2019

Lake Pontchartrain & Vicinity, LA General Re-Evaluation Report

US Army Corps of Engineers®
New Orleans District

U.S. Army Corps of Engineers, New Orleans District

Non-Federal Sponsor: Coastal Protection and Restoration Authority Board

12/1/2019

Cover Sheet

Project Title: Lake Pontchartrain and Vicinity, Louisiana General Re-Evaluation Report with Integrated Environmental Impact Statement

Proposed Action: The New Orleans District of the U.S. Army Corps of Engineers is re-evaluating the performance of the Lake Pontchartrain and Vicinity system given the combined effects of consolidation, settlement, subsidence, sea level rise, and new datum over time to determine if additional actions are recommended to address the economic and life safety risks associated with flooding due to hurricanes and coastal storms.

Location: St. Charles, Jefferson, Orleans, and St. Bernard Parishes, Louisiana

Type of Statement: Draft Environmental Impact Statement

Lead Agency: U.S. Army Corps of Engineers

Cooperating Agencies: U.S. Fish and Wildlife Service
National Oceanic and Atmospheric Administration

For further Information:
Mr. Bradley Drouant, P.E.
U.S. Army Corps of Engineers, New Orleans District
CEMVN-PMO-L, Room 361
7400 Leake Avenue
New Orleans, LA 70118
(504)862-1516
CEMVN-LPVGRR@usace.army.mil
https://www.mvn.usace.army.mil/About/Projects/BBA-2018/studies/LPV-GRR/

Date by which comments must be received February 7, 2020

Abstract:
This General Re-Evaluation Report with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers coastal storm risk management study for the Lake Pontchartrain and Vicinity project located in the greater New Orleans area, Louisiana. The Corps is undertaking the study in partnership with the Coastal Protection and Restoration Authority Board of Louisiana, the study's non-Federal sponsor. Southeast Louisiana is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause levees to require future lifts to sustain performance. The Tentatively Selected Plan consists of 50 miles of levee lifts and 19 miles of floodwall modifications and replacements to be constructed as-needed before the combined effects of consolidation, settlement, subsidence and sea level rise reduce elevations below the required design elevations. The public will have the opportunity to review and comment on this draft report during the 8-week public comment period which ends on February 7, 2020. Public meetings are planned for January 2020 to present the study and allow the public to respond and ask questions. The final report is scheduled to be complete in 2021.

LAKE PONTCHARTRAIN & VICINITY, LOUISIANA GENERAL RE-EVALUATION REPORT

EXECUTIVE SUMMARY

This General Re-Evaluation Report (GRR) with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the Lake Pontchartrain and Vicinity (LPV) project located in New Orleans, Louisiana. This study is authorized by Section 3017 of the Water Resources Reform and Development Act of 2014. USACE is undertaking the Study in partnership with the Coastal Protection and Restoration Authority Board of Louisiana, the study's non-Federal sponsor. This report provides documentation of the plan formulation process to identify a recommended coastal storm risk management plan, along with environmental, engineering, and cost details of the Tentatively Selected Plan (TSP).

The existing LPV project includes features in four parishes (St. Charles, Jefferson, Orleans, and St. Bernard) located in the greater New Orleans area on the east bank of the Mississippi River. This is a high-density residential and commercial area. Currently, LPV includes approximately a total of 126.5 miles of levees and floodwalls. There are approximately 83 miles of armored perimeter levees and floodwalls and approximately 43.5 miles of interior levees and floodwalls. The project reduces the risk of flooding due to a coastal storm with a 1% chance of being exceeded in any given year.

Southeast Louisiana, including the Greater New Orleans area, is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause levees to require future lifts (raises) to sustain the current performance of the project. This GRR will reevaluate the performance of the LPV system given the combined effects of consolidation, settlement, subsidence, sea level rise, and new datum over time and determine if additional actions are recommended to address the economic and life safety risks associated with flooding due to hurricanes and tropical storms.

The study utilized a 50-year period of analysis and estimated future conditions at the end of that period if no action is taken to address the identified problems. These projections include over $230 million in annual economic damages and average life loss estimates ranging from low to extremely high. The Corps identified several structural and non-structural measures s to reduce coastal storm risk in the study area. An initial array of six action alternatives was formulated, evaluated, and compared primarily (but not exclusively) based on cost, economic damage reduction, life safety risk reduction, and environmental and cultural resources impacts.

The National Economic Development (NED) Plan is the alternative that reasonably maximizes net economic benefits while remaining consistent with the Federal objective of protecting the environment. Alternative 2 was identified as the NED Plan and the Tentatively Selected Plan (TSP). The TSP includes system-wide levee lifts and raising floodwalls to address the projected 1% annual exceedance probability event. The general TSP features can be seen in Figure ES-1. The plan consists of 50 miles of levee lifts to be constructed as-needed before the combined effects of consolidation, settlement, subsidence and sea level rise reduce the levee elevations in each levee reach below the required design elevation. Additionally, the TSP includes 19 miles of

floodwall modifications and replacements to be constructed as-needed prior to the combined effects causing the design requirements to be exceeded for each structure. Existing foreshore protection along Lake Pontchartrain will be restored following levee or floodwall modifications. Mitigation is anticipated to be required to address potential impacts to habitat along the Mississippi River. The TSP has a total project first cost of approximately $2.6 billion and a benefit-to-cost ratio of 2.5. It reduces the estimated annual economic damages to approximately $30 million and significantly reduces life loss estimates.

Implementation of the TSP would result in potential impacts to Bottomland Hardwood-Wet (BLH-Wet) habitat. These impacts would be avoided to the maximum extent practicable but would be unavoidable in some locations due to avoidance of existing infrastructure on the protected side of the levees. The proposed mitigation plan assumes these 17.2 Average Annual Habitat Units (AAHUs) of BLH-Wet impacted by the TSP would be offset through the purchases of mitigation bank credits equal to 17.2 AAHUs.

The public will have the opportunity to review and comment on this draft report during the 55-day public review period which will begin in December 2019. Public meetings are planned for January 2020 to present the TSP and allow the public to respond and ask questions. The final report is scheduled to be complete in 2021.

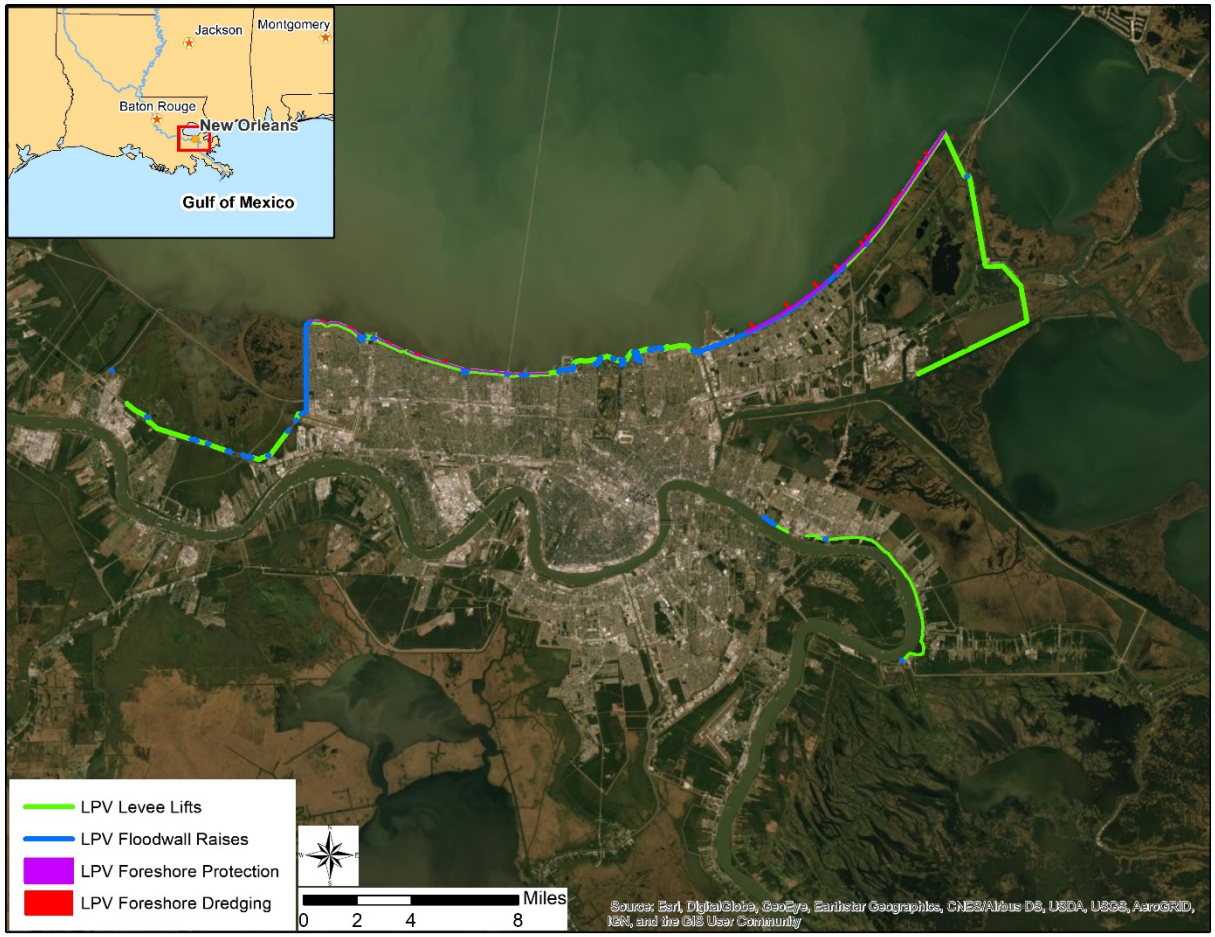

Figure ES-1. LPV Tentatively Selected Plan – General Features

TABLE OF CONTENTS

**Sections marked with an asterisk are required content for compliance with the National Environmental Policy Act*

1 Introduction 1
1.1 Study Scope 1
1.2 Purpose of Report 2
1.3 Project Authority 2
1.4 Study Authority 3
1.5 Non-Federal Sponsor 4
1.6 Study Area and Maps 4
1.7 Interagency Study Team & Cooperating Agencies 8
1.8 Prior Reports, Existing Water Projects, & Ongoing Programs 8
2 Problems & Opportunities 11
2.1 Purpose & Need* 11
2.2 Problem Identification 12
2.3 Opportunities 17
2.4 Federal Interest 17
2.5 Goals & Objectives* 17
2.6 Constraints 18
3 Existing Conditions Levee Performance 19
3.1 Existing Levee System Condition 19
3.2 Hydrologic and Hydraulic Conditions 21
3.3 Existing Economic Damages 24
3.4 Existing Conditions Risk 27
4 Affected Environment* 32
4.1 Environmental Setting 32
4.2 Geology and Soils 38
4.3 Hydrology & Hydraulics 42
4.4 Water Resources 43
4.5 Forest and Wetland Resources 47
4.6 Uplands 54
4.7 Fisheries 55
4.8 Wildlife 61
4.9 Invasive Species (Executive Order 13112) 66
4.10 Threatened and Endangered Species 68
4.11 Cultural and Historical Resources 70
4.12 Aesthetics (Visual) 71
4.13 Recreational Resources 73
4.14 Air Quality 74
4.15 Noise 75
4.16 Transportation 77
4.17 Human Environment 80
4.18 Hazardous, Toxic and Radioactive Waste 87
5 Future Without Project Condition 89
5.1 Future Levee System Conditions 90
5.2 Climate 91
5.3 Future Hydrology and Hydraulics 93
5.4 Future Economic Damages 95
5.5 Future Conditions Risk 96

