOUISIANA
LOCATION & VICINITY MAP
DRAWING NO.
DRAWN BY
CHECKED BY
DATE
DESCRIPTION
NO.
REVISIONS
U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS DISTRICT
NEW ORLEANS, LOUISIANA
P114+50.00
P101+00.00
EXISTING "BORROW DITCH"
19 APRIL 96
U.S. HIGHWAY 61
TOE OF SLOPE
BL CHANNEL
TOP OF BANK
BEGIN CHANNEL CONST
STA 1+45.85
EXIST. GROUND
PROPOSED CHANNEL BOTTOM
CONST. 156 LF OF
4'-0" W. CONC. BOX CULVERTS
@ 0.00%
CONST. 38 LF OF
4'-0" W. CONC. BOX CULVERTS
@ 0.00%
SEC 61
S 0.00%




LEVEL TRANSMITTER SHALL BE INSTALLED IN A STILLING WELL.
MULTIPLE-PATH TRANSIT-TIME FLOWMETER SHALL BE USED IN TRANSMISSION CANAL.
TRANSMISSION CANAL
TYPICAL FOR 3 LOOPS
TYPICAL FOR 3 LOOPS
TYPICAL FOR 3 LOOPS
SLUICE GATES w/MOTOR OPERATOR
TRASH RACKS
OUTLET CHANNEL
INTAKE CHANNEL
CONTROL BUILDING
PLC


SATELLITE ETHERNET LINK
PYLOS 400GS 3M SPACE CANOPY
WORD PLC
BATTERY
MONITORING PLC ENCLOSURE
SOLAR PANEL
LIGHTING TOWER MOTOR MONITORING VIA ETHERNET

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Volume IV

APPENDIX L—Annex L-7

Project Costs and Schedule Risk Analysis

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****** TOTAL PROJECT COST SUMMARY ******

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

This Estimate reflects the scope and schedule in report; Blind River Diversion Project, March 2010

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Spent Thru: 22-Mar-10 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
02	RELOCATIONS	10,611	8,431	60.6%	17,042	2.6%	10890.2	6599.4	17489.6			11192.8	6782.8	17975.6
06	FISH & WILDLIFE FACILITIES	6,820			6,820		6820.0		6820.0			6820.0		6820.0
15	FLOODWAY CONTROL & DIVERSION STR	56,980	16,068	28.2%	73,048	2.6%	58476.3	16490.3	74966.6			60536.2	17071.2	77607.4
	CONSTRUCTION ESTIMATE TOTALS:	74,212	22,499		96,710	2.4%	75,988	23,090	99,078			78,349	23,854	102,203
01	LANDS AND DAMAGES	2,070	1,850	89.4%	3,920	2.6%	2,124	1,899	4,023			2,133	1,907	4,041
30	PLANNING, ENGINEERING & DESIGN	6,759	777	11.5%	7,536	2.6%	6,937	798	7,734			6,953	800	7,753
31	CONSTRUCTION MANAGEMENT	7,435	1,190	16.0%	8,625	2.6%	7,630	1,221	8,851			7,890	1,262	9,153
	PROJECT COST TOTALS:	90,476	26,316	29.1%	116,792	2.5%	92,678	27,007	119,685			95,326	27,823	123,140

CHIEF, COST ENGINEERING

PROJECT MANAGER

ESTIMATED FEDERAL COST:	65%	**80,041**
ESTIMATED NON-FEDERAL COST:	35%	**43,099**
ESTIMATED TOTAL PROJECT COST:		**123,140**

1692

**** CONTRACT COST SUMMARY ****

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Diversion Culvert
This Estimate reflects the scope and schedule in report: Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 22-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ 2,668	$ 1,617	60.6%	$ 4,284	2.6%	2737.8	1659.1	4396.9	2014Q1	3.6%	2836.2	1718.7	4554.9
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ 11,116	$ 3,135	28.2%	$ 14,254	2.6%	11410.5	3217.8	14628.2	2014Q1	3.6%	11820.5	3333.4	15153.9
	CONSTRUCTION ESTIMATE TOTALS:	13,786	4,752	34.5%	18,538		13786.2	4876.9	18663.1			14656.8	5052.1	19708.7
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	28	$ 3	11.5%	31	2.6%	28.3	3.3	31.6	2012Q1		28.3	3.3	31.6
0.6%	Planning & Environmental Compliance	69	$ 8	11.5%	77	2.6%	70.7	8.1	78.9	2012Q1		70.7	8.1	78.9
8.0%	Engineering & Design	1,103	$ 127	11.5%	1,230	2.6%	1131.9	130.2	1262.0	2012Q1		1131.9	130.2	1262.0
0.2%	Engineering Tech Review ITR & VE	28	$ 3	11.5%	31	2.6%	28.3	3.3	31.6	2012Q1		28.3	3.3	31.6
0.2%	Contracting & Reprographics	28	$ 3	11.5%	31	2.6%	28.3	3.3	31.6	2012Q1		28.3	3.3	31.6
0.6%	Engineering During Construction	69	$ 8	11.5%	77	2.6%	70.7	8.1	78.9	2014Q1	3.6%	73.3	8.4	81.7
0.2%	Planning During Construction	28	$ 3	11.5%	31	2.6%	28.3	3.3	31.6	2014Q1	3.6%	29.3	3.4	32.7
0.2%	Project Operations	28	$ 3	11.5%	31	2.6%	28.3	3.3	31.6	2012Q1		28.3	3.3	31.6
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	1,379	$ 221	16.0%	1,699	2.6%	1414.8	226.4	1641.2	2014Q1	3.6%	1465.7	234.5	1700.2
	Project Operation:		$ -	16.0%										
1.0%	Project Management	138	$ 22	16.0%	160	2.6%	141.5	22.6	164.1	2014Q1	3.6%	146.6	23.5	170.0
	CONTRACT COST TOTALS:	16,681	5,153		21,835		16757.4	5288.6	22045.9			17687.3	5473.2	**23160.4**

1693

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Transmission Canal
This Estimate reflects the scope and schedule in report: Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 22-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ 411	$ 249	60.6%	$ 660	2.6%	421.5	255.4	676.9	2014Q2	4.1%	438.6	265.8	704.4
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ 17,716	$ 4,998	28.2%	$ 22,714	2.6%	18183.1	5127.6	23310.7	2014Q2	4.1%	18921.8	5335.9	24257.7
	CONSTRUCTION ESTIMATE TOTALS:	18,128	5,245	28.9%	23,374		18604.5	5383.0	23987.6			19360.4	5601.7	24962.1
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	36	$ 4	11.5%	40	2.6%	37.2	4.3	41.5	2012Q1		37.2	4.3	41.5
0.5%	Planning & Environmental Compliance	91	$ 10	11.5%	101	2.6%	93.0	10.7	103.7	2012Q1		93.0	10.7	103.7
8.0%	Engineering & Design	1,450	$ 167	11.5%	1,617	2.6%	1488.4	171.2	1659.5	2012Q1		1488.4	171.2	1659.5
0.2%	Engineering Tech Review ITR & VE	36	$ 4	11.5%	40	2.6%	37.2	4.3	41.5	2012Q1		37.2	4.3	41.5
0.2%	Contracting & Reprographics	36	$ 4	11.5%	40	2.6%	37.2	4.3	41.5	2012Q1		37.2	4.3	41.5
0.5%	Engineering During Construction	91	$ 10	11.5%	101	2.6%	93.0	10.7	103.7	2014Q2	4.1%	96.8	11.1	107.9
0.2%	Planning During Construction	36	$ 4	11.5%	40	2.6%	37.2	4.3	41.5	2014Q2	4.1%	38.7	4.5	43.2
0.2%	Project Operations	36	$ 4	11.5%	40	2.6%	37.2	4.3	41.5	2012Q1		37.2	4.3	41.5
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	1,813	$ 290	16.0%	2,103	2.6%	1860.5	297.7	2158.1	2014Q2	4.1%	1936.0	309.8	2245.8
	Project Operation:		$ -	16.0%										
1.0%	Project Management	181	$ 29	16.0%	210	2.6%	186.0	29.8	215.8	2014Q2	4.1%	193.6	31.0	224.6
	CONTRACT COST TOTALS:	21,935	5,773		27,708		22511.5	5924.4	28435.9			23365.8	6157.0	29512.8

1694

Filename: BRDP_TPCS07222010.r0.xls
TPCS

**** CONTRACT COST SUMMARY ****

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Canadian National Railroad Relocation and Reconstruction
This Estimate reflects the scope and schedule in report; Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 22-Mar-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ 1,232	$ 747	60.6%	$ 1,979	2.6%	1264.6	766.3	2030.9	2013Q4	3.1%	1304.4	790.4	2094.8
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ -	$ -	28.2%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	1,232	747	60.6%	1,979		1264.6	766.3	2030.9			1304.4	790.4	2094.8
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	2	$ 0	11.5%	3	2.6%	2.5	0.3	2.8	2012Q1		2.5	0.3	2.8
0.5%	Planning & Environmental Compliance	6	$ 1	11.5%	7	2.6%	6.3	0.7	7.1	2012Q1		6.3	0.7	7.1
8.0%	Engineering & Design	99	$ 11	11.5%	110	2.6%	101.2	11.6	112.8	2012Q1		101.2	11.6	112.8
0.2%	Engineering Tech Review ITR & VE	2	$ 0	11.5%	3	2.6%	2.5	0.3	2.8	2012Q1		2.5	0.3	2.8
0.2%	Contracting & Reprographics	2	$ 0	11.5%	3	2.6%	2.5	0.3	2.8	2012Q1		2.5	0.3	2.8
0.5%	Engineering During Construction	6	$ 1	11.5%	7	2.6%	6.3	0.7	7.1	2013Q4	3.1%	6.5	0.8	7.3
0.2%	Planning During Construction	2	$ 0	11.5%	3	2.6%	2.5	0.3	2.8	2013Q4	3.1%	2.6	0.3	2.9
0.2%	Project Operations	2	$ 0	11.5%	3	2.6%	2.5	0.3	2.8	2012Q1		2.5	0.3	2.8
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	123	$ 20	16.0%	143	2.6%	126.5	20.2	146.7	2013Q4	3.1%	130.4	20.9	151.3
	Project Operation:		$ -	16.0%										
1.0%	Project Management	12	$ 2	16.0%	14	2.6%	12.6	2.0	14.7	2013Q4	3.1%	13.0	2.1	15.1
	CONTRACT COST TOTALS:	1,491	783		2,274		1530.2	803.1	2333.3			1574.6	828.0	**2402.5**

1695

Filename: BRDP_TPCS07222010.r0.xls
TPCS

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Control Structures and Berm Gaps
This Estimate reflects the scope and schedule in report; Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 2-Feb-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	FULLY FUNDED PROJECT ESTIMATE COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ -	$ -	60.6%	$ -									
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ 27,526	$ 7,762	28.2%	$ 35,288	2.6%	28248.4	7966.1	36214.5	2013Q4	3.1%	29136.8	8216.6	37353.3
	CONSTRUCTION ESTIMATE TOTALS:	27,526	7,762	28.2%	35,288		28248.4	7966.1	36214.6			29136.8	8216.6	37353.3
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	55	$ 6	11.5%	61	2.6%	56.5	6.5	63.0	2012Q1		56.5	6.5	63.0
0.5%	Planning & Environmental Compliance	138	$ 16	11.5%	153	2.6%	141.2	16.2	157.5	2012Q1		141.2	16.2	157.5
8.0%	Engineering & Design	2,202	$ 253	11.5%	2,455	2.6%	2259.9	259.9	2519.8	2012Q1		2259.9	259.9	2519.8
0.2%	Engineering Tech Review ITR & VE	55	$ 6	11.5%	61	2.6%	56.5	6.5	63.0	2012Q1		56.5	6.5	63.0
0.2%	Contracting & Reprographics	55	$ 6	11.5%	61	2.6%	56.5	6.5	63.0	2012Q1		56.5	6.5	63.0
0.5%	Engineering During Construction	138	$ 16	11.5%	153	2.6%	141.2	16.2	157.5	2013Q4	3.1%	145.7	16.8	162.4
0.2%	Planning During Construction	55	$ 6	11.5%	61	2.6%	56.5	6.5	63.0	2013Q4	3.1%	58.3	6.7	65.0
0.2%	Project Operations	55	$ 6	11.5%	61	2.6%	56.5	6.5	63.0	2012Q1		56.5	6.5	63.0
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	2,753	$ 440	16.0%	3,193	2.6%	2824.8	452.0	3276.8	2013Q4	3.1%	2913.7	466.2	3379.9
	Project Operation:		$ -	16.0%										
1.0%	Project Management	275	$ 44	16.0%	319	2.6%	282.5	45.2	327.7	2013Q4	3.1%	291.4	46.6	338.0
	CONTRACT COST TOTALS:	33,308	8,553		41,859		34180.6	8788.1	42968.7			35172.9	9054.9	**44227.8**

1696

Filename: BRDP_TPCS07222010.r0.xls
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**** CONTRACT COST SUMMARY ****