5.6 Relevant Resources 98
6 Plan Formulation 99
6.1 Assumptions 100
6.2 Measure Development 100
6.3 Screening of measures 105
6.4 Formulation Strategies 106
6.5 Initial Array of Alternatives 108
6.6 Screening of Initial Array of Alternatives 111
6.7 Final Array of Alternatives 113
7 Environmental Effects* 116
7.1 Informational Background 116
7.2 Soils 138
7.3 Water Quality 141
7.4 Wetland and Forest Resources 144
7.5 Uplands 147
7.6 Fisheries 149
7.7 Essential Fish Habitat 152
7.8 Wildlife 155
7.9 Threatened & Endangered Species 157
7.10 Invasive Species 160
7.11 Cultural & Historical Resources 161
7.12 Aesthetics 163
7.13 Recreational Resources 166
7.14 Air Quality 168
7.15 Noise 170
7.16 Transportation 173
7.17 Human Environment 176
7.18 Hazardous, Toxic, and Radioactive Waste (HTRW) 180
7.19 Probable Unavoidable Adverse Impacts (on All resources) 183
7.20 Relationship between Short-Term Uses and Long-Term Productivity 184
7.21 Irreversible or Irretrievable Commitment of Resources 185
7.22 Compliance with Environmental Statutes 186
7.23 List of Preparers 192
8 Evaluate & Compare Alternative Plans 193
8.1 Alternatives Design 194
8.2 Economic Costs and Benefits of Alternatives 195
8.3 Life Safety Risk Reduction of the Alternatives 196
8.4 Completeness, Effectiveness, Efficiency & Acceptability 197
8.5 Comparison Summary 199
8.6 Tentatively Selected Plan / National Economic Development Plan 200
9 Tentatively Selected Plan (TSP) 201
9.1 Description 201
9.2 Costs 203
9.3 Economic and Life Safety Benefits 203
9.4 Real Estate Requirements 204
9.5 Cultural Resources Requirements 204
9.6 Mitigation Requirements 204
9.7 Risk & Uncertainty 204
9.8 Residual Risk 209
9.9 Executive Order 11988 211
9.10 Meeting Environmental Operating Principles 213

9.11 Lessons Learned During Hurricanes Katrina and Rita 214
9.12 USACE Campaign Plan 215
9.13 Sponsor Support 215
9.14 Total Project Cost and benefit-to-Cost-Ratio 216
10 Project implementation 217
10.1 Real Estate Considerations 217
10.2 Design Considerations 217
10.3 Construction Considerations 217
10.4 OMRR&R Requirements 217
10.5 Mitigation Requirements 217
10.6 Implementation Schedule 218
10.7 Sponsor Requirements 218
10.8 Cost Sharing Requirements 221
10.9 Financial Analysis 221
11 Public Involvement 222
12 Recommendation 223
13 References 224

APPENDICES

Appendix A Civil Engineering

Appendix B Geotechnical Engineering

Appendix C Hydrology and Hydraulics

Appendix D Semi-Quantitative Risk Assessment

Appendix E Structural Engineering

Appendix F Real Estate

Appendix G Environmental

Appendix H HTRW

Appendix I Cost

Appendix J Economics

Appendix K Mitigation Plan

Appendix L Coordination

LIST OF FIGURES

Figure 1-1 General Study Area Including Parishes 5
Figure 1-2. General Project Area Including Water Bodies 6
Figure 1-3. LPV Levees and Floodwalls 7
Figure 2-1. Graphical depiction of subsidence and sea level rise effects and potential rates. (Adapted from Erkens et al., 2015, accessed at: https://www.researchgate.net/publication/283771445) 14
Figure 3-1. LPV Sub-Basins 22
Figure 3-2. 1% AEP Peak Depths (ft.) for Existing Conditions 23
Figure 3-3. 0.2% AEP Peak Depths (ft.) for Existing Conditions 24
Figure 3-4. Risk Matrix 29
Figure 4-1. Sub-basins of the Lake Pontchartrain and Vicinity Study Area 33
Figure 4-2. Land use categories within the Lake Pontchartrain and Vicinity Study Area 35
Figure 4-3. Prime and Unique Farmland Locations within the Study Area 41
Figure 4-4. LDEQ Sub-watersheds within and adjacent to the Study Area 45
Figure 4-5. Percent of land area classified as forest by county in the Lower Mississippi Alluvial Valley, 2010 (Graphic from (Oswalt, 2013)) 48
Figure 4-6. Land change in the vicinity of the Study Area from 1932 to 2016 50
Figure 4-7. Wetlands in and around the Study Area 53
Figure 4-8. Projected Land Area Change from 2017 to 2067 based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation) 54
Figure 4-9. Essential Fish Habitat in the vicinity of the Study Area 59
Figure 4-10. Projected Vegetation in 2067 based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation) 66
Figure 4-11. Locations of transportation systems in the Study Area 79
Figure 4-12. Total population trends for Study Area parishes 81
Figure 4-13. Trends in number of households for Study Area parishes 82
Figure 5-11 Projected Levee Settlement Values by 2073 90
Figure 5-22 Location of Water Level Gages Used for RSLC Projections 92
Figure 5-3. 1% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions 94
Figure 5-4. 0.2% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions 95
Figure 6-1 Two dimensional representation of measures considered 100
Figure 6-2. Life Risk Matrix 107
Figure 6-3. LPV Alternative 2 and 3 – General Footprint 115
Figure 7-1. Ecoregions of Louisiana impacted by Lake Pontchartrain and Vicinity. 121
Figure 7-2. PotentialSuitable Borrow Sites Based on Soil Types and Avoidance of Potential Mitigation (data provided by USFWS, 2019; based on 2016 National Land Cover Database and National Resources Conservation Service (NRCS) soil surveys) 137
Figure 8-1. Conceptual Levee Lifts 194
Figure 9-1. Location of features included in the TSP 202
Figure 9-2. Existing (black) and With-Project (yellow) Crossover Points on the MRL 203
Figure 9-3. Illustration of TSP Risk Reduction Performance for Different RSLR Scenarios 208
Figure 9-4. Illustration of TSP Performance Over Time for Different RSLR Scenarios 209
Figure 9-5. Residual Flooding for the 1% AEP Event with Full Performance of the TSP 210

Figure 9-6. Residual Flooding for the 0.2% AEP Event with Full Performance of the TSP 211

LIST OF TABLES

Table 1-1. Relevant Data Sources 9
Table 2-1. Comparison of AEP and Return Period Terminology.....11
Table 3-1. Structure Counts by Occupancy Type 25
Table 3-2. Content to Structure Ratios and Standard Deviations 26
Table 3-3. Existing Conditions Damages by Probability Event 27
Table 3-4. Existing Conditions Annualized Economic Damages.....27
Table 3-5. Example Number Equivalents 29
Table 4-1. Study Area Overview 32
Table 4-2. Land Use Acreage in Study Area by Sub-Basin 34
Table 4-3 Study Area Climate Averages at New Orleans 36
Table 4-4. Recent Storms of Record 37
Table 4-5. Summary of Soils within the Study Area.....39
Table 4-6. Acres of Prime and Unique Farmland Soils within the Study Area Sub-Basins.....42
Table 4-7. Water Quality Attainment Status of LDEQ Sub-Watersheds in and near the Study Area 46
Table 4-8. Average Annual Value of Commercial Landings of Top Five Species in Louisiana from 2008 to 2017 56
Table 4-9. Federally managed species in and near the Study Area.....58
Table 4-10. Habitat types found in and near the Study Area 62
Table 4-11. Invasive species found in or near the Study Area.....66
Table 4-12. Federally-Listed Species Potentially Occurring in the Study Area 69
Table 4-13. Noise level limits by land use category in Study Area parishes 77
Table 4-14. Population Trend in the Study Area*, Total Population in Thousands.....80
Table 4-15. Number of Households in the Study Area*, Total Number in Thousands.....81
Table 4-16. Employment Trends* for the Study Area 83
Table 4-17. Study Area Unemployment Rates* 83
Table 4-18. Per Capita Income* ($) within the Study Area 84
Table 4-19. Total Population and Racial/Ethnic Composition of Communities* in LPV Study Area 86
Table 4-20. Persons Living Below Poverty Level in Communities* in LPV Study Area 87
Table 5-1 RSLC Projections.....92
Table 5-2. Future Conditions Damages by Probability Event.....96
Table 5-3. Future Conditions Economic Damages 96
Table 5-4. Critical Infrastructure Inundated in the FWOP Scenario 97
Table 6-1 Measures and Screening 105
Table 6-2. Initial Array of Alternatives.....111
Table 6-3. Evaluation of Initial Array.....112
Table 7-1. Magnitude of Impacts for the Lake Pontchartrain and Vicinity Proposed Alternatives and Generalized Borrow Areas 118
Table 7-2. Checklist for Identifying Potential Cumulative Effects 123

Table 7-3. Cumulative Effects Summary for Identified Resources 124
Table 7-4. Borrow Area Assumptions and Requirements Incorporated into Borrow Area Analysis 134
Table 7-5 Lake Pontchartrain and Vicinity Summary of Threatened and Endangered Species ESA Determination 159
Table 7-6. Sound Levels (dBA) of Construction Equipment and Modeled Attenuation at Various Distances 172
Table 7-7. Number of Sensitive Noise Receptors Impacted from Proposed Action (USACE, 2013) 172
Table 7-8. Relevant Laws and Regulations 186
Table 8-1. First Costs of Final Array of Alternatives (October 2019 Price Level)* 195
Table 8-2. Costs and Benefits of Final Array of Alternatives (October 2019 Price Level).....196
Table 8-3. Levee Performance and Consequences 196
Table 8-4. Comparison of Critical Infrastructure Risk Reduction 197
Table 8-5. Evaluation of Alternatives using Principles and Guidelines Criteria 198
Table 8-6. Evaluation of Final Array (October 2019 Price Level) 199
Table 9-1. Details of the TSP 216

ACRONYMS AND ABBREVIATIONS

AAHU: Average Annual Habitat Units
AALL: Average Annualized Life Loss
ACS: American Community Survey
ADCIRC: Advanced Circulation
AEP: Annual Exceedance Probability
APE: Area of Potential Effects
APF: Annual Probability of Failure
ASTM: American Society for Testing and Materials
ATR: Agency Technical Review
BCR: Benefit-to-Cost Ratio
BGEPA: Bald and Golden Eagle Protection Act
BLH-Wet: Bottomland Hardwood-Wet habitat
BMP: Best Management Practice
CDP: Census Designated Place
CED: Comprehensive Environmental Document
CEQ: Council of Environmental Quality
CERCLA: Comprehensive Environmental Response, Compensation and Liability Act
cfs: cubic feet per second
CFR: Code of Federal Regulations
CO: Carbon Monoxide
COTP: Captain of the Port
CPRAB: Coastal Protection and Restoration Authority Board
CSVR: Content-to-Structure Value Ratio
CWA: Clean Water Act
dB: Decibel
dBA: A-Weighted Decibel
DNL: Day-night Average Sound Level
DO: Dissolved Oxygen
DoD: Department of Defense
DQC: District Quality Control
DWS: Drinking Water Supply
EAD: equivalent annual damage
ECB: Engineering and Construction Bulletin
EFH: Essential Fish Habitat
EIS: Environmental Impact Statement
EJ: Environmental Justice
EO: Executive Order
EOP: Environmental Operating Principles
EPA: Environmental Protection Agency
EQ: Environmental Quality
ER: Engineer Regulation
ERDC: Engineer Research and Development Center
ESA: Environmental Site Assessment
FEMA: Federal Emergency Management Agency
FMP: Fishery Management Plan
FPPA: Farmland Protection Policy Act
FWAC: Future Without Action Condition
FWOP: Future Without Project
FWP: Fish and Wildlife Propagation
FY: Fiscal Year
GIWW: Gulf Intracoastal Waterway
GMFMC: Gulf of Mexico Fisheries Management Council
GRR: General Re-evaluation Report
HEC: Hydrologic Engineering Center
HEC-FDA: Hydrologic Engineering Center Flood Damage Analysis
H&H: Hydrology and Hydraulics
HSDRRS: Hurricane Storm Damage and Risk Reduction System
HTRW: Hazardous, Toxic, and Radioactive Waste
HUD: Housing and Urban Development
IER: Individual Environmental Report
IHNC: Inner Harbor Navigation Canal
IPET: Interagency Performance Evaluation Task Force
JPM-OS: Joint Probability Method-Optimal Sampling
LDEQ: Louisiana Department of Environmental Quality
LDWF: Louisiana Department of Wildlife and Fisheries
LERRD: Lands, Easements, Rights-of-way, Relocations, and Disposal
LORR: Level of Risk Reduction

LPV: Lake Pontchartrain and Vicinity, Louisiana
MM: Mile Marker
MR&T: Mississippi River and Tributaries
MRGO: Mississippi River Gulf Outlet
MRL: Mississippi River Levee
NAAQS: National Ambient Air Quality Standards
NAVD88: North American Vertical Datum of 1988
NED: National Economic Development
NEPA: National Environmental Policy Act
NMFS: National Marines Fisheries Service
NOAA: National Oceanic and Atmospheric Administration
NO_x: Nitrogen Oxides
NRCS: National Resources Conservation Service
NRHP: National Register of Historic Places
NSI: National Structure Inventory
O_3: Ozone
O&M: Operations and Maintenance
OMRR&R: Operations, Maintenance, Repair, Replacement, and Rehabilitation
OSE: Other Social Effects
OYS: Oyster Propagation
PCR: Primary Contact Recreation
PED: Preconstruction Engineering and Design
PFM: Probable Failure Mode
PM: Particulate Matter
PPA: Project Partnership Agreement
RAS: River Analysis System
REC: Recognized Environmental Conditions
RED: Regional Economic Development
RM: River Mile
RNA: Regulated Navigation Areas
ROW: Rights-of-Way
RSLC: Relative Sea-Level Change
RSLR: Relative Sea-Level Rise
SAV: Submerged Aquatic Vegetation
SCR: Secondary Contact Recreation
SELA: Southeast Louisiana Urban Flood Control Project
SHPO: State Historic Preservation Office
SO_x: Sulfur Oxides
SQRA: Semi-Quantitative Risk Assessment
SWPPP: Stormwater Pollution Prevention Plan
TDS: Total Dissolved Solids
THPO: Tribal Historic Preservation Officer
TRG: Tolerable Risk Guidelines
TSP: Tentatively Selected Plan
USACE: U.S. Army Corps of Engineers
USCG: United States Coast Guard
USDA: U.S. Department of Agriculture
USEPA: United States Environmental Protection Agency
USFWS: U.S. Fish and Wildlife Service
USGS: United States Geological Survey
VOC: Volatile Organic Compound
VRAP: Visual Resources Assessment Procedure
WBV: West Bank and Vicinity, Louisiana
WRDA: Water Resources Development Act
WRRDA: Water Resources Reform and Development Act

LAKE PONTCHARTRAIN & VICINITY, LOUISIANA GENERAL RE-EVALUATION REPORT

1 INTRODUCTION

1.1 STUDY SCOPE

This General Re-Evaluation Report (GRR) with integrated Environmental Impact Statement presents the results of a U.S. Army Corps of Engineers (USACE) coastal storm risk management study for the Lake Pontchartrain and Vicinity project located within the Greater New Orleans Area, Louisiana. This study is authorized by Section 3017 of the Water Resources Reform and Development Act of 2014 (Public Law 113-121).

Following the storm damage that occurred as a result of Hurricane Katrina in 2005, the Congress and Administration provided authorization and appropriations through supplemental acts, "…to raise levee heights where necessary and otherwise enhance the existing Lake Pontchartrain and Vicinity (LPV) project and the existing West Bank and Vicinity (WBV) project to provide the levels of protection necessary to achieve the certification required for participation in the National Flood Insurance Program under the base flood elevations current at the time of this construction;…" This level has sometimes been referred to in the past as the "100-year", "1% Level of Risk Reduction (LORR)", or "1% annual chance exceedance (ACE) probability" event. For more information on terminology, see Section 2.0 (Problems and Opportunities).

There are multiple projects adjacent to the existing LPV and WBV projects. Although not a hurricane and storm damage risk reduction project, the Mississippi River and Tributaries Project ("MR&T") is a riverine flood risk reduction project, which between River Miles (RM) 81 and 127 on the East Bank and RM 70 and 119 on the West Bank tie into the hurricane alignments (LPV & WBV, respectively) to form the comprehensive system perimeter. This includes a small portion of the East Bonnet Carré Lower Guide Levee making a connection between Mississippi River Levee (MRL) and LPV alignments on the west side of the system. There are also several Gulf Intracoastal Water Way (GIWW) locks which provide navigation connections to the Mississippi River and as such provide MR&T riverine flood risk reduction at those points.

Interior to the LPV, WBV, and MRL perimeter alignments, there are numerous complex structures situated within these alignments, interior levee alignments (lining interior navigable and drainage retention areas), and a complex interior drainage infrastructure. The interior drainage infrastructure is provided by local pump stations and drainage canals, the flood risk reduction Southeast Louisiana Urban Flood Control Project ("SELA"), and the post-Hurricane Katrina authorized storm-proofing of interior pump stations to ensure the operability of the stations during hurricanes, storms, and high water events. LPV and WBV are designed and constructed so as not to adversely impact internal drainage.

The authorization found in Section 3017 of WRRDA 2014 is only applicable to the LPV and WBV projects. Thus, while this GRR, under Section 3017 of WRRDA 2014, is for LPV/WBV, when used herein the term Hurricane and Storm Damage Risk Reduction System (HSDRRS) is used to refer the LPV/WBV projects and other projects which contribute, as an incidental

benefit, to providing risk reduction for the 1% AEP event. The scope of this study will focus on the LPV project and components of adjacent projects if applicable and necessary for LPV to provide coastal storm risk management.

This GRR will reevaluate the performance of the LPV project given the combined effects of consolidation, settlement, subsidence, sea level rise, and new datum over time and determine if additional actions are recommended to sustain the current level of risk reduction for hurricane and tropical storms. To be recommended, these actions must be determined to be technically feasible, environmentally acceptable, and economically justified. In order to identify the National Economic Development (NED) plan, the study will also consider other levels of risk reduction beyond 1% AEP.

1.2 PURPOSE OF REPORT

The general purpose of this study with integrated Environmental Impact Statement (EIS) is to analyze alternatives to reduce hurricane and storm risk within the LPV study area. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether an economically justified plan exists to reduce economic damages and life safety risk due to the combined effects of subsidence, consolidation, settlement, datum changes, and sea level rise on the LPV system. This report also satisfies the requirement of the National Environmental Policy Act (NEPA) to evaluate the proposed Federal action.

1.3 PROJECT AUTHORITY

The Secretary of the Army is authorized to construct the Lake Pontchartrain and Vicinity, Louisiana Project for hurricane storm protection in Southeastern Louisiana by:

- The Flood Control Act of 1965 (P.L. 89-298, Title II, Sec. 204);
- Water Resource Development Acts of 1974 (P.L. 93-251, Title I, Sec. 92), 1986 (P.L. 99-662, Title VIII, Sec. 805), 1990 (P.L. 101-640, Sec. 116), 1992 (P.L. 102-580, Sec. 102), 1996 (P.L. 104-303, Sec. 325), 1999 (P.L. 106-53, Sec. 324), and 2000 (P.L. 106-541, Sec. 432);
- Energy and Water Development Appropriations Acts of 1992 (P.L. 102-104, Title I, Construction, General), 1993 (P.L. 102-377, Title I, Construction, General), and 1994 (P.L. 103-126, Title I, Construction, General).

Following Hurricanes Katrina and Rita in August and September 2005, several supplemental acts provided authority and appropriated funds to repair, accelerate to complete, and improve the hurricane and storm damage risk reduction features in the LPV study Area.

The (Department of Defense) DoD Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and the Pandemic Influenza Act of 2006 (Public Law 109- 148, Chapter 3, Construction, and Flood Control and Coastal Emergencies) or “3rd Supplemental,” appropriated funds to accelerate the completion of the previously authorized project, and to restore and repair the project at full Federal expense.

In June 2006, the Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and the Hurricane Recovery of 2006 (Public Law 109-234, Title II, Chapter 3, Construction, and Flood Control and Coastal Emergencies) or “4th Supplemental,” appropriated funds and added the authority to raise levee heights where necessary, reinforce and replace floodwalls, armor critical elements, and otherwise enhance the project to provide the levels of protection necessary to achieve the certification required for participation in the National Flood Insurance Program under the base flood elevations current at the time of construction.

In May 2007, the U.S. Troop Readiness, Veterans’ Care, Katrina Recovery, and Iraq Accountability Appropriations Act, 2007 (Public Law110-28, Title IV, Chapter 3, Flood Control and Coastal Emergencies and Sec. 4302) or “5th Supplemental” provided $1,300,000,000 to carry out projects and measures for the WBV and LPV projects as described in Public Law 109-148 and provided flexibility to the Secretary to reallocate un-obligated funds from the Public Law 109-234 projects funded under the Flood Control and Coastal Emergencies heading, subject to coordination with the House and Senate Committees on Appropriation.