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Highway 61 Crossing Culverts
This Estimate reflects the scope and schedule in report; Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 2-Feb-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ 258	$ 166	60.6%	$ 414	2.6%	264.3	160.2	424.5	2014Q1	3.6%	273.8	165.9	439.7
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ 618	$ 174	28.2%	$ 792	2.6%	634.4	178.9	813.2	2014Q1	3.6%	657.2	185.3	842.5
	CONSTRUCTION ESTIMATE TOTALS:	876	330	37.7%	1,206		898.7	339.1	1237.7			930.9	351.2	1282.2
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	2	$ 0	11.5%	2	2.6%	1.8	0.2	2.0	2012Q1		1.8	0.2	2.0
0.5%	Planning & Environmental Compliance	4	$ 1	11.5%	5	2.6%	4.5	0.5	5.0	2012Q1		4.6	0.5	5.0
8.0%	Engineering & Design	70	$ 8	11.5%	78	2.6%	71.9	8.3	80.2	2012Q1		71.9	8.3	80.2
0.2%	Engineering Tech Review ITR & VE	2	$ 0	11.5%	2	2.6%	1.8	0.2	2.0	2012Q1		1.8	0.2	2.0
0.2%	Contracting & Reprographics	2	$ 0	11.5%	2	2.6%	1.8	0.2	2.0	2012Q1		1.8	0.2	2.0
0.5%	Engineering During Construction	4	$ 1	11.5%	5	2.6%	4.5	0.5	5.0	2014Q1	3.6%	4.7	0.5	5.2
0.2%	Planning During Construction	2	$ 0	11.5%	2	2.6%	1.8	0.2	2.0	2014Q1	3.6%	1.9	0.2	2.1
0.2%	Project Operations	2	$ 0	11.5%	2	2.6%	1.8	0.2	2.0	2012Q1		1.8	0.2	2.0
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	88	$ 14	16.0%	102	2.6%	89.9	14.4	104.2	2014Q1	3.6%	93.1	14.9	108.0
	Project Operation:		$ -	16.0%										
1.0%	Project Management	9	$ 1	16.0%	10	2.6%	9.0	1.4	10.4	2014Q1	3.6%	9.3	1.5	10.8
	CONTRACT COST TOTALS:	1,060	356		1,415		1087.4	365.2	1452.6			1123.4	378.0	**1501.4**

**** CONTRACT COST SUMMARY ****

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Pipeline Relocation
This Estimate reflects the scope and schedule in report: Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 2-Feb-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS	$ 6,043	$ 3,662	60.6%	$ 9,706	2.6%	6202.0	3758.4	9960.4	2013Q2	2.2%	6339.8	3841.9	10181.8
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STR	$ -	$ -	28.2%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	6,043	3,662	60.6%	9,706		6202.0	3758.4	9960.4			6339.8	3841.9	10181.8
01	LANDS AND DAMAGES	$ -	$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management	12	$ 1	11.5%	13	2.6%	12.4	1.4	13.8	2012Q1		12.4	1.4	13.8
0.5%	Planning & Environmental Compliance	30	$ 3	11.5%	34	2.6%	31.0	3.6	34.6	2012Q1		31.0	3.6	34.6
8.0%	Engineering & Design	483	$ 56	11.5%	539	2.6%	496.2	57.1	553.2	2012Q1		496.2	57.1	553.2
0.2%	Engineering Tech Review ITR & VE	12	$ 1	11.5%	13	2.6%	12.4	1.4	13.8	2012Q1		12.4	1.4	13.8
0.2%	Contracting & Reprographics	12	$ 1	11.5%	13	2.6%	12.4	1.4	13.8	2012Q1		12.4	1.4	13.8
0.5%	Engineering During Construction	30	$ 3	11.5%	34	2.6%	31.0	3.6	34.6	2013Q2	2.2%	31.7	3.6	35.3
0.2%	Planning During Construction	12	$ 1	11.5%	13	2.6%	12.4	1.4	13.8	2013Q2	2.2%	12.7	1.5	14.1
0.2%	Project Operations	12	$ 1	11.5%	13	2.6%	12.4	1.4	13.8	2012Q1		12.4	1.4	13.8
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	604	$ 97	16.0%	701	2.6%	620.2	99.2	719.4	2013Q2	2.2%	634.0	101.4	735.4
	Project Operation:		$ -	16.0%										
1.0%	Project Management	60	$ 10	16.0%	70	2.6%	62.0	9.9	71.9	2013Q2	2.2%	63.4	10.1	73.5
	CONTRACT COST TOTALS:	7,312	3,838		11,150		7504.4	3938.9	11443.3			7658.4	4025.0	**11683.4**

1698

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**** CONTRACT COST SUMMARY ****

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Adaptive Management
This Estimate reflects the scope and schedule in report: Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 2-Feb-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS		$ -	60.6%	$ -									
06	FISH & WILDLIFE FACILITIES	$ 6,620	$ -		$ 6,620		6620.0		6620.0	2015Q1		6620.0		6620.0
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$ -	28.2%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:	6,620			6,620		6620.0		6620.0			6620.0		6620.0
01	LANDS AND DAMAGES		$ -	89.4%	$ -									
30	PLANNING, ENGINEERING & DESIGN													
	Project Management		$ -	11.5%										
	Planning & Environmental Compliance		$ -	11.5%										
	Engineering & Design		$ -	11.5%										
	Engineering Tech Review ITR & VE		$ -	11.5%										
	Contracting & Reprographics		$ -	11.5%										
	Engineering During Construction		$ -	11.5%										
	Planning During Construction		$ -	11.5%										
	Project Operations		$ -	11.5%										
31	CONSTRUCTION MANAGEMENT													
	Construction Management		$ -	16.0%										
	Project Operation:		$ -	16.0%										
	Project Management		$ -	16.0%										
	CONTRACT COST TOTALS:	6,620			6,620		6620.0		6620.0			6620.0		**6620.0**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: Convent/Blind River Diversion Project
LOCATION: St. James Parish, Louisiana
CONTRACT: Real Estate Acquisition
This Estimate reflects the scope and schedule in report: Blind River Diversion Project, March 2010

DISTRICT: MVN
POC: CHIEF, COST ENGINEERING

PREPARED: 3/24/2010

Estimate Prepared: 2-Feb-10
Effective Price Level: 1 OCT 10

Program Year (Budget EC): 2012
Effective Price Level Date: 1 OCT 11

WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED PROJECT ESTIMATE: Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
02	RELOCATIONS		$ -	60.6%	$ -									
06	FISH & WILDLIFE FACILITIES	$ -	$ -		$ -									
15	FLOODWAY CONTROL & DIVERSION STRUCTURE		$ -	28.2%	$ -									
	CONSTRUCTION ESTIMATE TOTALS:													
01	LANDS AND DAMAGES	$ 2,070	$ 1,850	89.4%	$ 3,920	2.6%	2124.3	1899.1	4023.3	2012Q2	0.4%	2133.3	1907.2	4040.5
30	PLANNING, ENGINEERING & DESIGN													
0.2%	Project Management		$ -	11.5%										
0.5%	Planning & Environmental Compliance		$ -	11.5%										
8.0%	Engineering & Design		$ -	11.5%										
0.2%	Engineering Tech Review ITR & VE		$ -	11.5%										
0.2%	Contracting & Reprographics		$ -	11.5%										
0.5%	Engineering During Construction		$ -	11.5%										
0.2%	Planning During Construction		$ -	11.5%										
0.2%	Project Operations		$ -	11.5%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management		$ -	16.0%										
	Project Operation:		$ -	16.0%										
1.0%	Project Management		$ -	16.0%										
	CONTRACT COST TOTALS:	2,070	1,850		3,920		2124.3	1899.1	4023.3			2133.3	1907.2	**4040.5**

1700

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Convent/Blind River Diversion Project
Louisiana Coastal Area Ecosystem Restoration
St. James Parish, Louisiana

1702

Estimated by	CDM
Designed by	CDM
Prepared by	M. Schlebusch
Preparation Date	3/23/2010
Effective Date of Pricing	3/23/2010
Estimated Construction Time	1,095 Days

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Description	Page
Library Properties	i
Project Notes	ii
Markup Properties	ix
Project Cost Summary Report	1
01 Lands and Damages	1
01 10 Real Estate Acquisition	1
02 Relocations	1
02 01 Roads	1
02 02 Railroads	1
02 03 Cemeteries, Utilities, and Structures	1
06 Fish and Wildlife Facilities	1
06 03 Wildlife Facilities and Sanctuaries	1
15 Floodway Control-Diversion Structures	1
15 00 Floodway Control-Diversion Structures	1
30 Planning, Engineering, and Design	1
31 Construction Management	1

1703

Designed by
CDM
Estimated by
CDM
Prepared by
M. Schlebusch

Direct Costs
LaborCost
EQCost
MatlCost
SubBidCost
Supply/Allowan

Design Document	Blind River Diversion Project
Document Date	1/29/2010
District	New Orleans District
Contact	CDM - 816-444-8270
Budget Year	2010
UOM System	Original

Timeline/Currency

Preparation Date	3/23/2010
Escalation Date	9/30/2009
Eff. Pricing Date	3/23/2010
Estimated Duration	1095 Day(s)
Currency	US dollars
Exchange Rate	1.000000

Costbook CB06EB: MII English Cost Book 2006

Labor LB10NatFD: Labor National 2010

Labor Rates
LaborCost1
LaborCost2
LaborCost3
LaborCost4

1704

Equipment EP10R03: MII Equipment Region 3r 2010
Note: Fuel and electrical costs updated as of February 2010.

03 SOUTHEAST

Sales Tax	8.75
Working Hours per Year	1,530
Labor Adjustment Factor	0.83
Cost of Money	3.25
Cost of Money Discount	25.00
Tire Recap Cost Factor	1.50
Tire Recap Wear Factor	1.80
Tire Repair Factor	0.15
Equipment Cost Factor	1.00
Standby Depreciation Factor	0.50

Fuel

Electricity	0.103
Gas	2.810
Diesel Off-Road	2.799
Diesel On-Road	2.564

Shipping Rates

Over 0 CWT	10.26
Over 240 CWT	9.59
Over 300 CWT	8.41
Over 400 CWT	7.64
Over 500 CWT	4.49
Over 700 CWT	4.36
Over 800 CWT	4.99

Date	Author	Note

3/11/2010

LOUISIANA COASTAL AREA ECOSYSTEM RESTORATION
CONVENT/BLIND RIVER DIVERSION PROJECT
ST. JAMES PARISH, LOUISIANA

1.0 PROJECT DESCRIPTION
The study area for this project is located in the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. The study area for this project is within the Upper Lake Pontchartrain Sub-basin; the Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the IH-10/Airline Highway corridor. Development along the IH-10/Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

The Small Diversion at Convent/Blind River restoration project was proposed to reverse the current decline of a portion of the southwestern portion of the Maurepas Swamp and to prevent the transition of the Swamp into marsh and open water. Reversing this decline would help to develop more sustainable wetland ecosystem which can serve to protect the local environment, economy, and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The specific restoration project objectives for the diversion at Convent/Blind River would be to:
- Promote water distribution in the southeastern portion of Maurepas Swamp to move stagnant water out of the system
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to maintain or increase elevation in the swamp
- Increase the durations of dry periods in the swamp to improve bald cypress and tupelo productivity and to increase seed germination and survival of these key species
- Improve fish and wildlife habitat in the swamp and in Blind River

The study of the Diversion at Convent / Blind River restoration project is evaluating a small hydraulic diversion (less than 3,000 cubic feet per second [cfs]) from the Mississippi River into Maurepas Swamp. Alternative locations for the proposed control structure in the vicinity of Convent, Louisiana, located at Mississippi River mile 159 are being investigated. The purpose of this study is to identify reasonable alternatives and to screen the alternatives down to a recommended plan. The Blind River headwaters are located in St. James Parish approximately 2 to 3 miles north of the east bank of the Mississippi River at Convent. The Blind River flows north then east through Ascension and St. John the Baptist Parishes before it empties into Lake Maurepas. The objective of this project is to introduce freshwater, sediment, and nutrients into the southwestern portion of the Maurepas Swamp to improve biological productivity that would facilitate accretion in the Swamp, and prevent further Swamp deterioration.

2.0 CONSTRUCTION ELEMENTS
The Romeville diversion alignment, with a 3,000 cfs capacity, would have six major components: a diversion culvert facility, a transmission canal, control structures of various sizes, berm gaps, cross culverts along the Highway 61 corridor, and instrumentation. Following is a general summary of the components.

2.1 DIVERSION CULVERT FACILITY
The diversion culvert facility would divert fresh water from the Mississippi River, transfer it under the east levee through a box culvert, and discharge it into the transmission canal. The primary hydraulic elements of the diversion culvert facility would be as follows:
- Three 10-feet x 10-feet multi-cell cast-in-place reinforced concrete box culverts under the east levee and LA 44

1705

Date	Author	Note

3/11/2010

- Three 10-feet x 10-feet cast iron sluice gates with motor operators on the culvert inlets
- Trash racks near the culvert inlet
- Inlet canal across the batture from the Mississippi River to the culvert inlet

LA 44 (River Road) is adjacent to the levee and the box culvert would extend under the road and discharge into the transmission canal 100 feet east of the road. Erosion protection would be provided at locations with higher flow velocities and turbulence, such as at the Mississippi River bank, in the inlet canal entrance, at the box culvert entrance, and at the culvert outlet.

Ancillary elements at the diversion culvert facility would include a gate tower to raise the sluice gate operators and operator access above the Mississippi River flood stage, a steel sheet pile cut-off wall in the levee to reduce the potential for seepage and piping (loss of fines), and stop logs both upstream and downstream of the sluice gates to isolate them for maintenance. The diversion site would include an access driveway, a site road for access to the top of the levee, fence, drainage, lighting, a security system, and a control building.

2.2 TRANSMISSION CANAL
The transmission canal would transfer the diverted water approximately three miles from the diversion culvert facility to an existing drainage channel at the perimeter of the Swamp. The transmission canal would be constructed with a 25% factor of safety for the flow rate to avoid overtopping the berms. This is in anticipation that as the Mississippi River stage varies, the diversion control system, though automated for flow regulation, may not control the flow rate to the precise design value. For the 3,000 cfs diversion, the transmission canal would be designed for 3,750 cfs.

The canal would be an earthen trapezoidal channel section, with a 155-foot wide bottom, 4:1 (H:V) side slopes, and a depth of approximately 12 feet, including a 2-foot freeboard. The top width would be approximately 250 feet. The hydraulic grade line would be above natural ground for most of the route. Therefore, embankments or berms with 34-foot wide tops would be constructed on both sides of the canal. The material excavated to form the channel would be used to construct the embankments.