The Water Resources Development Act (WRDA) of 2007 (Public Law 110-114 at Section 7012) authorized the raising of levee heights where necessary and otherwise enhance the WBV and LPV projects to provide the level of protection necessary to achieve the certification required for participation in the National flood insurance program under the base flood elevation current at the time of this construction.

The 6th Supplemental, “Supplemental Appropriations Act, 2008,” (Public Law 110-252, Title III, Chapter. 3, Construction) provided WBV $920 million dollars (funds that became available October 1, 2008) subject to a Federal 65% and 35% non-Federal cost share "to modify authorized projects in southeast Louisiana to provide hurricane, storm and flood damage reduction in the greater New Orleans and surrounding areas to the level of protection necessary to achieve the certification required for participation in the NFIP under the base flood elevations current at the time of enactment of this Act". This Act was passed on 30 June 2008.

The 7th Supplemental, “Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009,” (Construction heading, Division B, Title I, Chapter 3 of Public Law 110-329) provides that the Secretary of the Army is directed to use $350,000,000 of the $1,500,000,000 appropriated under that heading to fund the estimated amount of non-Federal cash contributions to be financed in accordance with Section 103(k) of WRDA of 1986, over a period of 30 years from the date of completion of the work undertaken pursuant to the LPV Project Partnership Agreement (PPA), or separable element thereof.

1.4 STUDY AUTHORITY

Section 3017 of WRRDA 2014 (Public Law 113-121) authorizes the Secretary of the Army to carry out measures that address consolidation, settlement, subsidence, sea level rise, and new datum to restore certain Federally authorized hurricane and storm damage reduction projects to their authorized levels of protection, if the Secretary determines the necessary work is technically feasible, environmentally acceptable, and economically justified. In addition, the authority terminates 10 years after the date of enactment of WRRDA 2014 on 10 June 2024.

Water Resources Reform and Development Act of 2014 (WRRDA 2014) stipulates:

SEC. 3017. REHABILITATION OF EXISTING LEVEES.

(a) IN GENERAL – The Secretary shall carry out measures that address consolidation, settlement, subsidence, sea level rise, and new datum to restore Federally authorized hurricane and storm damage reduction projects that were constructed as of the date of enactment of this Act to the authorized levels of protection of the projects if the Secretary determines the necessary work is technically feasible, environmentally acceptable, and economically justified.

(b) LIMITATION. – This section shall only apply to those projects for which the executed project partnership agreement provides that the non-Federal interest is not required to perform future measures to restore the project to the authorized level of protection of the project to account for subsidence and sea-level rise as part of the operation, maintenance, repair, replacement, and rehabilitation responsibilities.

(e) TERMINATION OF AUTHORITY – The authority of the Secretary under this subsection terminates on the date that is 10 years after the date of enactment of this Act.

The above authority of the Secretary terminates on 10 June 2024. The GRR will be fully Federally funded in accordance with Public Law 115-123 (Supplemental Appropriation).

1.5 NON-FEDERAL SPONSOR

The non-Federal sponsor for this study is the Coastal Protection and Restoration Authority Board of Louisiana (CPRAB) and the feasibility cost-share agreement was executed on October 09, 2018.

The CPRAB is established as the single state entity with authority to articulate a clear statement of priorities and to focus development and implementation efforts to achieve comprehensive coastal protection for Louisiana. The CPRAB's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration Master Plan. Working with Federal, state and local political subdivisions, including levee districts, the CPRAB is working to establish a safe and sustainable coast that will protect communities, the nation's critical energy infrastructure, and natural resources into the future.

The CPRAB has stated that it intended or intends to enter into cooperation endeavor agreements or other sub-agreements, in accordance with the Constitution and Laws of the State of Louisiana, for performance of CPRAB's obligations under a Project Partnership Agreement. Some of the State entities which CPRAB may enter into cooperation endeavor agreements or other sub-agreements with include, but are not limited to:

- The Southeast Louisiana Flood Protection Authority – East
- The Pontchartrain Levee District

1.6 STUDY AREA AND MAPS

1.6.1 GENERAL STUDY AREA

The general study area (Figures 1-1 and Figure 1-2) includes the areas within the hurricane and storm damage risk reduction systems of the LPV and WBV projects. It includes the parishes of Jefferson, St. Bernard, Orleans, Plaquemines, and St. Charles. It is located in southeast

Louisiana and is bounded by Lake Pontchartrain to the north, Lake Borgne and Breton Sound to the east, and Bayou Trepagnier and Cross Bayou to the west. The study area is also bisected by the Mississippi River, with LPV to the north and WBV to the south. To the south there are numerous lakes, bayous, fragmented marsh, and wetlands that ultimately terminate in the Gulf of Mexico.

The City of New Orleans and the surrounding metropolitan area is a mixture of highly urbanized and industrial areas abutting wooded lands, wetlands, numerous man-made canals, bayous, and other watercourses which serve as a rich landscape for wildlife. The study area occupies a portion of one of the oldest delta complexes in the Mississippi River Deltaic Plain. It is in the lower Mississippi River alluvial plain in the Pontchartrain Basin.

The study area is dissected by numerous canals and waterways. Numerous sensitive environmental resources are located near the study area. In general, these environmental resources are largely comprised of bottomland hardwood forests, cypress-tupelo swamps, and various freshwater, brackish and saline marsh, and scrub-shrub habitats.