1706

The transmission canal alignment crosses the Canadian National Railroad (CN RR) and LA 3125, a local highway. Both crossings would consist of eight 12-feet x 8-feet reinforced concrete box culverts across the full right-of-way.

2.3 CONTROL STRUCTURES
The project would use the existing drainage channels at the perimeter of the Swamp to distribute the diverted flow throughout and into the Swamp. The hydraulic grade line, or water surface elevation would need to be raised and controlled slightly (0.5 feet to 1.0 feet) above the existing levels and controlled to force the diverted water out of the drainage channels into the Swamp. Control structures with downward opening crest gates would be installed at key locations in the existing Parish Drainage System channels to perform this function.

The crest gate is a specialty gate that rotates on a shaft at the bottom of the channel and is operated by large hydraulic cylinders. The gate would be rotated up to the vertical position to increase the water surface elevation during the flow diversion. The gate would be rotated down to the channel bottom into the open position when there is no diversion, to allow for normal drainage, and to allow the passage of boats and barges. The crest gates would be installed in large concrete structures constructed in the existing drainage channel. Instrumentation, controls, a hydraulic power unit, and a generator would be located in a precast concrete building at each control structure site.

2.4 BERM GAPS
When the existing drainage channels were excavated in the Swamp, the excavated material was cast to one side of the channel forming spoil banks. The size of the spoil banks vary, with the top elevations ranging from Elev. 4 to Elev. 12. From field observations and the hydro-dynamic modeling, it has been determined that the spoil banks currently block flow circulation into and out of the swamp, resulting in stagnant areas and poor circulation of water through the hydrologic units. In the current *configuration, the spoil banks prevent the diverted water from easily entering and flowing through the Swamp.* Therefore, new 500-foot wide berm gaps would be excavated in the spoil banks at an approximate spacing of 2,500 feet on center. The gaps would be excavated to the elevation of the adjacent Swamp natural ground elevations and the spoil would be disposed behind the existing spoil banks. The spoil would be piled up to Elev. 6 to provide additional refuge areas for wildlife during

Date	Author	Note

3/11/2010

flood events in the Swamp.

2.5 CROSS CULVERTS AT THE HIGHWAY 61 CORRIDOR
The hydrodynamic modeling of the Swamp project area indicated that the Kansas City Southern Railroad (KCS RR) and the Highway 61 embankments disrupted the natural flow and circulation of water through the Swamp. This resulted in hydrologic units east and west of the KCS RR/Highway 61 corridor having stagnant water, poor drainage, and lack of sources of fresh water input. New culvert crossings would be added under Highway 61 at four locations. Each installation would consist of three 3-feet x 4-feet reinforced concrete box culverts. It is assumed that there are sufficient cross drainage openings at the KCS RR and additional culverts are not be required. Earthen channels (large ditches) would be excavated across the 500-foot space between the KCS RR and Highway 61 to interconnect the drainage capacity at the railroad with the new culverts at Highway 61.

2.6 INSTRUMENTATION
Instrumentation would be required to monitor and control the diversion flow rate and the water surface elevations in the diversion, transmission, and distribution system in the Swamp. Typically, flow rates and water levels would be measured and the feedback data would be used to adjust gate positions to control the desired parameters at the diversion culvert and the control structures. The monitoring and control data would be collected, analyzed, and transmitted to and from a control building on the diversion culvert site. Following are the main instrumentation for data collection and control that would be installed for each component:

- Diversion Culvert – The flow control at the diversion culvert would establish the flow rate for the project. The diversion flow rate would be set manually by an operator, with adjustments as necessary. The diversion culvert would have instrumentation for water levels at the culvert entrance and exit, for flow measurement, and for sluice gate positions. The control system at the diversion structure would be designed to automatically adjust the sluice gate openings as the Mississippi River stage varies to maintain a constant flow rate.
- Control Structures – The crest gates at the control structures would require water level measurement on both sides of the gates, and gate position measurement, to control gate position, water levels, and flow rates over the gates. The control gates would have manually set positions, with occasional adjustments based on feedback from system monitoring.

There would be no flow or water level control at the following components:
- Transmission Canal – There would be no instrumentation in the transmission canal to control flow rates or water surface elevations. However, the transmission canal would have level monitors at several locations to ensure that the berms are not overtopped.
- Berm Gaps – there would be no flow measurement, level measurement, or controls at the individual berm gaps. All water level control would be at the control structures.
- Cross Culverts at the Highway 61 Corridor – there would be no flow measurement, level measurement, or controls at the four cross culvert locations.

Water level monitors would be required in the Blind River at Highway 61, at IH-10, and possibly additional locations on Blind River and the existing drainage channel network within the Swamp. These monitors would provide feedback for the flow rate control and control gate settings.

The environmental monitoring and hydrological monitoring and data collection within the Swamp would be monitored and transmitted to the control building at the levee for recording and observation.

The data collected from the project would be used as input for adaptive management.

Real-time data would be required from the system components to allow the operator to control and adjust the system flow rates. Radio towers would be provided at each control structure in the Highway 61 corridor to communicate to the control building via a radio tower at the diversion facility. The towers would be 150 to 200 feet tall to have clear line-of-sight communications above the mature Bald Cypress trees.

3.0 ESTIMATED CONSTRUCTION DURATION
The project (for bond calculation purposes) is assumed to have a duration of approximately 3 years or 780 working days (working day is defined as an 8-hour day Monday

1707

Date	Author	Note

3/11/2010

through Friday excluding major holidays). It is assumed that actual project duration is approximately 36 months from notice to proceed (NTP). The NTP date and field mobilization date are unknown at this phase of the conceptual planning; however, for planning purposes a design completion date in June 2012 was assumed. Procurement and contract award were assumed to occur from July to September 2012 with construction activities starting January 2013.

4.0 ESTIMATE PREPARATION
This cost estimate was prepared based on the guidance provided in U.S. Army Corps of Engineers (USACE) engineer regulation ER 1110-2-1302 and engineer technical letter ETL 1110-2-573 and using the Micro Computer Aided Cost Engineering System (MCACES) Second Generation (MII) software version 3.0, build 4.

This cost estimate assumes that all the necessary equipment, labor, and material would be available for the project because it is located near New Orleans, Louisiana which is a major metropolitan area.

The quantities used in the estimate preparation were determined from the conceptual plans for the work and assumptions made by the cost estimators.

The structure of the estimate is organized according to the Civil Works Work Breakdown Structure (ETL 1110-2-573). The costs presented in this estimate are considered Class 4 with an accuracy range of +50%/-30% of actual cost according to the American Society for Testing and Materials (ASTM) Standard Classification for Cost Estimate Classification System (Designation E 2516-06).

4.1 LABOR RATES
This estimate is based on the latest available/supported MCACES MII labor rate database, which has been updated using the most recent Davis Bacon Wage Determinations for St. James Parish, Louisiana for the base and fringe rates. A labor premium was applied to the Davis Bacon wage determinations to account for a tight construction labor market in the New Orleans area. Subsistence was applied at the rate of $1 per hour.

A worker productivity of 95% was assumed due to the heat and humidity common to southern Louisiana.

Overtime was assumed for this cost estimate to address local concerns on accessibility and ability for hurricane evacuation routes to be available, and to anticipate potential contractor competitiveness with other projects in the area.

In addition, payroll taxes and insurance have been updated for each laborer using the following 2010 factors:

Federal/State Unemployment Taxes: 5.03% (0.8% Federal/4.23% State)
Social Security Taxes: 7.65%
Workmen's Compensation: Varies by trade. Ranges from 22.47% to 26.56%

4.2 EQUIPMENT RATES
This estimate is based on the latest available/supported MCACES MII equipment rate database (EP07R03), which has been updated using the latest Region 3 (LA) Area Factors, as provided in Appendix B of Engineering Pamphlet EP 1110-1-8, dated 10 September 2007. The Area Factors were further adjusted to account for LA state sales tax and current fuel costs (gasoline and diesel) at the time of estimate preparation, and therefore the equipment rates used in the estimate more accurately represent current 2010 energy prices.

4.3 CONTRACTORS/SUBCONTRACTORS
It is assumed that the work will be divided into more than one contract. The following provides an initial breakdown in contracts for this project:

- Diversion Culvert
  LA 44 detour and reconstruction
  Temporary Mississippi river levee

1708

Date	Author	Note

3/11/2010

Permanent levee removal and replacement
Diversion culverts construction

- Transmission Canal
  LA 3125 detour and reconstruction
  LA 3125 crossing
  CN RR crossing culverts construction
  Construction of earthen channel

- CN RR Relocation
  CN RR temporary relocation and reconstruction

- Control Structures and Berm Gaps
  Construction of control structures
  Formation of berm gaps
  Installation of instrumentation

- Highway 61 Crossing
  Highway 61 detour and reconstruction
  Construction of earthen channels between the KCS RR and Highway 61
  Highway 61 crossing culverts construction

- Pipeline Relocation
  Temporary or permanent relocation of utilities and pipelines in the LA 44 right-of-way

Although the cost estimate assigns different prime contractors based on the work division above, it is not separated into the different contracts. However, the Total Project Cost Summary tables in Appendix A are broken out by the potential contracts listed above.

The estimate assumes the work would be performed by a Prime Contractor or one of the following Subcontractors to the Prime Contractor:

SUBCONTRACTORS
Piling Subcontractor
Concrete Subcontractor
Mechanical Subcontractor
Building Subcontractor
Electrical/Instrumentation Subcontractor
Asphalt Paving Subcontractor
Fence Subcontractor
Revegetation Subcontractor

A Class B surety bond rate was assumed for the both the Prime Contractor and its subcontractors for civil works projects (Construction Cost Estimating Guide For Civil Works, ETL 1110-2-573). The bond rate is calculated by the MCACES MII software.

The following Prime Contractor overhead, profit, and bond markups are assumed:

1709

Date	Author	Note

3/11/2010

Job Office Overhead (JOOH) = 10%
Home Office Overhead (HOOH) = 10%
Profit = 8%
Bond = Class B – computed by the MCACES MII software

For most of the subcontractors, the following Subcontractor overhead, profit, and bond markups are assumed:

Job Office Overhead (JOOH) = 2%
Home Office Overhead (HOOH) = 10%
Profit = 10%

For the Piling Subcontractor, the following overhead, profit, and bond markups are assumed:

Job Office Overhead (JOOH) = 5%
Home Office Overhead (HOOH) = 10%
Profit = 10%

The Prime Contractor also applies their markups on work done by the subcontractor. The following Prime Contractor markups on Subcontractors are assumed:

Job Office Overhead (JOOH) = 2%
Home Office Overhead (HOOH) = 3%
Profit = 3%
Bond = Computed by the MCACES MII software

4.4 PROJECT OWNER MARKUPS

The owner also has markups on the project level that are applied after contractor markups. These markups are included below. Project owner markups (escalation and contingency) were not applied in the MCACES MII estimate but rather in a separate Total Project Cost Summary Tables in Attachment A. Escalation was determined by the Preliminary Project Schedule in Attachment B.

An 8.75% state sales tax is applied for St. James Parish, Louisiana (4% state sales tax and 4.75% Parish sales tax); it is assumed that the Contractor has an in-state address for purposes of ordering/purchasing materials that incur sales tax.

For the base estimate contingency was applied to lands and damages property acquisition and owner relocations and all construction features. Total project contingency was quantified using the August 2007 USACE Cost and Schedule Risk Analysis Process guidance and is based on Monte Carlo simulation of the cost estimate using Crystal Ball software. The cost risk analysis served to quantify contingency based on an 80% level of confidence and corresponds directly to the risk register prepared by the project delivery team. Total project contingency was quantitatively allocated to individual project features based on dollar-weighted relative risk as measured by the standard deviation of the feature-specific Crystal Ball forecast.

4.5 DETAIL COST SOURCES

The MCACES MII supporting databases (labor, equipment, materials) were used whenever vendor quotes could not be obtained for this cost estimate. Direct detail costs were derived using several sources of cost information. The following are the reference codes used in the detail section to identify sources and are listed in order of usage within the estimate:

1) MCACES MII English Cost Book 2008 (as listed by database ID) Note: Labor, equipment and crew databases have been updated to 2010 using current cost data. Material costs were updated with current vendor quotes or from RS Means CostWorks 2010.

1710

Date	Author	Note
3/11/2010		2) Vendor Quotes or costs based on Previous Work by CDM (no code listed) 3) CostWorks 2010 from RS MEANS "00 00 0000 0000"

5.0 RISK ANALYSIS

The overall risk management process for the project involves (1) identifying risk factors, (2) analyzing and quantifying the properties of those risk factors, (3) mitigating the impact of the factors on planned project performance, and (4) developing and implementing a risk management plan. While the risk management process is just one part of the overall project planning process, it is incorporated in a concurrent and iterative manner with the other planning processes so as to refine project plans with a goal of increasing performance certainty. The first two elements of the risk management process (identifying risk factors; analyzing and quantifying the properties of those risk factors) have been performed in accordance with the Cost and Schedule Risk Analysis Process described in the August 2007 guidance developed by the USACE Walla Walla District.