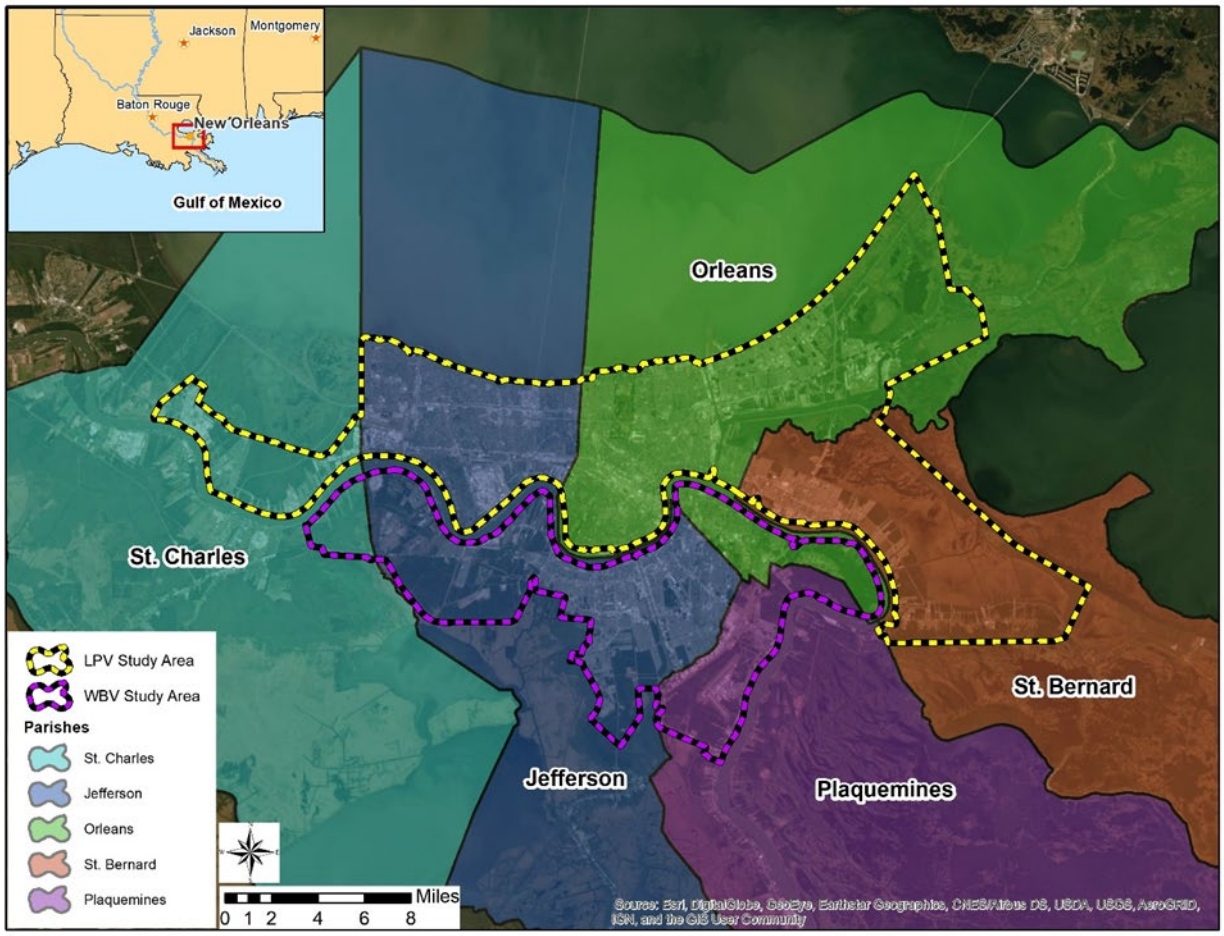

Figure 1-1 General Study Area Including Parishes

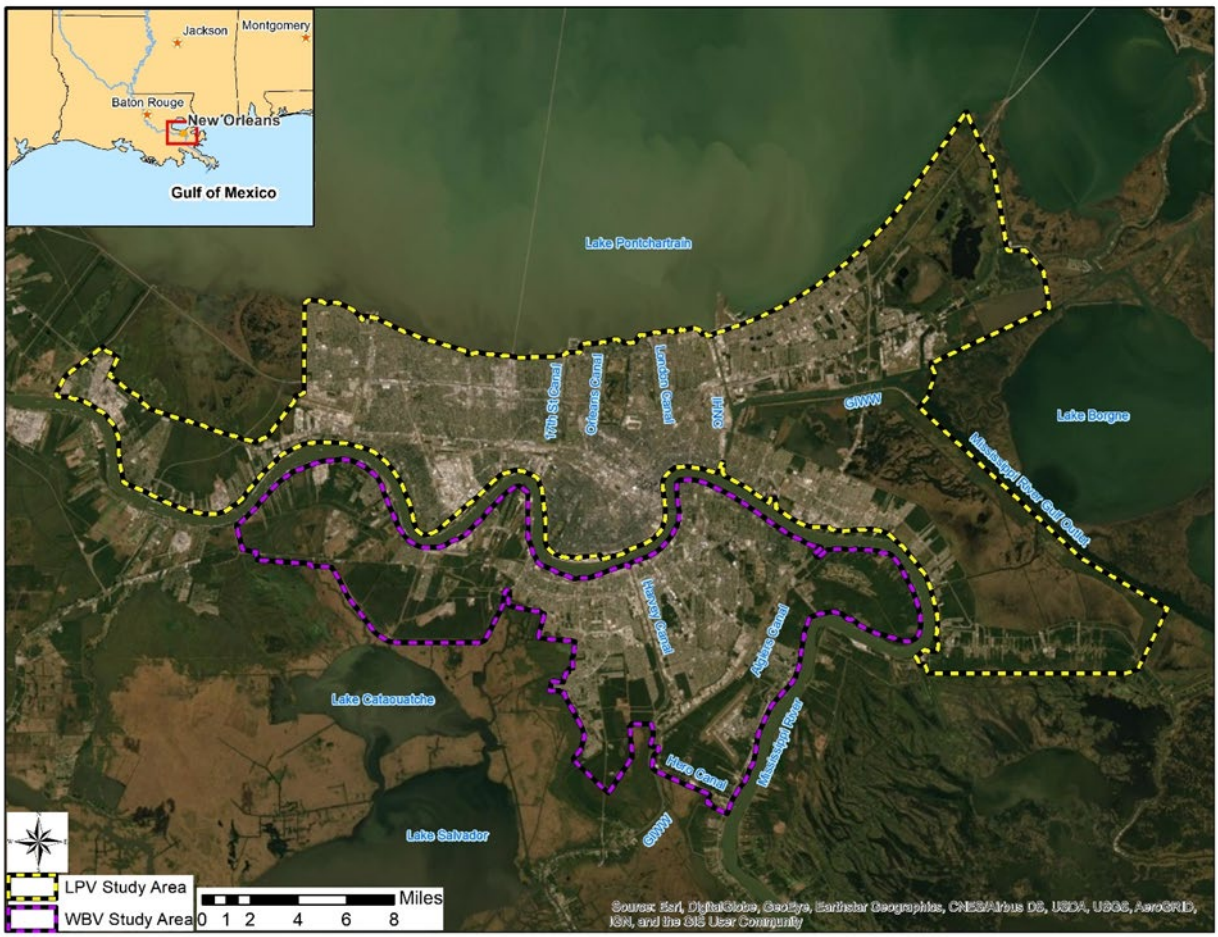

Figure 1-2. General Project Area Including Water Bodies

1.6.2 LPV PROJECT AND STUDY AREA

The LPV project includes features in four parishes (St. Charles, Jefferson, Orleans, and St. Bernard) located in the greater New Orleans area on the east bank of the Mississippi River. Currently, LPV contains approximately a total of 126.5 miles of levees and floodwalls (Figure 1-3). There are approximately 83 miles of armored perimeter levees and floodwalls and approximately 43.5 miles of interior levees and floodwalls. The project is in a high-density residential and commercial area.

The Mississippi River and Tributaries' levee (MR&T levees or MRL) along with the Upper Bonnet Carré Guide Levee provides risk reduction from riverine flow flood risks. The LPV project connects to the MRL at both the west and east of the system.

The levees and floodwalls along the Inner Harbor Navigation Canal (IHNC) and Orleans Parish outfall canals were removed from frontline or perimeter risk reduction features and became interior risk reduction features by construction of the Seabrook Gate Closure and the IHNC - Lake Borgne Surge Barrier and Permanent Canal Closures and Pumps. Although these interior levees and floodwalls are not part of the hurricane perimeter defenses, they are an integral part of the LPV hurricane and storm damage reduction system required for reducing the risk of

flooding caused by precipitation during a hurricane or tropical storm and over topping of the Lake Borgne Closure Surge Barrier.

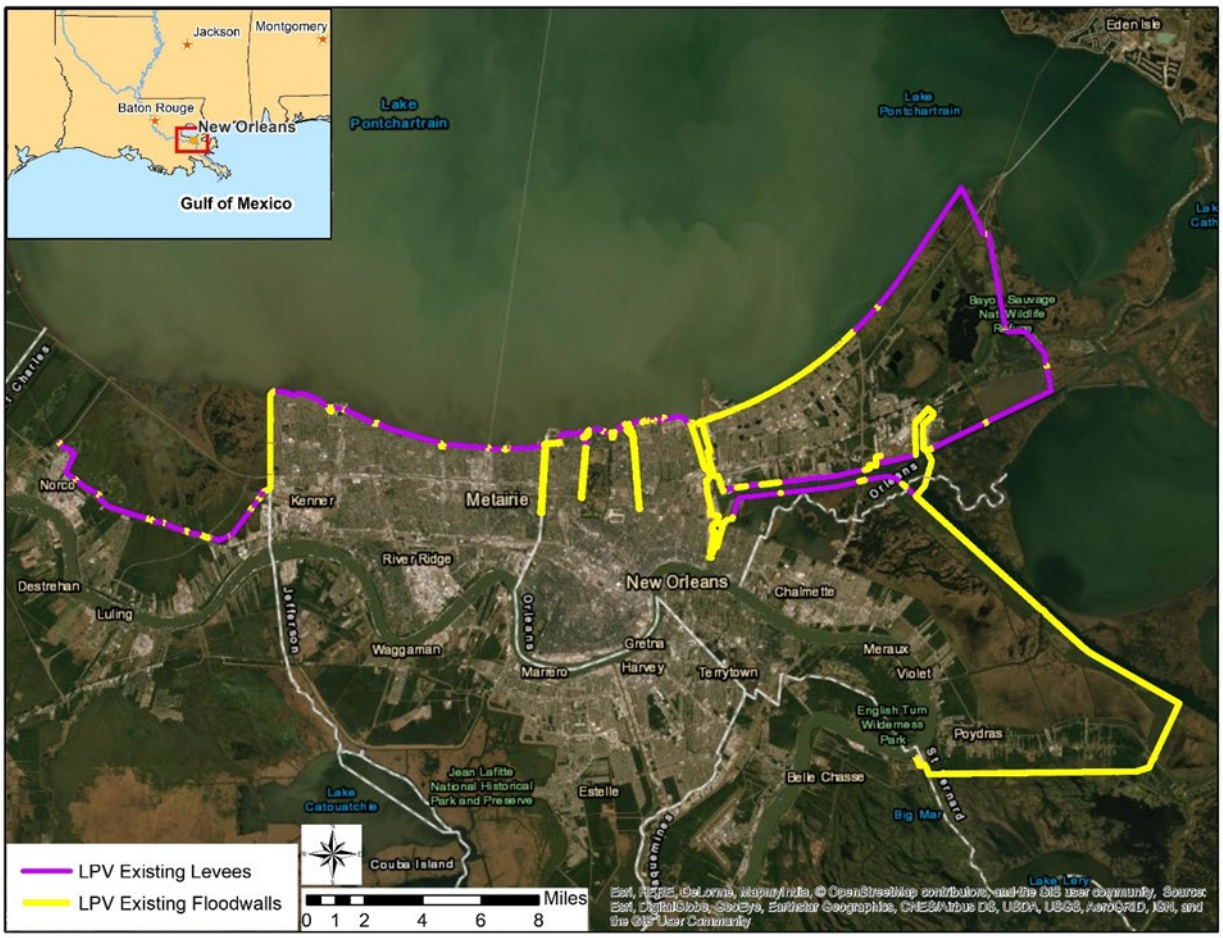

Figure 1-3. LPV Levees and Floodwalls

1.7 INTERAGENCY STUDY TEAM & COOPERATING AGENCIES

The CPRAB was part of the interagency study team. The interagency study team provided data and subject matter expertise to identify problems, characterize existing and future conditions, develop measures, and formulate and evaluate alternatives.

Cooperating agencies include the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA).

1.8 PRIOR REPORTS, EXISTING WATER PROJECTS, & ONGOING PROGRAMS

1.8.1 PRIOR REPORTS

The following is a list of recent or ongoing programs and studies in the study area relevant to the Lake Pontchartrain and Vicinity Project:

- USACE. 2007. Elevations for Design of Hurricane Protection Levees and Structures Lake Pontchartrain, Louisiana and Vicinity Hurricane Protection Project and West Bank and Vicinity, Hurricane Protection Project. This report provides a detailed documentation of the coastal and hydraulic engineering analysis performed to determine the 1% AEP project design elevations for these two hurricane protection projects. The report has been prepared to provide levee and structure elevations so that USACE can initiate detailed design and construction as described in the 4th Supplemental Appropriation, Public Law 109-234 of the One Hundred Ninth Congress. Available at: https://www.mvn.usace.army.mil/Portals/56/docs/engineering/HurrGuide/ElevationsforDesignofHurricaneProtectionLeveesandStructures.pdf
- Interagency Performance Evaluation Task Force (IPET). 2009. Interagency Performance Evaluation of the New Orleans and Southeast Louisiana Hurricane Protection System. Final Report of the Interagency Performance Evaluation Task Force.
- USACE. 2009. Louisiana Coastal Protection and Restoration Final Technical Report, Hydraulics and Hydrology Appendix – Volume 1. New Orleans District, New Orleans, LA.
- USACE. 2012. Hurricane Isaac With and Without 2012 100-year HSDRRS Evaluation. Preliminary Report. February 2012. New Orleans District, New Orleans, LA. Available at: www.mvn.usace.army.mil/Portals/56/.../20130208HurrIsaacW-WO2012HSDRRS.pdf
- USACE. 2013. Comprehensive Environmental Documents - Phase I, Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Volumes 1-3 https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/
- USACE. 2014. Elevations for Design of Hurricane Protection Levees and Structures Report, Version 2.0. This report provides a detailed documentation of the coastal and hydraulic engineering analysis performed to determine the project design elevations for three projects within the Greater New Orleans HSDRRS: Lake Pontchartrain and Vicinity, West Bank and Vicinity, and New Orleans to Venice Projects, including the portions of the Mississippi River levees coincident with these projects. Available at: https://www.mvn.usace.army.mil/Portals/56/docs/PAO/Matt/%281%29-FINAL-MAIN-REPORT-2014-DER.pdf

- CPRA. 2017. Louisiana's Comprehensive Master Plan for a Sustainable Coast. Available at: http://coastal.la.gov/wp-content/uploads/2017/04/2017-Coastal-Master-Plan_Web-Single-Page_CFinal-with-Effective-Date-06092017.pdf
- Long Distance Sediment Pipeline, Bayou Dupont Marsh and Ridge Creation (p36 CPRA MP)
- Mid-Barataria and Mid-Breton Sediment Diversions (p133 CPRA MP)
- USACE 2013. Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Levee Armoring Research Document Report (LARDR).
- USACE. 2014. Greater New Orleans Hurricane and Storm Damage Risk Reduction System, Levee Armoring, Engineering Alternatives Report (EAR).
- USACE 2013. Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS) National Flood Insurance Program (NFIP) Levee System Evaluation Report (NLSER)
- USACE 2007. Hurricane Protection Office (HPO). Senior Review Panel Best Technical Solution Evaluation Report. Conceptual Design Services for Permanent Pump Stations and Canal Closures at the Outfalls of the 17th Street, Orleans Avenue and London Avenue Canals, Orleans Parish, Louisiana.
- USACE. 2009. Inner Harbor Navigation Channel (IHNC) Lock Replacement Project. Supplemental Environmental Impact Statement. Available at: https://www.mvn.usace.army.mil/Portals/56/docs/PD/Projects/IHNCLockRepl/2009/2009%20Final_SEIS_03_23_09.pdf