6.0 ATTACHMENTS

Attachment A - Total Project Cost Summary Tables
Attachment B - Preliminary Project Schedule
Attachment C - Calculations
Attachment D - Wage Determinations
Attachment E - Vendor Quotes
Attachment F - MCACES MII Input Backup

1711

Direct Cost Markups
Productivity
Overtime

Category
Productivity
Overtime

Method
Productivity
Overtime

	Days/Week	Hours/Shift	Shifts/Day	1st Shift	2nd Shift	3rd Shift
Standard	*5.00*	*8.00*	*1.00*	*8.00*	*0.00*	*0.00*
Actual	*6.00*	*8.00*	*1.00*	*10.00*	*0.00*	*0.00*

Day	OT Factor	Working	OT Percent	FCCM Percent
Monday	*1.00*	*Yes*	*18.33*	*(33.33)*
Tuesday	*1.00*	*Yes*		
Wednesday	*1.00*	*Yes*		
Thursday	*1.00*	*Yes*		
Friday	*1.50*	*Yes*		
Saturday	*2.00*	*Yes*		
Sunday	*2.00*	*No*		

Sales Tax — TaxAdj — Running % on Selected Costs
MatlCost
Supply/Allowan

Contractor Markups

	Category	Method
JOOH	JOOH	Direct %
JOOH Subcontrator	JOOH	Direct %
JOOH Specialized Sub	Allowance	Running %
HOOH	HOOH	Direct %
HOOH Subcontractor	HOOH	Direct %
HOOH Specialized Sub	Allowance	Running %
Profit	Profit	Direct %
Profit Subcontractor	Profit	Direct %
Profit - Specialized Sub	Allowance	Running %
Bond	Bond	Bond Table

Class B, Tiered, 24 months, 1.00% Surcharge

Contract Price	Bond Rate
500,000	*15.84*
2,000,000	*9.57*
2,500,000	*7.59*
2,500,000	*6.93*
100,000,000,000	*6.34*

1712

Description	Quantity	UOM	LaborCost	EQCost	MatlCost	SubBidCost	CostToPrime	ContractCost
Project Cost Summary Report			8,837,494	8,023,928	19,372,127	30,423,190	57,878,880	90,475,627
01 Lands and Damages	1.00	LS	0	0	0	2,069,900	0	2,069,900
01 10 Real Estate Acquisition	1.00	LS	0	0	0	2,069,900	0	2,069,900
02 Relocations	1.00	LS	930,425	1,056,002	898,823	4,680,000	8,286,175	10,611,495
02 01 Roads	1.00	LS	127,083	138,430	445,326	0	879,728	1,076,508
02 02 Railroads	1.00	LS	242,481	161,011	373,106	0	949,758	1,232,231
02 03 Cemeteries, Utilities, and Structures	1.00	LS	560,861	756,561	80,391	4,680,000	6,456,690	8,302,756
06 Fish and Wildlife Facilities	1.00	LS	0	0	0	6,620,000	0	6,620,000
06 03 Wildlife Facilities and Sanctuaries	1.00	LS	0	0	0	6,620,000	0	6,620,000
15 Floodway Control-Diversion Structures	1.00	LS	7,907,069	6,967,926	18,473,304	2,859,072	49,592,704	56,980,014
15 00 Floodway Control-Diversion Structures	1.00	LS	7,907,069	6,967,926	18,473,304	2,859,072	49,592,704	56,980,014
30 Planning, Engineering, and Design	1.00	LS	0	0	0	6,759,152	0	6,759,152
31 Construction Management	1.00	LS	0	0	0	7,435,066	0	7,435,066



US Army Corps
of Engineers®



State of Louisiana

LCA SMALL DIVERSION AT CONVENT/BLIND RIVER

COST AND SCHEDULE RISK ANALYSIS

Prepared for:

CDM

CAMP DRESSER & MCKEE INC.
Baton Rouge, Louisiana

Prepared by:

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The Risk & Decision Analysis Company

RISK STRATEGICS, LLC
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March 23, 2010

TABLE OF CONTENTS

EXECUTIVE SUMMARY ES-1

MAIN REPORT 1

1.0 PURPOSE 1

2.0 BACKGROUND 1

3.0 REPORT SCOPE 2

3.1 Project Scope 2

3.2 USACE Risk Analysis Process 2

4.0 METHODOLOGY / PROCESS 3

4.1 Identify and Assess Risk Factors 4

4.2 Quantify Risk Factor Impacts 5

4.3 Analyze Cost Estimate and Schedule Contingency 5

5.0 KEY ASSUMPTIONS AND LIMITATIONS 6

6.0 RESULTS 7

6.1 Risk Register 8

6.1 Cost Risk Analysis - Cost Contingency Results 9

6.3 Schedule Risk Analysis – Schedule Contingency Results 12

6.4 Combined Cost and Schedule Contingency Results 14

7.0 MAJOR FINDINGS/OBSERVATIONS 16

8.0 RECOMMENDATIONS 17

LIST OF TABLES

Table ES-1. Tentatively Selected Plan Contingency Summary ES-2

Table ES-2. Feature Level Contingency at P80 ..... ES-3

Table 1. Cost Contingency Summary 9

Table 2. Schedule Contingency Summary 12

Table 3. Tentatively Selected Plan Contingency Summary 14

Table 4. Feature Level Contingency at P80 16

LIST OF FIGURES

Figure 1. Sensitivity Analysis – Cost Risks 11

Figure 2. Sensitivity Analysis – Schedule Risks 13

Figure 3. Remaining Cost Risk Analysis 15

LIST OF APPENDICES

Risk Register ..... APPENDIX A

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EXECUTIVE SUMMARY

The purpose of this report is to document the results of the Cost and Schedule Risk Analysis (CSRA) performed for the Louisiana Coastal Area (LCA) Small Diversion at Convent/Blind River (Blind River Diversion Project) located in St. James Parish, Louisiana. The CSRA results reflect both cost and schedule risks and are intended to define contingency for the remaining base cost estimate on the Tentatively Selected Plan for the project.

The CSRA was prepared in accordance with US Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features. The resulting study provides a Tentatively Selected Plan cost estimate summary indicating the estimated remaining base costs and contingencies required for various levels of statistical confidence.

The Blind River Diversion Project technical scope, cost estimates, and schedules were developed by the USACE New Orleans District and the State of Louisiana. These work projects serve as the basis for the risk analysis. For CSRA purposes, the project scope consists of the following features:

- Lands and Damages
- Relocations
- Floodway Control - Diversion Structures
- Planning, Engineering and Design
- Construction Management

Fish and Wildlife Facilities (Adaptive Management) costs estimated at $6,620,000 are assumed to include appropriate contingency and have been excluded from the project scope for CSRA purposes.

Summary of Findings

Table ES-1 was developed as part of the CSRA and provides total Tentatively Selected Plan cost contingencies for the Blind River Diversion Project calculated at various confidence level intervals and rounded to the nearest thousand dollars. Contingency values are rounded to the nearest percent. The total Tentatively Selected Plan cost contingency was quantified as approximately $26.3 million at the eighty-percent confidence level (P80) or about 31% of the remaining base cost estimate of $83,855,627.

To combine cost and schedule contingency results into the total cost contingency presented in Table ES-1, schedule contingency was used to calculate the additional hotel costs and escalation risk impact of project delays. These calculated costs were then added to the cost contingency amount to reflect the USACE standard for presenting the estimated cost for the fully funded project amount.

The P80 level is the contingency value most commonly reported for programming and management purposes within USACE. These results reflect contingencies based on both the cost and schedule risk analyses. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

Table ES-1. Tentatively Selected Plan Contingency Summary

Confidence Level	Remaining Base Cost + Contingency	Contingency ($)	Contingency (%)
P0	$86,627,000.00	$2,771,000.00	3.0%
P10	$98,384,000.00	$14,528,000.00	17.0%
P20	$100,786,000.00	$16,930,000.00	20.0%
P30	$102,481,000.00	$18,625,000.00	22.0%
P40	$103,931,000.00	$20,075,000.00	24.0%
P50	$105,272,000.00	$21,416,000.00	26.0%
P60	$106,654,000.00	$22,798,000.00	27.0%
P70	$108,179,000.00	$24,323,000.00	29.0%
P80	**$110,193,000.00**	**$26,337,000.00**	**31.0%**
P90	$112,994,000.00	$29,138,000.00	35.0%
P100	$141,358,000.00	$57,502,000.00	69.0%

The key cost risk drivers identified through sensitivity analysis are *Railroad Involvement* and *Relocation of Unknown Utilities* which respectively contribute about 19.0 and 12.4 percent of statistical cost variance during *Monte Carlo* simulation. *Construction Productivity Assumptions*, *Geotechnical Uncertainty*, *Lack of Surveys*, *Timing of Project Funding*, and *Market Condition and Bidding Environment* are also important cost risk drivers which together contribute about 42.7 percent of statistical cost variance.

The key schedule risk driver identified through sensitivity analysis is *Timely Design* which contributes about 66.4 percent of statistical schedule duration variance during *Monte Carlo* simulation. *Timing of Project Funding*, *Railroad Involvement*, and *Project*

Priority are also important schedule risk drivers which together contribute about 32.7 percent of statistical schedule variance.

Table ES-2 provides a breakdown of Blind River Diversion Project Tentatively Selected Plan contingency by WBS feature at P80. Values in Table ES-2 are rounded to the nearest dollar or one tenth of one percent.

Table ES-2. Feature Level Contingency at P80

Feature	Remaining Base Cost	Contingency ($)	Contingency (%)	Remaining Base Cost + Contingency
Lands and Damages	$2,069,900	$1,849,471	89.4%	$3,919,371
Relocations	$10,611,495	$6,428,476	60.6%	$17,039,971
Floodway Control - Diversion Structure	$56,980,014	$16,092,218	28.2%	$73,072,232
Planning, Engineering and Design	$6,759,152	$774,178	11.5%	$7,533,330
Construction Management	$7,435,066	$1,192,658	16.0%	$8,627,724

Summary of Recommendations

Several recommendations are provided in the CSRA, as follows:

1. Periodically update the CSRA. Risk events are dynamic and should be evaluated regularly through all phases of design, construction and O&M. To fully recognize its benefits, CSRA should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

2. Consider the entire risk analysis curve for budgeting and scheduling purposes. The amount of contingency included in project control plans usually depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans.

3. Develop a standalone Risk Management Plan or substantially incorporate the key elements of risk management into the Project Management Plan. The key elements of project risk management include risk management planning, risk identification, risk analysis, risk responses, and risk monitoring/control. The CSRA focuses on risk identification and risk analysis but is not intended to address the other key elements of risk management.

4. Use the risk register routinely as a tool for tracking risk mitigation effectiveness and include the risk mitigation actions identified in the risk register for high-level risks on the project schedule. Updating the risk register as risks are realized or eliminated during project execution may simplify periodic CSRA updates and maintain PDT focus on key risk drivers.

MAIN REPORT

1.0 PURPOSE

The purpose of this report is to document the results of the Cost and Schedule Risk Analysis (CSRA) performed for the Louisiana Coastal Area (LCA) Small Diversion at Convent/Blind River (Blind River Diversion Project) located in St. James Parish, Louisiana. The CSRA results reflect both cost and schedule risks and are intended to define contingency for the remaining base cost estimate on the Tentatively Selected Plan for the project.

2.0 BACKGROUND

The study area for the Blind River Diversion Project is within the Upper Lake Pontchartrain Sub-basin; the Upper Lake Pontchartrain Sub-basin includes Lake Maurepas, Maurepas Swamp, Blind River, and portions of the Amite River.

The Maurepas Swamp is one of the largest remaining tracts of coastal freshwater swamp in Louisiana. The Blind River flows from St. James Parish, through Ascension Parish and St John the Baptist Parish, and then discharges into Lake Maurepas.

The Maurepas Swamp serves as a buffer between the open water areas of Lakes Maurepas and Pontchartrain and developed areas along the I-10/Airline Highway corridor. Development along the I-10/Airline Highway corridor in this area includes residential, commercial, and industrial land use. The Maurepas Swamp is used for fishing, hunting, and other recreational activities, and as a large contiguous tract of bald cypress-tupelo swamp near the New Orleans metropolitan area, has considerable cultural significance.

The Small Diversion at Convent/Blind River restoration project was proposed to reverse the current decline of a portion of the southwestern portion of the Maurepas Swamp and to prevent the transition of the Swamp into marsh and open water. Reversing this decline would help to develop a more sustainable wetland ecosystem which can serve to protect the local environment, economy, and culture. In light of Louisiana's extreme vulnerability to intense storms this project may also provide some measure of flood damage protection.

The specific restoration project objectives for the diversion at Convent/Blind River would be to:

- Promote water distribution in the southeastern portion of Maurepas Swamp to move stagnant water out of the system.
- Facilitate swamp building, at a rate greater than swamp loss due to subsidence and sea level rise, by increasing sediment input and swamp production to

maintain or increase elevation in the swamp.

- Increase the durations of dry periods in the swamp to improve bald cypress and tupelo productivity and to increase seed germination and survival of these key species.
- Improve fish and wildlife habitat in the swamp and in Blind River.

3.0 REPORT SCOPE

The CSRA was prepared in accordance with US Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for both cost and schedule risks for all project features. The resulting study provides a Tentatively Selected Plan cost estimate summary indicating the estimated remaining base costs and contingencies required for various levels of statistical confidence.

3.1 Project Scope

The Blind River Diversion Project technical scope, cost estimates, and schedules were developed by the USACE New Orleans District and the State of Louisiana. These work projects serve as the basis for the risk analysis. For CSRA purposes, the project scope consists of the following features:

- Lands and Damages
- Relocations
- Floodway Control - Diversion Structures
- Planning, Engineering and Design
- Construction Management

Fish and Wildlife Facilities (Adaptive Management) costs estimated at $6,620,000 are assumed to include appropriate contingency and have been excluded from the project scope for CSRA purposes.

3.2 USACE Risk Analysis Process

The risk analysis process for this study generally follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Oracle Crystal Ball software application. The risk analysis results are intended to serve several functions, one being the establishment of reasonable

contingencies reflective of various levels of confidence to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to substantially meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.
- Memorandum from Major General Don T. Riley (US Army Director of Civil Works), dated July 3, 2007.
- Engineering and Construction Bulletin issued by James C. Dalton, P.E. (Chief, Engineering and Construction, Directorate of Civil Works), dated September 10, 2007.
- Engineering Regulation ER 1110-2-1150 dated August 31, 1999.
- Engineering Regulation ER 1110-2-1302 dated September 15, 2008.
- Engineering Technical Letter ETL 1110-2-573 dated September 30, 2008.

4.0 METHODOLOGY / PROCESS

The risk analysis process used for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the Tentatively Selected Plan cost estimate to achieve any desired level of cost confidence. A parallel process was also used to determine the probability of various project schedule duration outcomes and quantify the required schedule contingency (float) needed in the schedule to achieve any desired level of schedule confidence.

In simple terms, contingency is an amount added to an estimate (cost or schedule) to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency

should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost Engineering DX guidance for cost and schedule risk analysis generally focuses on the eighty-percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk adverse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. Consistent with Cost Engineering DX guidance, the *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software application (Oracle Crystal Ball) that is an add-in to Microsoft Excel.

The Blind River Diversion Project Tentatively Selected Plan cost estimate was prepared by the State of Louisiana and USACE New Orleans District in MII, the second generation of the Micro-Computer Aided Cost Estimating System (MCACES). The Tentatively Selected Plan schedule was prepared by the State of Louisiana and USACE New Orleans District using the Microsoft Project scheduling software application. Because Crystal Ball is an Excel add-in, the cost estimate and schedule were recreated in Excel format from their native MII and Microsoft Project formats, respectively. The level of detail recreated in the Excel-format cost estimate and schedule is sufficient for risk analysis purposes, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1 Identify and Assess Risk Factors

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT should be obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and was considered.

A formal risk identification and analysis teleconference was conducted for the Blind River Diversion Project Tentatively Selected Plan on February 24, 2010. The teleconference included capable and qualified representatives from multiple project team disciplines and functions, including:

- Project Management
- Design Engineering

- Economics
- Biological Assessment
- Environmental
- Hydraulics and Hydrology
- Cost Engineering

Additionally, numerous informal discussions were conducted with the project team throughout the risk analysis process on an as-needed basis to further facilitate risk factor identification, market analysis and risk assessment.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans were analyzed using a combination of professional judgment, empirical data and analytical techniques. Risk factor impacts were represented by probabilistic distribution functions (density functions) for inputs into the Crystal Ball software application. The probabilistic distribution functions are used to describe the characteristic population (tendencies) of the risk factor inputs. The following elements of each risk factor were addressed in the risk factor quantification process:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.
- Mathematical correlations between risk factors.
- Affected cost estimate and schedule elements.

Risk factor quantification focused on the various project features as presented in the Tentatively Selected Plan cost estimate and listed in Section 3.1 (Project Scope). This was done because it was recognized that the various features carry differing degrees of risk as related to cost, schedule, design complexity and design progress.

The resulting product from risk factor identification, assessment and quantification was captured within a risk register for both cost and schedule risk concerns. The risk register is presented in Appendix A.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency was analyzed using the Crystal Ball software application. *Monte Carlo* analysis was performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified in the risk register. Contingencies were calculated by applying only the moderate and high level

risks identified for the Tentatively Selected Plan (*i.e.*, low-level risks were not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies).

For the cost estimate, contingency was calculated as the difference between the cost forecast at various confidence level intervals and the remaining base cost estimate. The remaining base cost estimate is the most likely cost estimate less any assumed contingency.

For the schedule, contingency was calculated as the difference between the duration forecast at various confidence level intervals and the base schedule duration. The duration contingency was then used to estimate *hotel* costs (see next paragraph) and calculate the additional time value of money impact of project delays that are included in the presentation of total cost contingency in Section 6. The resulting time value of money, or added escalation risk, and hotel costs are added into the cost contingency amount to reflect the USACE standard for presenting the estimated cost for the fully funded project amount.

Hotel costs are fixed costs that are inherently incurred as a result of schedule delays. These fixed costs may include general site conditions, rents, project management, supervision and administration, and elements of home office or field office overhead. In practice, sufficiently detailed cost estimates and resource-loaded schedules are often not available to support detailed *hotel* cost estimates for risk analysis and only rough order of magnitude estimates can be developed.

Total contingency (reflecting cost and schedule impacts) was allocated on a WBS feature level based on the dollar-weighted relative risk of each feature as quantified by *Monte Carlo* simulation. Standard deviation was used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of total project contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0 KEY ASSUMPTIONS AND LIMITATIONS

Key assumptions and limitations are those that are most likely to significantly affect the determinations of contingency presented in the CSRA. The key assumptions and limitations are important to help ensure that project leadership and other decision makers understand the steps, logic, and decisions made in the risk analysis, as well as any resultant implications on the use of outcomes and results.

The following list identifies the key risk analysis assumptions and limitations within the context of the Blind River Diversion Project CSRA. For each item, the context is first provided and then followed by the key assumption or limitation.

1. Unknown Decisions or Decision Makers: The CSRA was prepared using a framework to generate contingency information that is appropriate for use by State of Louisiana and USACE decision makers for scheduling, budgeting, and project

control purposes. The framework may generate results that are appropriate for use by a wide variety of decision makers or stakeholders; however, the assumed use of CSRA results is limited to scheduling, budgeting, and project control. Other uses by unknown decision makers may not be appropriate.

2. Dynamic Risks: Risk events are dynamic, not static, and should be evaluated regularly through all phases of design, construction and O&M (if required). The CSRA is based on the identification and assessment of risks as of the date of this document. Reduced utility of current CSRA results should be assumed if the likelihood and impact of risks change over time.

3. Causal Relationships: With the exception of risk events identified as correlated in the risk register, it is assumed that the impacts of risks are independent and that the realization of one risk does not cause the realization of another. Significant variance of the risk model results from actual project costs and schedules may be experienced if significant causal relationships exist between risks assumed to be independent.

4. Conservation of Market Pricing Risk: The CSRA assumes that market pricing risks are not created or destroyed but can only be transferred or shared *at a price* as a result of various contract acquisition strategies. As an example, it is assumed that a contractor will add a level of contingency to a fixed price bid, relative to a cost reimbursable bid, that is reflective of the risk transferred contractually from the Government to the contractor. Other aspects of contract acquisition strategies not related to market pricing, such as the management cost of modifications or claims, are not included in this assumption. Any contract acquisition strategy that actually transfers market pricing risk to a contractor *at no cost* to the Government is not reflected in the CSRA.

5. *Unknown Unknown* and *Unknowable Risks*: The Cynefin Framework describes decision-making contexts, in part, by characteristic types of uncertainty. Simple, complicated, complex and chaotic contexts within the framework are respectively associated with *known known*, *known unknown*, *unknown unknown* and *unknowable* uncertainties. The CSRA process focuses on *known known* and *known unknown* risks and is not intended to quantify the impacts of *unknown unknown* or *unknowable* risks. Significant variance of the risk model results from actual project costs and schedules may be experienced if *unknown unknown* or *unknowable* risks, as defined in the Cynefin Framework, are realized.

6.0 RESULTS

The results of the Blind River Diversion Project CSRA are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are

presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1 Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The risk register for the Blind River Diversion Project is presented as Appendix A. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis.

The Blind River Diversion Project risk register identifies 35 risks that are organized into the following categories:

- Project Management and Organizational Risks
- Contract Acquisition Risks
- Technical Risks
- Lands and Damages Risks
- Regulatory and Environmental Risks
- Construction Risks
- Estimate and Schedule Risks
- External Risks

In regard to project cost, 21 risks are rated as either moderate level or high level based on the risk level matrix identified in Cost Engineering DX guidance. Eighteen risks are identified as either moderate level or high level in regard to project schedule. Contingencies were calculated by applying only the moderate and high level risks identified for the Tentatively Selected Plan (*i.e.*, low-level risks were not considered, but remain within the risk register to serve historical purposes as well as support follow-on risk studies).

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project lifecycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact.
- Providing project sponsors, stakeholders and leadership/management with a documented framework from which risk status can be monitored.
- Communicating risk management issues.
- Providing a mechanism for eliciting risk analysis feedback and project control input.

- Identifying risk transfer, elimination or mitigation actions required for implementation of risk management plans.

6.1 Cost Risk Analysis - Cost Contingency Results

Table 1 provides the cost contingencies for the Blind River Diversion Project calculated at various confidence level intervals and rounded to the nearest thousand dollars. Contingency values are rounded to the nearest one-tenth of one percent. Cost contingency was quantified as approximately $22.3 million at P80 (about 26.6% of the remaining base cost estimate of $83,855,627).

Table 1. Cost Contingency Summary

Confidence Level	Remaining Base Cost + Contingency	Contingency ($)	Contingency (%)
P0	$86,380,000	$2,525,000	3.0%
P10	$96,898,000	$13,043,000	15.6%
P20	$98,725,000	$14,870,000	17.7%
P30	$100,072,000	$16,216,000	19.3%
P40	$101,273,000	$17,417,000	20.8%
P50	$102,379,000	$18,523,000	22.1%
P60	$103,511,000	$19,655,000	23.4%
P70	$104,736,000	$20,880,000	24.9%
P80	**$106,157,000**	**$22,302,000**	**26.6%**
P90	$108,163,000	$24,308,000	29.0%
P100	$132,817,000	$48,962,000	58.4%

Sensitivity analysis generally ranks the relative importance of each risk. The Crystal Ball software uses a statistical measure (contribution to variance) that approximates the importance of each risk contributing to variability of cost outcomes during *Monte Carlo* simulation. In variance-based sensitivity analysis, expectation values have to be evaluated to generate a global sensitivity measure. Because expectation values are means (probability-weighted averages), using the importance measures to calculate the contingency associated with a risk at any given confidence level would generally not be meaningful. Furthermore, variance-based sensitivity analysis may provide misleading results for correlated risks.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register,

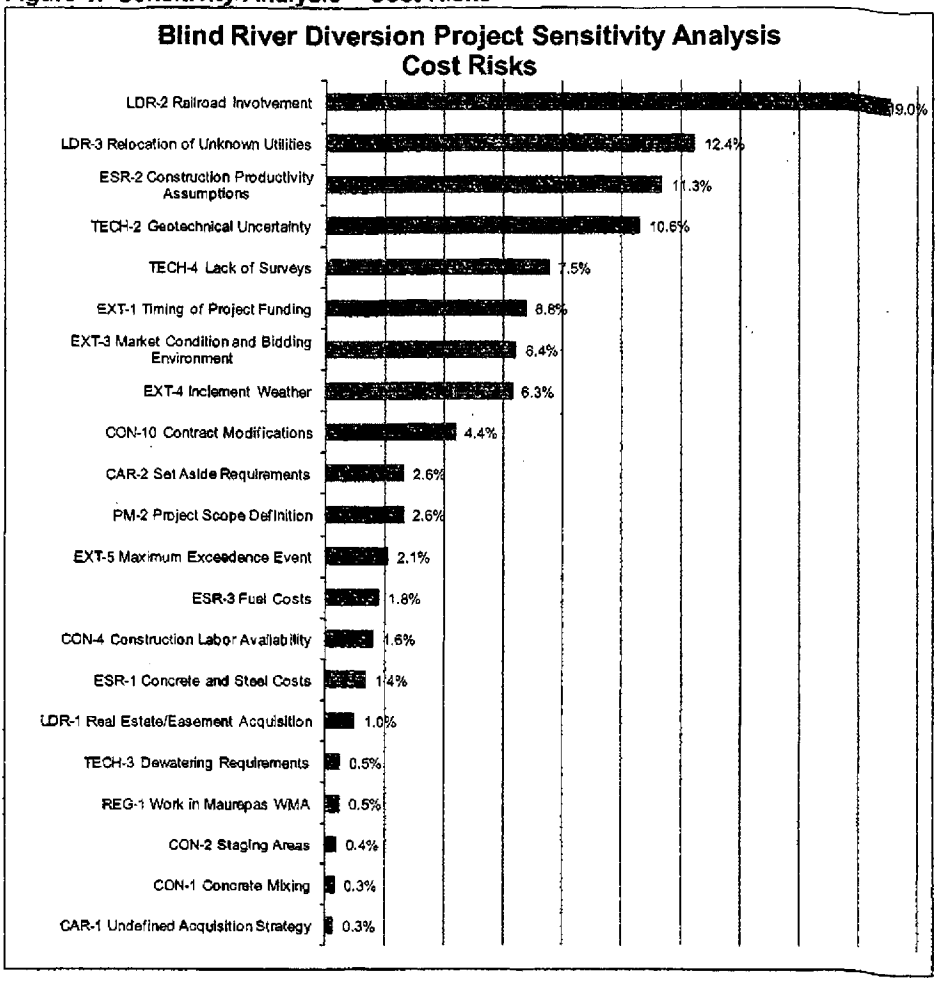
sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept or transfer key risks.

The risks considered as key or primary cost drivers are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost and are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to total project cost.

Figure 1 presents a sensitivity analysis that includes the moderate and high level cost risks identified in the risk register for the Blind River Diversion Project. Risks that contribute less than 0.1% of statistical cost variance during *Monte Carlo* simulation are omitted from the figure.

The key cost risk drivers identified through sensitivity analysis are *Railroad Involvement* and *Relocation of Unknown Utilities* which respectively contribute about 19.0 and 12.4 percent of statistical cost variance during *Monte Carlo* simulation. *Construction Productivity Assumptions*, *Geotechnical Uncertainty*, *Lack of Surveys*, *Timing of Project Funding*, and *Market Condition and Bidding Environment* are also important cost risk drivers which together contribute about 42.7 percent of statistical cost variance.

Figure 1. Sensitivity Analysis – Cost Risks



Note: Variance-based sensitivity analysis provides quantitative information about the importance of the risks; however, extrapolations or ancillary uses of the information are not recommended. Rather than evaluation of contingency, the primary intended use of sensitivity analysis is evaluation of the risk model. Risks preceded by an asterisk are correlated with one or more other risks as indicated in the risk register. Variance-based sensitivity analysis may provide misleading results for correlated risks.