Table 1-1. Relevant Data Sources

		Relevance to LPV			
		Data Source	Structural	Non Structural	FWOP
1965	Chief of Engineers Report on Lake Pontchartrain and Vicinity, LA Hurricane Protection Project	X	X		
1967	Amite River and Tributaries, Comite River Basin, LA		X		
1984	Chief of Engineers Report on Lake Pontchartrain and Vicinity, LA Hurricane Protection Project	X	X		
1990	LA Coastal Area Mississippi River Delta Study	X			X
1994	Southeast Coastal LA Hurricane Preparedness Study	X	X	X	X
2006	HSDRRS Design Report	X	X	X	X
2009	LACPR Final Technical Report	X	X	X	X
2012	CPRA 2012 Coastal Master Plan	X	X	X	X
2013	NFIP Levee System Evaluation Report	X	X	X	X
2017	CPRA 2017 Coastal Master Plan	X	X	X	X

After hurricanes Katrina and Rita, USACE satisfied the NEPA requirements for the LPV and WBV projects through the use of Council of Environmental Quality (CEQ)-approved Emergency Alternative Arrangements which acknowledged that emergency circumstances warranted the use of alternative NEPA procedures as allowed by the NEPA regulations (40 Code of Federal Regulations (CFR) 1506.11). The notice of the Emergency Alternative Arrangements was published in the Federal Register (Federal Register Volume 72, Number 48, March 13, 2007). This allowed separate environmental evaluation of numerous smaller construction projects as the engineering design for each segment was developed, rather than waiting to complete the NEPA evaluation once the designs for the entire system were complete. Based on the Emergency Alternative Arrangements, each segment or reach of the LPV was described and analyzed in a document called an Individual Environmental Report (IER). The Emergency Alternative Arrangements also committed USACE to analyzing the cumulative impacts of the LPV in a Comprehensive Environmental Document (CED).

1.8.2 EXISTING WATER PROJECTS & ONGOING PROGRAMS

Mississippi River Levee (MRL)

The Mississippi River and Tributaries Project (MR&T) was authorized by Congress and designed to reduce the risk of flood damage from high river flows. At the time of this study the crossover point on the east bank, where LPV design height requirements exceed the MRL design elevations, is downstream of the study area. However, it will move upstream into the project area over the 50 year period of analysis. Operation and maintenance of the reaches of the MR&T where the MRL design grade are equal to or higher than the LPV design grade are funded and guided by the separate MR&T authorities and guidance.

The Southeast Louisiana Urban Flood Control Project (SELA)

SELA is a flood control project, authorized by Congress to improve the rainfall drainage systems in Orleans, Jefferson and St. Tammany Parishes. On the East Bank, SELA focuses on improving existing - and constructing new - drainage channels and stormwater pump stations. These features via pump stations do convey stormwater across the LPV risk reduction perimeter, and also impact the interior drainage flow that LPV gates and pump stations need to handle. CPRAB has been the non-Federal sponsor of SELA projects since 2009.

Inner Harbor Navigation Channel Surge Barrier

The Inner Harbor Navigation Channel (IHNC) provides risk reduction for the 1% AEP event to a large portion of Orleans and St. Bernard parishes by reducing the risk of surge entering the GIWW/IHNC corridor from Lake Borgne and the Gulf of Mexico.

Seabrook Floodgate Complex

The Seabrook Floodgate Complex is located at the north end of the IHNC and works in tandem with the IHNC Surge Barrier. This project consists of a 95 foot wide navigable sector gate and two 50 foot wide, non-navigable vertical lift gates with floodwall tie-ins on the east and west sides.

2 PROBLEMS & OPPORTUNITIES

This chapter focuses on the purpose and need for the study, including discussion of the problems to be addressed by the study, potential opportunities to be considered, study goals and objectives, as well as study constraints. Scoping and coordination with the public, State agencies, and Federal agencies was also conducted during the process of identifying the problems and opportunities. These activities are also described.

Throughout this chapter and all subsequent chapters, flood and coastal storm events will be referred to by their AEP, which is the probability that this level of flooding may be realized or exceeded in any given year. For example, a flood event with a 1% AEP would have a 1% probability of occurring every year. In the past, this has often been referred to as a 100-year event (return period) or having a 1% annual chance of exceedance (ACE). Table 2-1 provides a list of AEP events that were considered during the study, with their equivalent "return period."

Table 2-1. Comparison of AEP and Return Period Terminology

AEP	Return Period
20%	5-year
10%	10-year
4%	25-year
2%	50-year
1%	100-year
0.5%	200-year
0.2%	500-year
0.1%	1000-year

2.1 PURPOSE & NEED*

The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The purpose of the study with integrated Environmental Impact Statement (EIS) is to analyze alternatives to reduce flood risk due to coastal storms within the LPV study area. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether an NED plan exists to reduce life safety risk and economic damages due to the combined effects of subsidence, settlement, consolidation, sea level rise and new datum on the LPV system. The integrated report includes assessment of the environmental effects of a reasonable range of potential alternatives or actions designed by USACE, including the no action plan, prior to decision making.

2.2 PROBLEM IDENTIFICATION

2.2.1 PROJECT HISTORY

Since 1855, 70 hurricanes have made landfall within 65 nautical miles of metropolitan New Orleans. Hurricanes Betsy (1965), Camille (1969), Juan (1985), Andrew (1992), Katrina and Rita (2005), Gustav and Ike (2008), Isaac (2012), and Nate (2017) caused storm surge flooding. Storm surge flooding threatens lives, damages homes, businesses and infrastructure, and disrupts the nationally-significant energy industry. According to the Department of Health and Hospitals (DHH), approximately 1,400 deaths were reported following Hurricane Katrina and approximately 1.3 million residents were displaced immediately following the storm. Estimated property and infrastructure damages were in excess of $28 billion in the New Orleans area and as much as $125 billion along the Gulf Coast (NOAA 2018, IPET 2006).

After the devastation of the 2005 hurricane season, the U.S. embarked on one of the largest civil works projects ever undertaken at an estimated cost of $14.6 billion, with restoration, accelerated construction, improvements, and enhancements of various risk reduction projects and environmental mitigation within southeastern Louisiana, including the Lake Pontchartrain and Vicinity, Louisiana, Project (LPV) and the West Bank and Vicinity, Louisiana, Project (WBV). P.L 109-234 authorized the construction of a system to provide the levels of risk reduction necessary to achieve the certification required for participation in the National Flood Insurance Program under the base flood elevations current at the time of construction. The total budgeted cost for the LPV project, under the post-Katrina supplemental acts, is approximately $7 billion. The completion of the levees, floodwalls, gates, and pumps that together form the HSDRRS provided risk reduction for a 1% AEP hurricane and storm damage event to the areas within LPV and WBV.

Project performance is described by AEP and long-term risk rather than level-of-protection. AEP is defined as the probability that a certain threshold may be exceeded at a location in any given year. The LPV project is designed to address the 1% AEP hurricane and coastal storm event which is made up of the 1% AEP stillwater elevation, 1% AEP wave height, and 1% AEP wave period, while assuming simultaneous occurrence of maxima of surge level and wave characteristics (hereafter referred to the 1% event, 1% design or 1% level of risk reduction), at the time of construction. Levees in both LPV and WBV were constructed on a limited footprint with the understanding that additional height would need to be added (termed “levee lifts”) in the future to counteract soil consolidation, settlement, subsidence and sea level rise, and maintain the designed level of risk reduction. Floodwalls heights were designed to account for an estimated amount of future sea level rise.

The LPV project is currently accredited by the Federal Emergency Management Agency (FEMA) for the 1% AEP level of risk reduction, utilizing specific HSDRRS guidelines. However, as with any hurricane and storm damage risk reduction project, there are remaining life safety and economic damage risks associated with the potential for project non-performance (some form of physical failure) or design exceedance. In an extreme case, non-performance can result in sudden localized high velocity flows and rapid increases in flood depth on the interior of the system. Design exceedance occurs when a lower-probability event brings higher surge levels and greater wave overtopping rates than the system was designed to address. Design

exceedance impacts can range from increased interior flooding of the system to project non-performance.

2.2.2 PROBLEMS TO BE ADDRESSED BY THIS STUDY

Southeast Louisiana, including the Greater New Orleans area, is generally characterized by weak soils, general subsidence, and the global incidence of sea level rise that will cause existing levees to require future lifts to sustain performance of the LPV system. The post-Katrina supplemental acts authorities did not provide for future lifts. Engineering analysis indicates that absent future levee lifts to offset consolidation, settlement, subsidence, sea level rise, and new datum, at some point in the future the project will not provide risk reduction for the 1% AEP event.

New Datum

Following review of datum changes, changes to the existing or future performance of the LPV system based on new datum requirements were not identified as a problem. Survey and spatial data used in this study were collected utilizing the North American Vertical Datum of 1988 (NAVD88) and the standards set forth in EM 1110-2-6065 (DOA 2010). Additionally, an updated coefficient for calculating relative sea level rise (RSLR) was captured in the various scenarios.

Settlement and Consolidation

Levee settlement occurs after completion of construction when the forces of gravity acting on the soil gradually reduce the amount of air and water that fills the spaces between the grains of minerals that comprise the soil and the soil becomes more compacted. The rate of settlement varies based on the type of soil(s) utilized in the levee's construction.

Immediate settlement occurs just after the soils are placed and air is expelled. Consolidation is another component of settlement and it occurs as water is expelled over time under a constant load, such as gravity. For the remainder of this report the term "settlement" (as applied to levees) will be used to refer to the total settlement, which is composed of the immediate settlement plus consolidation over time.

Settlement below the 1% AEP design elevation increases the risk of overtopping by reducing the top elevation of the levee over time. Past settlement amounts and rates of continued settlement vary around the systems, depending largely on the timeframe of construction for each levee reach (settlement rates decrease over time as materials become compacted). Some settlement is accounted for in construction as "over build."

Subsidence

Subsidence is the sinking of the ground because of underground material movement. It is caused by naturally occurring geologic and human-caused processes. In the study area, subsidence is primarily caused by groundwater pumping and surface water pumping (known as dewatering). Other factors include faults in rock formations; human withdrawal of water, oil, and gas; shallow sediments compacting; and perpetual land movement from glaciers during the last glacial period.

In the study area, subsidence contributes to the lowering of the levee top elevations by lowering the ground that the levee sits on.

Sea Level Change

Sea level rise increases risk by increasing the initial water elevation (stillwater) that hurricanes have an effect on, thereby increasing storm surge and wave elevations. Relative sea-level change (RSLC) is a combination of eustatic (global or wide-spread) sea-level rise and local subsidence. Figure 2-1 below graphically depicts the combined effects of subsidence and sea level rise.