6.3 Schedule Risk Analysis – Schedule Contingency Results

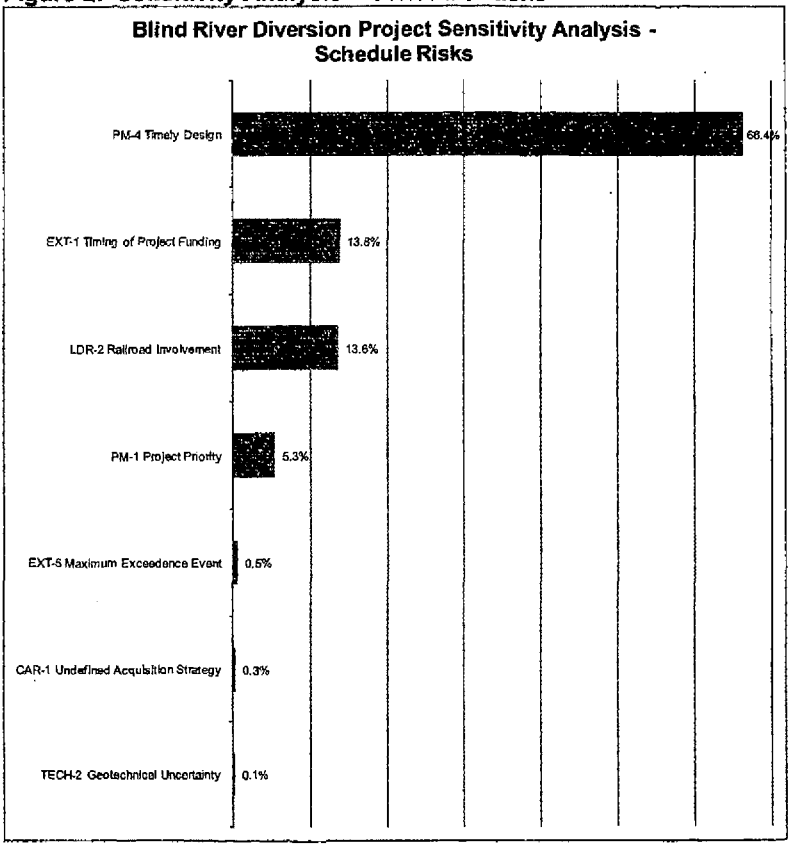
Table 2 provides the schedule duration contingencies for the Blind River Diversion Project calculated at various confidence level intervals and rounded to the nearest day. Contingency values are rounded to the nearest one-tenth of one percent. Schedule duration contingency was quantified as 568 days at P80 (about 30.4% of the remaining base schedule duration of approximately 1,866 calendar days). It is important to note that these results reflect only those contingencies established from the schedule risk analysis and do not reflect the influences of schedule float.

Table 2. Schedule Contingency Summary

Confidence Level	Base Duration + Contingency (calendar days)	Contingency (calendar days)	Contingency (%)
P0	1,901	35	1.9%
P10	2,076	210	11.3%
P20	2,157	291	15.6%
P30	2,206	340	18.2%
P40	2,241	375	20.1%
P50	2,274	408	21.9%
P60	2,309	443	23.7%
P70	2,351	485	26.0%
P80	**2,434**	**568**	**30.4%**
P90	2,545	679	36.4%
P100	3,059	1,193	63.9%

Figure 2 presents a sensitivity analysis that includes the moderate and high level schedule duration risks identified in the risk register for the Blind River Diversion Project. Risks that contribute less than 0.1% of statistical schedule variance during *Monte Carlo* simulation are omitted from the figure.

Figure 2. Sensitivity Analysis – Schedule Risks



Note: Variance-based sensitivity analysis provides quantitative information about the importance of the risks; however, extrapolations or ancillary uses of the information are not recommended. Rather than evaluation of contingency, the primary intended use of sensitivity analysis is evaluation of the risk model. Risks preceded by an asterisk are correlated with one or more other risks as indicated in the risk register. Variance-based sensitivity analysis may provide misleading results for correlated risks.

The key schedule risk driver identified through sensitivity analysis is *Timely Design* which contributes about 66.4 percent of statistical schedule duration variance during *Monte Carlo* simulation. *Timing of Project Funding*, *Railroad Involvement*, and *Project Priority* are also important schedule risk drivers which together contribute about 32.7 percent of statistical schedule variance.

6.4 Combined Cost and Schedule Contingency Results

Table 3 provides total Tentatively Selected Plan cost contingencies for the Blind River Diversion Project calculated at various confidence level intervals and rounded to the nearest thousand dollars. Contingency values are rounded to the nearest percent. To combine cost and schedule contingency results into a total cost contingency, schedule contingency was used to calculate the additional hotel costs and escalation risk impact of project delays. These calculated costs were then added to the cost contingency amount to reflect the USACE standard for presenting the estimated cost for the fully funded project amount.

The total Tentatively Selected Plan cost contingency was quantified as approximately $26.3 million at the eighty-percent confidence level (P80) or about 31% of the remaining base cost estimate of $83,855,627. About 14 percent of the total cost contingency is associated with schedule risk (*i.e.*, about 4.4 out of the 31 total percentage points). It is important to note that these results reflect contingencies based on both the cost and schedule risk analyses.

Table 3. Tentatively Selected Plan Contingency Summary

Confidence Level	Remaining Base Cost + Contingency	Contingency ($)	Contingency (%)
P0	$86,627,000.00	$2,771,000.00	3.0%
P10	$98,384,000.00	$14,528,000.00	17.0%
P20	$100,786,000.00	$16,930,000.00	20.0%
P30	$102,481,000.00	$18,625,000.00	22.0%
P40	$103,931,000.00	$20,075,000.00	24.0%
P50	$105,272,000.00	$21,416,000.00	26.0%
P60	$106,654,000.00	$22,798,000.00	27.0%
P70	$108,179,000.00	$24,323,000.00	29.0%
P80	**$110,193,000.00**	**$26,337,000.00**	**31.0%**
P90	$112,994,000.00	$29,138,000.00	35.0%
P100	$141,358,000.00	$57,502,000.00	69.0%

Figure 3 provides a summary graph of the Blind River Diversion Project Tentatively Selected Plan risk analysis.

Figure 3. Remaining Cost Risk Analysis

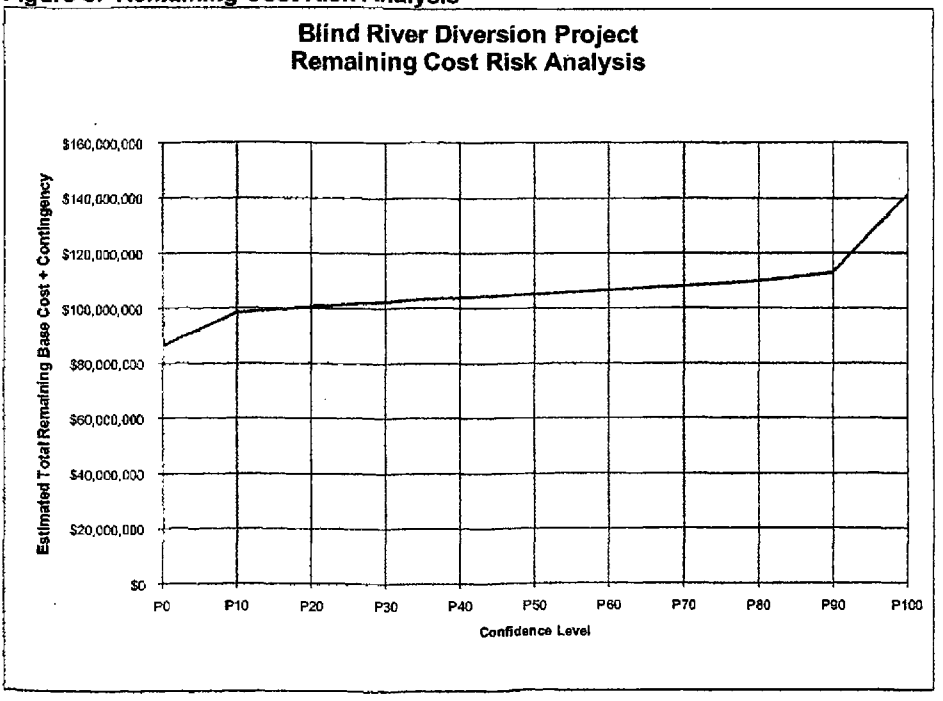


Table 4 provides a breakdown of Tentatively Selected Plan contingency by WBS feature at P80.

Table 4. Feature Level Contingency at P80

Feature	Remaining Base Cost	Contingency ($)	Contingency (%)	Remaining Base Cost + Contingency
Lands and Damages	$2,069,900	$1,849,471	89.4%	$3,919,371
Relocations	$10,611,495	$6,428,476	60.6%	$17,039,971
Floodway Control - Diversion Structure	$56,980,014	$16,092,218	28.2%	$73,072,232
Planning, Engineering and Design	$6,759,152	$774,178	11.5%	$7,533,330
Construction Management	$7,435,066	$1,192,658	16.0%	$8,627,724

7.0 MAJOR FINDINGS/OBSERVATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes. Results also provide tools to support decision making and risk management as projects progress through planning and implementation.

Major findings and observations of the risk analysis are listed below.

1. The total Tentatively Selected Plan cost contingency was quantified as approximately $26.3 million at the eighty-percent confidence level (P80) or about 31% of the remaining base cost estimate of $83,855,627. About 14 percent of the total cost contingency is associated with schedule risk (*i.e.*, about 4.4 out of the 31 total percentage points). It is important to note that these results reflect contingencies based on both the cost and schedule risk analyses.

2. The key cost risk drivers identified through sensitivity analysis are *Railroad Involvement* and *Relocation of Unknown Utilities* which respectively contribute about 19.0 and 12.4 percent of statistical cost variance during *Monte Carlo* simulation. *Construction Productivity Assumptions*, *Geotechnical Uncertainty*, *Lack of Surveys*, *Timing of Project Funding*, and *Market Condition and Bidding*

Environment are also important cost risk drivers which together contribute about 42.7 percent of statistical cost variance.

3. The key schedule risk driver identified through sensitivity analysis is *Timely Design* which contributes about 66.4 percent of statistical schedule duration variance during *Monte Carlo* simulation. *Timing of Project Funding, Railroad Involvement,* and *Project Priority* are also important schedule risk drivers which together contribute about 32.7 percent of statistical schedule variance.

8.0 RECOMMENDATIONS

This section provides several general recommendations based on the major CSRA findings and observations. CSRA does not address all key elements of project risk management and, accordingly, the list of recommendations should not be considered comprehensive. The recommendations are as follows:

1. Periodically update the CSRA. Risk events are dynamic and should be evaluated regularly through all phases of design, construction and O&M. To fully recognize its benefits, CSRA should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

2. Consider the entire risk analysis curve for budgeting and scheduling purposes. The amount of contingency included in project control plans usually depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans.

3. Develop a standalone Risk Management Plan or substantially incorporate the key elements of risk management into the Project Management Plan. The key elements of project risk management include risk management planning, risk identification, risk analysis, risk responses, and risk monitoring/control. The CSRA focuses on risk identification and risk analysis but is not intended to address the other key elements of risk management.

4. Use the risk register routinely as a tool for tracking risk mitigation effectiveness and include the risk mitigation actions identified in the risk register for high-level risks on the project schedule. Updating the risk register as risks are realized or eliminated during project execution may simplify periodic CSRA updates and maintain PDT focus on key risk drivers.

APPENDIX A

RISK REGISTER

Revised:
8-Mar-10

Blind River Diversion Project
Tentatively Selected Plan

The diversion alignment, with a 7,000 cfs capacity, has six major components, a navigation lock facility, a freshwater diversion canal, approximately six control structures of various sizes, approximately 30 borrow pits, three culverts at four locations along the Highway 61 corridor, and instrumentation. The study area for this project is bounded by the Mississippi River Gulf to Gulf Plan, within coastal Southeast Louisiana in the Lake Pontchartrain Basin. This recommended project was proposed to reverse the current decline of a portion of the southwestern portion of the Maurepas Swamp and to prevent the transition of the Swamp into a marsh and open water.