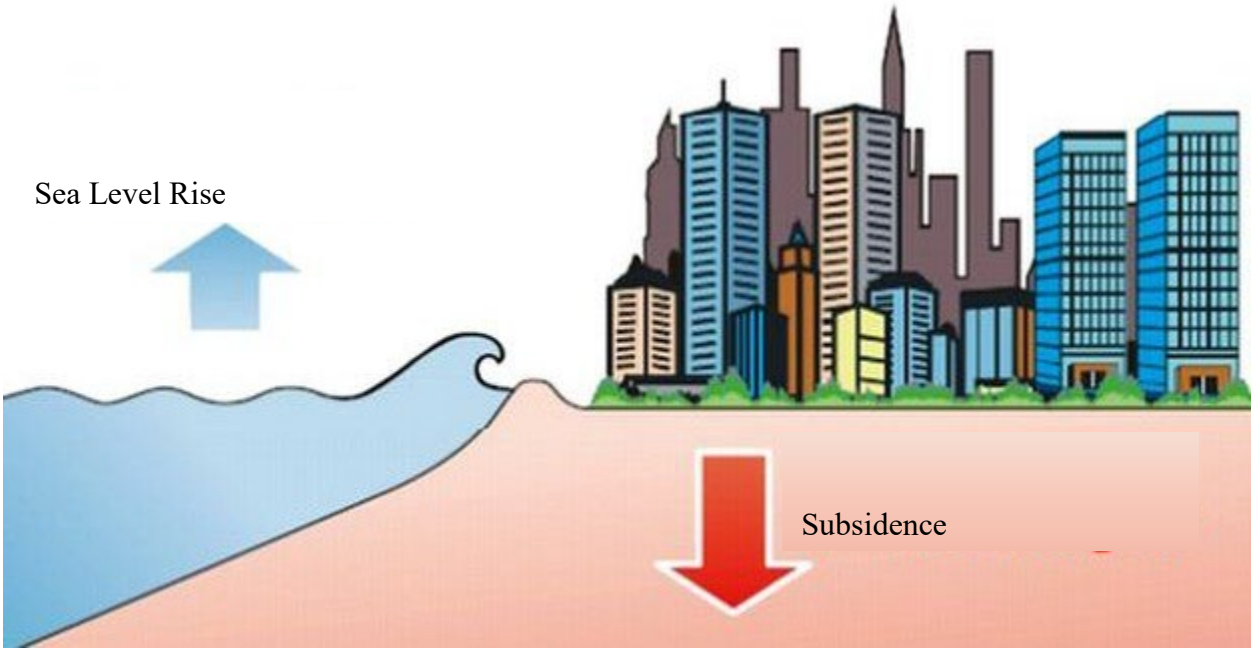

Figure 2-1. Graphical depiction of subsidence and sea level rise effects and potential rates. (Adapted from Erkens et al., 2015, accessed at: https://www.researchgate.net/publication/283771445)

Combined Effects

Figure 2-2 demonstrates how sea level rise (dashed blue line), changes in the levee top elevation due to settlement (dotted black line), and changes in ground elevation due to regional subsidence (dashed black line), combine to reduce the ability of the levee system to provide the designed 1% AEP risk reduction in the future, absent future levee lifts.

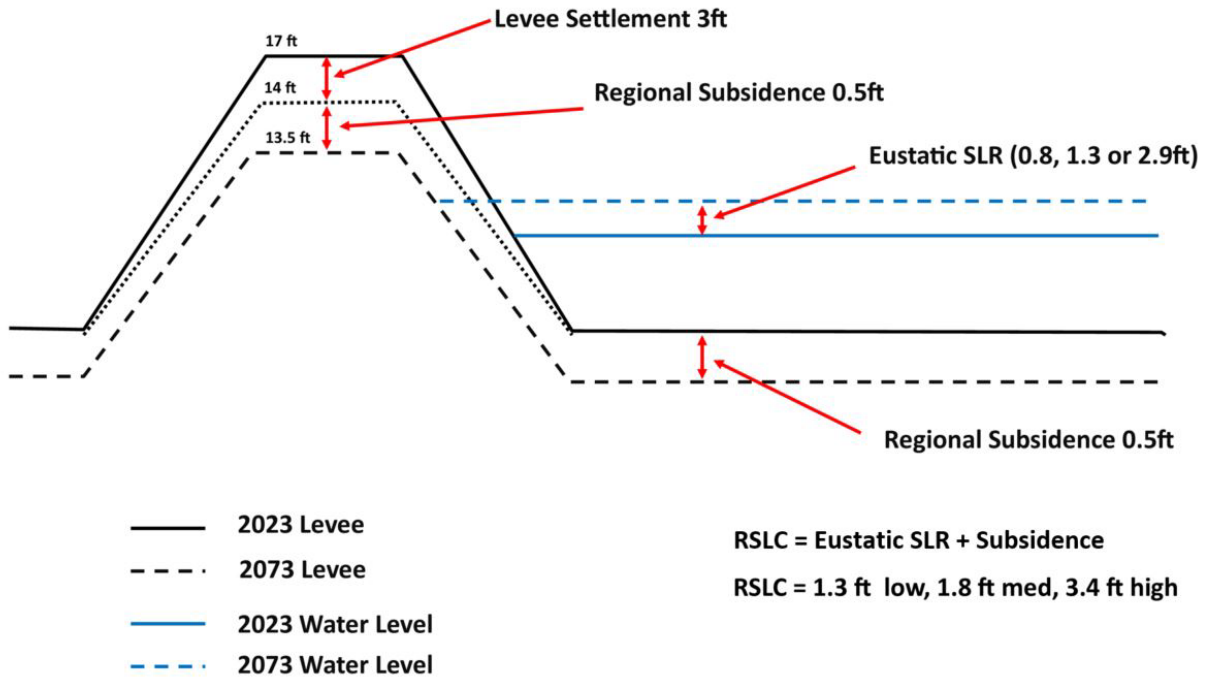

Figure 2 2. Combined Effects of Settlement, Subsidence and Sea Level Rise

2.2.3 SCOPING & COORDINATION*

Scoping is an early and open process for determining the range of issues to be addressed and for identifying the significant concerns related to a proposed Federal action. During the planning process, a variety of communication methods with the affected public, agencies, and organization occurred.

USACE conducted scoping and coordination with the following state and Federal agencies and other interested parties:

- Louisiana Coastal Protection and Restoration Authority Board
- Louisiana Coastal Protection and Restoration Authority
- U.S. Fish and Wildlife Service
- National Park Service
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration, National Marine Fisheries Service
- Louisiana Department of Natural Resources
- Louisiana Department of Environmental Quality
- Louisiana Department of Wildlife and Fisheries
- Louisiana State Historic Preservation Office
- Tribal Nations
- The Southeast Louisiana Flood Protection Authority – East
- The Pontchartrain Levee District
- St. Charles Parish

- Orleans Parish
- St. Bernard Parish
- Jefferson Parish

The input received during scoping helped assist USACE in making holistic, informed decisions throughout the study process. Please see Appendix L, *Coordination*, for related documents.

2.2.4 COORDINATION MEETINGS

Study collaborators discussed problems, opportunities, and potential measures through numerous coordination meetings. While not comprehensive, the following meetings are examples of ongoing coordination:

- Plan Formulation coordination meeting (1st iteration): September 10, 2018
- Plan Formulation coordination meeting (2nd iteration): November 6, 2018
- Stakeholder and sponsor: November 5, 2018
- Federal coordination: November 6, 2018
- State coordination: November 7, 2018
- Levee District Strategic Partnership Meeting: March 29, 2019

The intent of the 1st and 2nd iteration Plan Formulation meetings was to complete early rounds of the USACE 6-step planning process to inform development of potential alternatives for the study. Subsequent coordination meetings were focused on agency and stakeholder collaboration during early stages of the study process.

2.2.5 PUBLIC REVIEW AND COMMENTS

Public scoping occurred throughout the duration of the planning study. The general public could learn more about the study through the USACE public website. Public scoping meetings were held in April 2019 to encourage the public to provide comments on the proposed actions in the study area. For additional information see Appendix L, *Coordination*.

2.2.6 PROBLEM SUMMARY AND STATEMENT

The combined effect of subsidence, settlement, and sea level rise will continue and increase the risk of overtopping of levees during hurricane storm events as time progresses. This in turn increases:

- Risk of catastrophic failure from overtopping
- Risk to life safety
- Risk of damage to property & infrastructure
- Regional economic impacts
- Risk to cultural heritage, population, other social effects
- Risk of environmental damages and human health safety impacts from industrial flooding

PROBLEM STATEMENT: Due to subsidence, settlement, and potential sea level rise there is an increased risk of overtopping of LPV levees during hurricane storm events over the period of analysis, resulting in increased risk to life safety and storm-related flood damages within the

LPV area. Changes over time to the LPV hurricane risk reduction system are dynamic and therefore challenging to communicate to the public. However, multiple meetings were held with the public, agencies, and stakeholders and this document attempts to communicate this risk and need for action.

2.3 OPPORTUNITIES

Opportunities are positive conditions in the study area that may result from implementation of a Federal project such as:

- Sustain the initial ($7.1B) Federal investment in the LPV system
- Protect environmental resources
- Continue to provide FEMA certifiable level of risk reduction
- Reduce the costs associated with hurricane and storm damages to the environment and human health. This may be quantitatively measured by estimates of reduced damages or qualitatively assessed.

2.4 FEDERAL INTEREST

As originally established by the Flood Control Act of 1965, and further exemplified in the $7.1 billion dollars invested in the LPV system after Hurricane Katrina, there is a Federal interest in hurricane and storm risk reduction for the LPV area.

Since 1855, 70 hurricanes have made landfall within 65 nautical miles of metropolitan New Orleans. Hurricanes Betsy (1965), Camille (1969), Juan (1985), Andrew (1992), Katrina and Rita (2005), Gustav and Ike (2008), Isaac (2012), and Nate (2017) caused storm surge flooding. Storm surge flooding threatens lives, damages homes, businesses and infrastructure, and disrupts the nationally-significant energy industry. According to the Department of Health and Hospitals (DHH), approximately 1,400 deaths were reported following Hurricane Katrina and approximately 1.3 million residents were displaced immediately following the storm. Estimated property damages were in excess of $28 billion in the New Orleans area and as much as $125 billion along the Gulf Coast (NOAA 2018, IPET 2006).

2.5 GOALS & OBJECTIVES*

The overarching goal of this GRR is to reduce the risk of life loss and economic damages due to hurricane storm surge in the LPV area. The Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative.

Specific study objectives were developed to identify measures and alternatives which are capable of addressing the study area's problems while taking advantage of the identified opportunities and avoiding the constraints. The following study objectives were developed based on the study area problems, opportunities, and goals, as well as the Federal objective and regulations.

Objectives:

1. Reduce risk of life loss due to hurricane and storm damage in LPV over the period of analysis. This includes identifying at least one alternative which reduces life safety risk below the tolerable risk reference lines. This will be primarily measured by life safety risk reduction estimates.
2. Reduce economic damages due to hurricane and storm damage in LPV over the period of analysis. This will be primarily measured by economic benefits estimates.