Impact or Consequences of Occurrence

Likelihood	Negligible	Marginal	Significant	Critical
Very Likely		Moderate		
Likely		Moderate		
Unlikely			Moderate	Moderate
Very Unlikely				

Risk No.	PDT-developed Risk/Opportunity Event	PDT Concerns	PDT Discussions	Responsibility/POC	Project Cost Likelihood	Project Cost Impact	Project Cost Risk Level	Project Schedule Likelihood	Project Schedule Impact	Project Schedule Risk Level	Mitigation Actions
PROJECT MANAGEMENT											
PM-1	Project Priority	The project will be competing with other projects for resources.	The project has relatively high priority for the State and New Orleans District. It also enjoys strong local support. However, it may receive lower priority from USACE HQ as a restoration project (as compared to hurricane and storm damage protection).	Project Management State of Louisiana	UNLIKELY	MARGINAL	LOW	UNLIKELY	CRITICAL	MODERATE	1. Ensure that the strong local support for the project is effectively communicated. 2. State may also mitigate by maintaining project visibility with USACE.
PM-2	Project Scope Definition	The level of project definition is approximately 15%.	The level of project definition is not unusual for a project at this stage of design. The current estimate and schedule may not fully reflect the final design.	Project Management	LIKELY	CRITICAL	[redacted]	LIKELY	SIGNIFICANT	[redacted]	1. Proceed with a robust design process. 2. Update the cost estimate and schedule to reflect design progress and communicate any significant changes in funding needs early.
PM-3	Approval or Decision Delays	Both design and construction will require numerous document reviews and key decisions by both the State and USACE.	Communication and the timing of reviews and decisions by the State and USACE has been good to date. Significant delays related to approval dates or key decisions are not anticipated.	Project Management	UNLIKELY	NEGLIGIBLE	LOW	UNLIKELY	MARGINAL	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
PM-4	Timely Design	The project involves significant permitting and coordination with outside agencies. Untimely or rushed design may result in permitting delays.	Permitting agencies and the Canadian National Railroad (CN RR) will need sufficient detailed design information before significant decisions can be made and requirements identified.	Project Management	UNLIKELY	MARGINAL	LOW	UNLIKELY	CRITICAL	MODERATE	1. Schedule detailed design early and include sufficient time in the schedule so that unanticipated design delays do not impact the permitting schedule. 2. Early and frequent consultation with permitting agencies and CN RR as the design progresses.
CONTRACTING											
CAR-1	Undefined Acquisition Strategy	An acquisition plan has not yet been developed.	Four construction contracts are currently anticipated for planning purposes. It is not clear if the State, USACE, or the State and USACE will lead and manage the construction contracts. The State prefers handling all of the contracting but no decisions have been made. Railroad work may be contracted directly by CN RR.	Contract Acquisition	VERY LIKELY	MARGINAL	MODERATE	VERY LIKELY	MARGINAL	MODERATE	1. Early consultation with contract acquisition specialist to validate planning assumptions regarding contracting. 2. Make a key decision regarding acquisition strategy early in the design process and reach agreement between the State, USACE and CN RR.
CAR-2	Set Aside Requirements	The use of SDB and 8(a) contracts may be required.	The cost estimate may not reflect the costs of subcontractors and potential for increased costs if set aside requirements are imposed on the project. The pool of qualified SDB and 8(a) firms is likely limited in competition to an unrestricted procurement. This could result in a less competitive bidding process.	Contract Acquisition	LIKELY	SIGNIFICANT	[redacted]	LIKELY	MARGINAL	MODERATE	1. Early consultation with contract acquisition specialist to validate planning assumptions regarding set aside requirements. 2. Make a key decision regarding set aside requirements.
ENGINEERING											
TECH-1	Level of Technical Complexity	Innovative, complex or first-of-a-kind designs may result in unanticipated schedule delays and cost impacts.	The project involves relatively standard heavy civil construction. Features are not technically complex. Design and construction contractors have extensive regional experience with similar projects.	Engineering	VERY UNLIKELY	SIGNIFICANT	LOW	VERY UNLIKELY	SIGNIFICANT	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
TECH-2	Geotechnical Uncertainty	Cost estimate and schedule rely on significant assumptions regarding geotechnical conditions.	Cut and fill balance calculations are based on the assumption that dirt excavated during the diversion canal construction will be suitable for temporary levee construction. Geotechnical conditions also impact structural support design (e.g., concrete piles).	Engineering	LIKELY	SIGNIFICANT	[redacted]	LIKELY	MARGINAL	MODERATE	1. Conduct geotechnical investigations early in the design process. 2. Update the cost estimate and schedule to reflect geotechnical data and communicate any significant changes in funding needs early.
TECH-3	Dewatering Requirements	Estimated low-diversion canal dewatering costs may be low.	Actual dewatering needs are uncertain because subsurface conditions are not well known at this stage of the project. Cost estimate may be low.	Engineering	LIKELY	MARGINAL	MODERATE	LIKELY	NEGLIGIBLE	LOW	1. Conduct dewatering-related studies and investigations early in the design process. 2. Update the cost estimate and schedule to reflect dewatering studies and communicate any significant changes in funding needs early.
TECH-4	Lack of Surveys	Detailed surveys have not yet been performed.	No surveys are available for the control structures, except for channel depth. Current design and cost estimate assumptions may not be valid after detailed survey data is received.	Engineering	LIKELY	SIGNIFICANT	[redacted]	LIKELY	NEGLIGIBLE	LOW	1. Conduct detailed surveys early in the design process. 2. Update the cost estimate and schedule to reflect survey data and communicate any significant changes in funding needs early.
LANDS, DAMAGES, AND RELOCATIONS											
LDR-1	Real Estate/Easement Acquisition	Real estate acquisition has not yet begun.	The State will handle real estate acquisition and can use eminent domain to compel acquisition if necessary. Significant uncertainty exists in the timing and cost of acquisitions. Development of adjacent or nearby parcels may result in significantly increased costs.	Real Estate	LIKELY	CRITICAL	[redacted]	LIKELY	MARGINAL	MODERATE	1. Refine real estate needs early in the design. 2. Acquire real estate early to minimize risk of adjacent and nearby land use changes that cause land values to increase.
LDR-2	Railroad Involvement	Project requires relocation and reconstruction of CN RR crossing.	Input from CN RR regarding their requirements has been requested but not received. Design, cost and schedule assumptions may not be accurate. State and USACE will have no control if CN RR bases and manages relocation contracts for design and construction.	Real Estate	LIKELY	SIGNIFICANT	[redacted]	LIKELY	CRITICAL	[redacted]	1. Proactively manage interface with CN RR through frequent consultation. 2. Subs tantially complete all planning/design elements that CN RR will require to make decisions regarding their requirements and contracting. 3. Build float into the schedule if the State and/or USACE will not be in control of relocation and reconstruction contracts.

1740

Blind River Diversion Project
Tentatively Selected Plan

The diversion alignment, with a 3,000 cfs capacity, has six major components: a diversion culvert facility, a transmission canal, approximately six control structures at various sites, approximately 30 berm gaps, cross culverts at locations along the Highway 61 corridor, and instrumentation. The study area for this project is located in the Mississippi River Basin's Pontchartrain Basin of southeast Louisiana in the Lake Pontchartrain Basin. This restoration project was proposed to reverse the current decline of a portion of the southwestern portion of the Maurepas Swamp and to prevent the transition of the Swamp into marsh and open water.

Impact or Consequence of Occurrence

Likelihood	Negligible	Marginal	Significant	Critical	Catas
Very Likely					
Likely		Moderate			
Unlikely			Moderate		
Very Unlikely			Moderate	Moderate	

Revised:
8-Mar-10

Risk No.	PDT-developed Risk/Opportunity Event	PDT Concerns	PDT Discussions	Responsibility/POC	Project Cost			Project Schedule			Mitigation Actions
					Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*	
LDR-1	Relocation of Unknown Utilities	Cost and time required for relocating unknown utilities are not reflected in the estimate or schedule.	Pipeline location work is only partially complete and some larger petroleum and gas pipelines are likely to be identified in the future. Project will need to coordinate with pipeline owner and pay for relocation if necessary. Major fiber optic or other communication lines are not expected to be impacted.	Real Estate	LIKELY	SIGNIFICANT		LIKELY	MARGINAL	MODERATE	1. Conduct thorough utility locating surveys early in the design process. 2. Consult early with owners of any significant, currently unknown utilities to determine requirements and schedule for relocations. 3. Update the cost estimate and schedule to reflect necessary relocations and communicate any significant changes in funding needs early.
REG-1	Work in Maurepas WMA	Special requirements related to work within the Maurepas Swamp Wildlife Management Area (WMA) are not reflected in the cost estimate or schedule.	Work within the WMA will require environmental permits which may have significant special requirements. There are limitations on construction during bird nesting season. The WMA is culturally significant and historic, cultural resource and endangered species surveys are not yet complete.	Environmental	LIKELY	MARGINAL	MODERATE	LIKELY	MARGINAL	MODERATE	1. Complete historic, cultural resource and endangered species surveys early and consult with permitting agencies proactively 2. Substantially complete all planning/design elements required for environmental permitting early in the design process. 3. Incorporate any special requirements into the design and reflect in the cost estimate and schedule.
CON-1	Concrete Mixing	Uncertainty regarding where concrete for cast-in-place structures will be mixed may result in estimated unit costs being too low.	The project requires significant cast-in-place concrete work using ready mix concrete that will be brought in by barge. Mixing may occur at a staging area before loading onto barges or occur at the construction locations. The cost estimate may not reflect the true unit cost of concrete delivered by barge.	Cost Engineering	LIKELY	MARGINAL	MODERATE	LIKELY	NEGLIGIBLE	LOW	1. Conduct survey to determine how cast-in-place concrete has been handled for similar projects within the region. 2. Assess validity of unit costs in estimate and revise as appropriate.
CON-2	Staging Areas	Locations and requirements for staging areas have not yet been identified.	Staging areas are not likely to be allowed within the WMA. It is anticipated that the staging area(s) for control structures will be required to be located in upland areas and be self-contained. Cost and time required for locating and constru...ing staging areas may not be reflected in the cost estimate and schedule.	Engineering	LIKELY	MARGINAL	MODERATE	LIKELY	MARGINAL	MODERATE	1. Determine staging area requirements and locations during detailed design. 2. Consult with Real Estate early if any acquisition action is necessary.
CON-3	Site Access	Site access for work within the swamp will be by barge.	Contractors in the region have extensive experience doing work in the wet using barges. Availability of barges not anticipated to be an issue because of the timing of construction relative to other projects. Boat launch for barges is available.	Engineering	VERY UNLIKELY	MARGINAL	LOW	VERY UNLIKELY	MARGINAL	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
CON-4	Construction Labor Availability	A limited supply of construction labor could result in schedule delays or increased cost. Attracting labor in a tight market may require incentives (e.g., overtime).	Specialty labor not required for the project. Availability of labor not anticipated to be an issue because of the timing of construction relative to other projects.	Cost Engineering	UNLIKELY	SIGNIFICANT	MODERATE	UNLIKELY	MARGINAL	LOW	1. Monitor labor availability and market conditions. 2. Update the cost estimate to reflect labor costs and communicate any significant changes in funding needs early.
CON-5	Long Lead Fabrication	Construction may be delayed if design and procurement of long lead items is not timely. Added costs may be required if fabrication shop space is scarce.	The project does not involve significant long lead procurement. The 10' x 10' sluice gates and motors will require the longest lead time.	Cost Engineering	UNLIKELY	MARGINAL	LOW	UNLIKELY	SIGNIFICANT	MODERATE	1. Determine lead time required for sluice gates and reflect in schedule. 2. Complete design of gates early enough to support procurement schedule. 3. Monitor market conditions and fabrication specs to identify needs to accelerate schedule.
CON-6	Highway Permit	A permit will be required from the Louisiana Department of Transportation.	Untimely receipt of the permit from Louisiana Department of Transportation (DOT), or unanticipated permit requirements, may result in schedule delays or costs not reflected in the estimate. DOT permitting for the project is anticipated to be routine in nature.	Permitting	UNLIKELY	MARGINAL	LOW	UNLIKELY	MARGINAL	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
CON-7	Compatibility with Hunting Season	The State generally restricts work in the swamp during hunting season due to the risk of a hunting accident.	The project area is used widely for hunting, fishing and recreation. A hunting accident involving contractors may result in a work stoppage and safety reviews. Coordination and public outreach will be required. Hunting season runs from November through January.	Project Management State of Louisiana	UNLIKELY	MARGINAL	LOW	UNLIKELY	MARGINAL	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
CON-8	Mississippi River Permit	Uncertainty regarding the need to obtain a permit to withdraw water from the Mississippi River.	Because the 3,000 cfs diversion capacity is a small fraction of Mississippi River flows, permitting is not anticipated to be problematic (if a permit is needed). Permitting agencies would likely be USACE and the Coast Guard.	Permitting	LIKELY	NEGLIGIBLE	LOW	LIKELY	MARGINAL	MODERATE	1. Identify permitting needs through early. 2. If permitting is required, substantially complete all planning/design elements required for permitting early in the design process. 3. Incorporate any special requirements into the design and reflect in the cost estimate and schedule.
CON-9	HTW or CR Impacts	Potential to encounter unanticipated hazardous or toxic waste (HTW) or cultural resources (CR) during construction.	Subsurface CR (e.g. artifacts) or HTW (e.g. petroleum from old or abandoned pipelines) may be encountered during excavation activities resulting in schedule delays and added costs for study and disposal of contaminated soil.	Engineering	UNLIKELY	MARGINAL	LOW	UNLIKELY	SIGNIFICANT	MODERATE	1. Perform a thorough survey of known CR and HTW sites during detailed design. 2. Design around any known CR and HTW to the maximum extent possible. 3. Build sufficient float into the schedule if known CR or HTW sites are adjacent to or nearby construction locations.

1741

Blind River Diversion Project
Tentatively Selected Plan

The diversion alignment, with a 3,000 cfs capacity, has six major components: a diversion outlet facility; a transmission canal, approximately six control structures of various sizes, approximately 30 farm bays, cross culverts at four locations along the Highway 61 corridor, and a channelization. The study area for this project is located in the Mississippi River Deltaic Plain within coastal southeast Louisiana in the Lake Pontchartrain Basin. This restoration project was proposed to increase the current decline of a portion of the southwestern portion of the Maurepas Swamp and to prevent the transition of this Swamp into a marsh and open water.

Revised:
8-Mar-10

Impact or Consequence of Occurrence

Likelihood	Negligible	Marginal	Significant	Critical	Crisis
Very Likely		Likely (4)			
Likely		Moderate			
Unlikely			Unlikely	Improbable	
Very Unlikely					

Risk No.	POT-Anticipated Risk/Opportunity Event	POT Concerns	POT Discussions	Responsibility/POC	Project Cost			Project Schedule			Mitigation Actions
					Likelihood	Impact	Risk Level	Likelihood	Impact	Risk Level	
CON-10	Contract Modifications	Risk that unforeseen conditions will result in construction contract modification or other contract award.	There is a residual risk after construction contracts are awarded that significant contract modifications may be required. This is a risk common to all heavy civil projects. Because the contract acquisition strategy includes four construction contracts, it is considered likely that at least one will require a modification.	Engineering	LIKELY	SIGNIFICANT		LIKELY	NEGLIGIBLE	LOW	1. Perform thorough surveys and investigations as part of project design process. 2. Perform constructability reviews at key stages of the design process.
ESR-1	Concrete and Steel Costs	The cost estimate may not reflect the future prices of concrete and steel.	The project requires significant concrete and steel. Concrete and steel prices have been historically volatile and may increase if economic conditions improve. Concrete and steel prices are likely to be volatile and could increase or decrease from cost estimate assumptions. Increased prices may be more likely than decreases.	Cost Engineering	LIKELY	MARGINAL	MODERATE	LIKELY	NEGLIGIBLE	LOW	1. Monitor concrete and steel prices, as well as regional economic conditions. 2. Update the cost estimate to reflect concrete and steel prices and communicate any significant changes in funding needs early.
ESR-2	Construction Productivity Assumptions	Productivity assumptions in the cost estimate and schedule may not be valid.	The project requires significant wet work in the Mississippi River and in the swamp. Productivity for barge work can be significantly impacted by local conditions and the use of productivity assumptions based on historical data may not be accurate. Lower than anticipated productivity may result in sch edule delays and increased indirect costs (hotel load).	Cost Engineering	LIKELY	SIGNIFICANT		LIKELY	SIGNIFICANT		1. Conduct survey to identify productivities for similar projects near the project location. 2. Conduct constructability review at key stages of the design process. 2. Assess validity of productivity assumptions in estimate and schedule and revise as appropriate.
ESR-3	Fuel Costs	Fuel cost assumptions in the cost estimate may not be valid.	The project requires significant heavy equipment use and associated fuel consumption. Fuel prices have been historically volatile and may increase if economic conditions improve. Fuel prices are likely to be volatile and could increase or decrease from cost estimate assumptions. Increased prices may be more likely than decreases.	Cost Engineering	LIKELY	MARGINAL	MODERATE	LIKELY	NEGLIGIBLE	LOW	1. Monitor fuel prices, as well as regional economic conditions. 2. Update the cost estimate to reflect fuel prices and communicate any significant changes in funding needs early.
EXT-1	Timing of Project Funding	Funding delays, or lower than anticipated annual funding, could result in an extended construction schedule.	Annual funding over three fiscal years considered likely. Funding decisions will be made by the State and USACE.	Project Management	LIKELY	SIGNIFICANT		LIKELY	CRITICAL		1. Reach agreement between the State and USACE and make a key decision regarding incremental funding early in the design process. 2. Monitor changes in funding expectations and reflect any changes in the cost estimate and schedule.
EXT-2	Local Community Acceptance	Local community could object to the project and cause schedule delays or design changes.	The project has enjoyed strong support by the local community. Future issues are not anticipated.	Project Management	LIKELY	NEGLIGIBLE	LOW	LIKELY	NEGLIGIBLE	LOW	1. Periodically monitor and reassess this risk to determine if changes in risk probability or impact have occurred.
EXT-3	Market Condition and Bidding Environment	Cost estimate and schedule assumptions regarding future market conditions and bidding environment may not be valid.	The bidding environment is anticipated to be competitive, but prices may rise if market conditions improve significantly. Bidding is anticipated to occur in mid 2012 as many regional projects are being completed.	Cost Engineering	UNLIKELY	SIGNIFICANT	MODERATE	UNLIKELY	MARGINAL	LOW	1. Monitor market conditions and bidding environment. 2. Update the cost estimate to reflect conditions and communicate any significant changes in funding needs early.
EXT-4	Inclement Weather	Storm surge caused by hurricanes and tropical storms may damage partially completed construction.	Inclement weather may result in schedule delays related to pumping water from channels, excavating sediments, etc. Control buildings may experience water damage.	Cost Engineering	VERY LIKELY	SIGNIFICANT		VERY LIKELY	MARGINAL	MODERATE	1. Schedule vulnerable construction around hurricane season to the extent possible.
EXT-5	Maximum Exceedence Event	An unusual storm could cause significant spill-over into the project area and destroy the project or make it unconstructible.	A 500-year event would likely be catastrophic for the project.	Project Management	VERY UNLIKELY	CRISIS		VERY UNLIKELY	CRISIS		1. Accept risk.

1. Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).
1 Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT
2 Concerns and Discussions elaborate on Risk/Opportunity Events and includes any assumptions or findings (discussion to support the event rating)
3 The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the POT for the identified risk or opportunity
4 Likelihood is measured as likelihood of impacting cost or schedule.
5 Impact is a measure of the events effect on project objectives with relation to scope, cost, and/or schedule -- Negligible, Marginal, Significant, Critical, or Crisis. Impacts on Project Cost may vary in severity from impacts on Project Schedule.
6 Risk Level is the resultant of Likelihood and Impact Low, Moderate, or High. Refer to the matrix located at top of page.
7. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely event may would probably follow a triangular distribution. Complete unknowns related to "it could be anywhere" would fall into the category of uniform
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9 Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10 Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11 Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

1742

Volume IV

APPENDIX M:

Phase I ESA (HTRW)

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CDM

LCA Small Diversion at Convent/Blind River Project

Phase I Environmental Site Assessment

January 2010

Prepared by:

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Contents

Section 1 Introduction

1.1 Introduction 1-1
1.2 Limitations and Exceptions 1-2
1.3 Significant Assumptions 1-3

Section 2 Site Description and History

2.1 Site Description 2-1
2.2 Vicinity Characteristics 2-2
2.3 Site History 2-2
2.3.1 Historic Aerial Photographs 2-3
2.3.2 Historic Topographic Maps 2-3
2.3.3 Prior Reports 2-4
2.4 Operations 2-4
2.5 Interviews with Property Owners/Representatives 2-4
2.5.1 Properties Associated with Maurepas Swamp and Blind River 2-4
2.5.2 Properties Associated with the South Bridge Diversion Route 2-4
2.5.3 Properties Associated with the Romeville Diversion Route 2-5

Section 3 Physiography, Geology, Hydrology

Section 4 Environmental Conditions

4.1 Hazardous and Non-Hazardous Materials and Chemical Storage and Handling 4-1
4.2 Hazardous and Industrial Waste 4-1
4.3 Solid Waste 4-1
4.4 Aboveground Storage Tanks (ASTs) and Underground Storage Tanks (USTs) 4-1
4.5 Potable Water 4-1
4.6 Wastewater 4-1
4.7 Stormwater 4-2
4.8 Herbicides and Pesticides 4-2
4.9 Air Quality 4-2
4.10 Radon 4-2
4.11 Wetlands 4-2
4.12 Polychlorinated Biphenyls (PCBs) 4-2
4.13 Local/Regional Water Agency Records 4-2

Section 5 Environmental Records Review

5.1 Database Search Results Summary 5-1
5.1.1 National Priorities List (NPL) and Proposed NPL 5-1

5.1.2 Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) 5-1
5.1.3 CERCLIS - No Further Remedial Action Plan (CERCLIS-NFRAP) ... 5-1
5.1.4 Resources Conservation and Recovery Corrective Action Sites (CORRACTS) 5-2
5.1.5 Resource Conservation and Recovery Act (RCRA) Information 5-2
5.1.6 Facility Index System (FINDS) 5-2
5.1.7 Toxic Chemical Release Inventory System (TRIS) 5-3
5.1.8 Emergency Response Notification System (ERNS) 5-3
5.1.9 State Hazardous Waste Sites (SHWS) 5-3
5.1.10 Permitted Solid Waste Facilities/Landfills (SWF/LF) 5-3
5.1.11 Underground Storage Tanks (USTs) and Aboveground Storage Tank Database (AST) 5-4
5.1.12 Leaking Petroleum Storage Tanks (LUSTs) 5-4
5.1.13 Voluntary Cleanup Program (VCP) 5-4
5.1.14 Brownfield Sites 5-5
5.1.15 Orphan Sites 5-5
5.2 Summary of Database Findings 5-5

Section 6 Conclusions

Section 7 References

List of Figures

2-1 Project Site Map
2-2 Diversion Routes
2-3 Pipeline Locations
4-1 Groundwater Well Locations - Maurepas Swamp
4-2 Groundwater Well Locations - Diversion Routes

List of Tables

4-1 USGS Wells
5-1 Environmental Data Resources Summary

Appendices

Appendix A Site Photographs
Appendix B Historic Aerial Photographs and Topographic Maps
Appendix C Environmental Data Resources, Inc. Reports
Appendix D Prior Reports

Section 1
Introduction

1.1 Introduction

This Phase I Environmental Site Assessment (ESA) was conducted in a manner consistent with customary practice and in general conformance with the scope and limitations of the American Society for Testing and Materials (ASTM) Designation E 1527-05, *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM 1527); ASTM Designation E 2247-08 *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland and Rural Property*, and the U.S. Environmental Protection Agency's All Appropriate Inquiry (AAI) standards Rule, 40 CFR Part 312. The purpose of this ESA is to identify and investigate recognized environmental conditions on the subject property and surrounding properties that may constitute actual or potential sources of environmental risk or liability that may have resulted from past or present land uses, construction activities, site management or operations. Information regarding environmental conditions on the subject property and surrounding properties was obtained from a review of historical aerial photographs and topographic maps, various reports and government record sources, and a site drive-by and walk-through.

As part of the Supplemental Environmental Impact Statement, Camp Dresser & McKee (CDM) performed an ESA of the approximately 36-square mile area designated as the LCA Small Diversion at Convent/Blind River Project (Subject Property). The project area consists of a portion of the Maurepas swamp and the Blind River southwest of Interstate I-10. Included in the project area are two proposed diversion routes between the Mississippi River and Maurepas swamp.

The purpose of the Phase I ESA is to determine the presence of recognized environmental conditions (REC) at the subject property and/or adjoining properties. A REC is defined as "...the presence or likely presence of any hazardous substance or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, ground water, or surface water of the property" (ASTM Standard E-1527-05).

From June 24 – 26, 2009 Mr. Brendan Brown and Matthew Petty of CDM conducted a site visit of the subject property including Maurepas Swamp, the Blind River, and the proposed Romeville diversion route. CDM was not accompanied during these site visits at the subject property. General site visits were conducted in the interior of Maurepas Swamp on the following dates: March 10 & 11, July 7 & 8, August 18 – 20, September 14 – 16, and October 28, 2009. During these general site visits, CDM was accompanied by employees of St. James Parish. Site access agreements had not been obtained for all the properties along the proposed south bridge diversion route at the

time the site visits were conducted. Therefore, site visits were not conducted along this proposed diversion route.

Observations made by CDM during the site visits were noted, and photographs were taken. Photographs are presented in **Appendix A** of this report. Available historical aerial photographs and historical topographic maps are provided in **Appendix B**.

A search of State and Federal environmental databases was conducted by Environmental Data Resources, Inc. (EDR) to obtain information regarding any past or current hazardous waste disposal sites, reported petroleum or hazardous waste releases, listed hazardous waste generation, transportation, storage, or disposal facilities, listed solid waste disposal facilities, and other issues related to reported environmental contamination problems. These database records are included as part of the EDR radius report in **Appendix C**.

The results of this Phase I ESA are based on:

- A review of the subject property operations;
- A walk-through observation of conditions at the subject property;
- A review of environmental regulatory databases searches;
- Interview with available owners of the subject property;
- A review of acquired environmental regulatory agency documents; and
- A review of property ownership information obtained by CDM.

1.2 Limitations and Exceptions

CDM's assessment represents a review of certain information relating to the subject property that was obtained by methods described above and did not include sampling or other monitoring activities at the property. CDM is not able to verify the accuracy or completeness of all data and information obtained during the assessment and some conclusions could be different if the information upon which they are based is determined to be false, inaccurate or incomplete. CDM makes no legal representations whatsoever concerning any matter, including, but not limited to, ownership of any property or the interpretation of any law. CDM further disclaims any obligations to update the report for events taking place after the assessment was conducted. This report is based upon information researched and available to CDM through the date of this report.

The site reconnaissance did not include visiting all areas of the subject property. The subject property is relatively large and includes areas that could not be reasonably accessed. CDM therefore visited areas that were accessible with an automobile or were reasonable and safely accessible by walking. Wetlands were present in most of

the subject property, which did inhibit observations of some portions of the subject property.

1.3 Significant Assumptions

Significant assumptions associated with this ESA include the following:

- On CDM's behalf, EDR conducted a search of federal, state, tribal, and specialty environmental databases for records pertaining to the subject property, and those properties within the required ASTM search distances. CDM assumes that products provided to CDM by EDR are accurate, complete, and can be relied upon for the purposes of this ESA.

- Certain verbal information regarding the subject property was supplied to CDM through interviews with representatives from the owners of the subject property and government agencies as detailed in Section 2. CDM assumes that the information provided is reasonably accurate and can be relied upon for the purposes of this Phase I ESA.

Section 6
Conclusions and Recommendations

This Phase I ESA was performed on the Subject Property, an approximately 36-square mile area designated as the LCA Small Diversion at Convent/Blind River Project to determine the presence of recognized environmental conditions (RECs) at the subject property and/or adjoining properties. The project area consists of a portion of the Maurepas Swamp and the Blind River southwest of Interstate I-10. Included in the project area are two proposed diversion routes (South Bridge and Romeville) between the Mississippi River and Maurepas Swamp. Although preliminary investigations were performed on the properties within the corridors associated with both proposed diversion routes to gather information regarding environmental conditions, only the property owner associated with the Romeville Diversion was contacted for this investigation. Site access agreements had not been obtained for all the properties along the proposed south bridge diversion route as of the date this report was finalized. Therefore, site visits should be conducted along the proposed south bridge diversion route to determine if there are any potential RECs on this property.

The results of this Phase I ESA are based on a review of regulatory environmental databases, a review of the subject property operations, a walk-through observation of conditions at the subject property, interviews with local regulatory officials and representatives of the subject property and the Romeville diversion parcel representative, and a review of property ownership information.

Based upon the information reviewed, no RECs were identified within Maurepas Swamp, the Blind River, or the proposed Romeville diversion route that would be expected to impact the subject property.

Section 7
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FOR CONTINUATION OF HOUSE DOCUMENT 112-43
RECOMMENDATIONS FOR THE IMPLEMENTATION
OF FOUR PROJECTS
SEE PART 1 OF VOLUME V

TEXAS CHRISTIAN UNIVERSITY
Recommendations for the Implementation
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