2.6 CONSTRAINTS

A planning constraint limits the extent of the plan formulation process. Plans should be formulated to meet study objectives and avoid violating the constraints. All USACE studies have a set of "universal" constraints and also study-specific constraints. These are outlined below, along with a list of additional considerations that, while not constraints, may influence the study process.

The criteria below are considered constraints when formulating management measures.

Universal Study Constraints Applicable to this Study

- Avoid and/or and minimize environmental and cultural resources impacts, including but not limited to endangered species and critical habitat.
- Avoid and/or minimize locating project features on lands known to have Hazardous, Toxic and Radioactive Waste (HTRW) concerns.
- Resource constraints – time, money, knowledge
- Adhere to applicable laws and policies

Study-Specific Constraints

- Avoid impacts to the functions of other Federal projects in the vicinity. These projects include but are not limited to the GIWW, MR&T, INHC, SELA, etc.

Additional Study Considerations

- *Real Estate*. Due to urbanization, many areas have very little open land adjacent to the existing levee features. Increases to the project footprint may be difficult without buying out structures.
- *Wetland mitigation*. Mitigation areas may be hard to find. Mitigation bank availability varies with time, and potentially impacted habitat types may have limited suitable land nearby for identification of potential mitigation sites.
- *Environmental Justice*. An Environmental Justice (EJ) analysis focuses on the potential for disproportionately high and adverse impacts to minority and low-income populations during the construction and normal operation of a Federal Action. The study must strive to avoid or minimize this potential impact.
- *Transfer of risk.* The study must identify and address any potential transfer of risk to other entities. Increases to economic, life safety, or environmental risk should be avoided and/or minimized.

3 EXISTING CONDITIONS LEVEE PERFORMANCE

One of the first steps in the USACE planning process is to assess the existing conditions in the study area. This generally includes describing all of the factors that are relevant to the study, as they exist during the study period. This chapter discusses the current condition of the levee, the hydrology and hydraulic conditions that affect the levee's performance, the potential economic damages if the levee's current elevations were to be exceeded by storm surge and/or waves (known as overtopping), and the potential life safety consequences if levees were overtopped or failed (breached). Chapter 4 discusses the potentially affected existing environment and forecasts change to that environment over the study's 50-year period of analysis. Chapter 5 will consider potential changes in the future which may affect the levee's performance and estimates corresponding changes to economic damages, levee performance risk, and life safety consequences.

3.1 EXISTING LEVEE SYSTEM CONDITION

Currently, LPV contains an approximate total of 126.5 miles of levees and floodwalls. There are approximately 83 miles of armored perimeter levees and floodwalls and approximately 43.5 miles of interior levees and floodwalls. The design elevations resulting from the post-Katrina Supplemental Acts were intended to reduce estimated tropical storm flood risk in the year 2057 (sometimes referred to as the "2057 design"). However, those authorities did not provide for future lifts to maintain the levee design elevations as levee soils consolidated over time.

Levee top elevation, top width, and side slopes vary throughout the system. In some areas there are landside stability berms and there are some reaches with wave berms. All LPV perimeter levees are armored with either high performance turf reinforcement mat, concrete aprons, rip-rap, or articulated concrete blocks. The LPV/MRL co-located project area is defined as the area in which the LPV design elevations are higher than the MR&T design elevations. However, since the MR&T is established and maintained by previous authority that is not superseded by the LPV authority, the projects are said to co-exist or coincide, meaning the LPV levee or feature is built on top of, and over, the MR&T levee. Currently, there are no LPV/MRL co-located levees.

The levees have settled over time. Settlement begins to occur as soon as construction is complete and, because the system was constructed over time, the amount of settlement varies throughout the system. Some reaches have been "lifted" (height added) by CPRAB and either Southeast Louisiana Flood Protection Authority - East or Pontchartrain Levee District, as a USACE Section 408 (Alteration to a Project) effort, prior to armoring being added, to compensate for settlement. However, the PPA does not require the non-Federal sponsor to maintain the authorized level of risk reduction to account for subsidence or sea level rise as part of its Operations, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) responsibilities. In order to assess the current levee elevations, a top-of-levee survey was completed in the fall of 2018. This survey was used to assess the accuracy of previous settlement projections and supported project future settlement (see Chapter 5).

Generally, armoring is intended to provide resiliency to the system when subject to events greater than the design event. The LPV was designed for the 1% AEP stillwater and wave

overtopping then checked for resiliency for the 0.2% AEP stillwater elevation. The purposes of armoring are to reduce the risk of catastrophic failure during these less-frequent, more severe events, and to ensure that the system remains in place and functional for subsequent storm events. To this end, armoring is essential and is included as part of the system on all perimeter levees and in critical areas to include: transition points where levees and floodwalls abut; pipeline crossings of levee alignments; and floodwalls where erosion could compromise wall stability. Although interior flooding due to wave overtopping could occur in larger events, the risk of catastrophic failure of the perimeter system is reduced with the installation of armoring.

Floodwalls including I-walls and T-walls are used throughout the LPV system. It is often not practical to add height to a completed hard structure. Therefore, the perimeter hard structures were constructed to the estimated 2057 required elevation based on projections for subsidence, sea level rise, and other variables at the time of design and construction. In some instances, structures were built with up to two feet of “structural superiority” for features that were deemed particularly difficult to modify in the future. Concrete T-walls are typically located at points along the levee where there is a high potential for erosion or insufficient space for an earthen levees. T-walls are located on either side of every river, railroad, interstate, and state highway crossings. Wall thickness varies by wall height and ranged between 1.5 and 4.5 feet. Base width and thickness varies by location and wall height. Base width ranged from 6 to 22.5 feet and base thickness ranged from 2 to 4.25 feet.

On the interior of the LPV system, drainage pump stations remove water that falls inside (rain) or overtops the system. These pumps remove water to the exterior of the system or to interior canals for storage and/or removal by other pumps.

The ability to withstand impacts from boats and barges that may become unmoored during a storm is an important consideration. Structural features located adjacent to major navigation routes are further protected by dolphins, berms, or Regulated Navigation Areas (RNA) to reduce the risk of contact from tows or loose vessels.

The United Stated Coast Guard (USCG), with support from USACE, has implemented RNA where there are floodwalls with high probability of catastrophic failure should an unmoored, unimpeded barge strike them with any substantial force. Most of the existing floodwalls in subject areas were constructed pre-Katrina and were not designed for barge impact loads. Risk reduction is maximized through evacuation of these areas prior to an event. If evacuation is not attainable, it is imperative that the USCG ensure that the requirements contained within 33 CFR 165.838 “Regulated Navigation Area; New Orleans Area of Responsibility, New Orleans, LA” are effective in keeping vessels under control and away from the floodwalls during tropical events.

The Inner Harbor Navigation Canal (IHNC) and Harvey and Algiers Canals are included in the USCG designated RNA which prohibits certain vessels from remaining in these areas during storm events. A supplemental notice for revisions to the RNA was filed in June 2013. Details of the RNA and revisions can be found in Chapter 33 of the Code of Federal Regulations: 33 CFR Part 165, [Docket No. USCG-2009-0139].

As of September 2013, this RNA is defined within the following area: The GIWW from MM 22 East of Harvey Locks, west on the GIWW, including the Michoud Canal and the IHNC,

extending North 1/2 mile from the Seabrook Floodgate Complex out into Lake Pontchartrain and South to the IHNC Lock; The Harvey Canal, between the Lapalco Boulevard Bridge and the confluence of the Harvey Canal and Algiers Canal; the Algiers Canal, from Algiers Lock to the confluence of the Algiers Canal and the Harvey Canal; and the GIWW from the confluence of Harvey Canal and Algiers Canal to MM 7.5 West of Harvey Locks.

The USCG and the Department of Homeland Security have responsibility for enforcing the RNA and informing commercial and private interests of its provisions. As of September 2013, the regulation states that the provisions of the RNA will be enforced during a tropical event beginning 24 hours in advance of the predicted closure of the Lake Borgne Surge barrier structure within the HSDRRS (IHNC & GIWW). If the Coast Guard receives notice of a closure less than 24 hours before closure, the RNA will be enforced upon the Captain of the Port (COTP) receiving the notice of planned closing. In the event that a particularly dangerous storm is predicted, the COTP may require all floating vessels to evacuate the RNA beginning as early as 72 hours before predicted closure of any navigational structure or upon notice that particularly dangerous storm conditions are approaching, whichever is less. The COTP will notify the maritime community of the enforcement periods for this RNA through Marine Safety Information Bulletins and Safety Broadcast Notices to Mariners.

All floating vessels are prohibited from entering into or remaining in the RNA during the enforcement period. Please refer to 33 CFR 165 for provisions allowing vessels to remain during the enforcement period.

3.2 HYDROLOGIC AND HYDRAULIC CONDITIONS

3.2.1 STORM MODELING

A suite of 152 synthetic storms was used to model storm effects for future without project conditions. The storms cover a range of hypothetical tracks, forward speeds, intensities and sizes. The Joint Probability Method – Optimal Sampling (JPM-OS) synthetic storms are basically an extension of the limited observed record. The JPM-OS code combines the meteorological probability and the peak surge elevation of al 152 storm events to estimate the 5%, 2%, 1%, 0.5%, 0.2%, and 0.1% AEP surge elevations for the existing and future without project condition. No rainfall time-series are available for the 152 synthetics storms. Rainfall was not included in the RAS 2D simulations described in subsequent sections.

3.2.2 INUNDATION MODELING

To model interior flooding extent and depths, a River Analysis System 2-dimensional (RAS 2D) model was developed. The LPV includes RAS 2D meshes for five sub-basins: St. Charles, Orleans and Jefferson Parish east bank, New Orleans East, and Chalmette Loop (Figure 3-1). All 2D meshes are connected using storage area connections with weir profiles assigned using the latest available surveys. The nominal mesh resolution is 700ft. Lower mesh resolution facilitates higher computational efficiency. Manning's "n" (roughness) values were assigned using the 2011 National Land Cover Database.

Figure 3-1. LPV Sub-Basins

The perimeter levee and floodwall elevations are not incorporated into the Hydrologic Engineering Center (HEC) HEC-RAS 2D geometry, but are used in overtopping calculations that are input as boundary conditions to the model. Pump information was extracted from the USACE pump database and the pumps in the model are modeled as 2D connections with outlet rating curves. The rating curve approach ensures the peak capacity of each pump is utilized in the simulations.

Overtopping rates were calculated at all design segments. Each segment has unique levee or floodwall geometry and hydraulic boundary conditions including surge elevation, significant wave height and mean wave periods.

ADvanced CIRCulation (ADCIRC) Hydrographs for all 152 synthetic storms were extracted at each segment using a Matlab script. The ADCIRC dataset used was the “2017 CPRA Master Plan”. This surge hazard analysis is the only dataset available from the extensive post-Katrina modeling of Southeast Louisiana that includes hydrographs, wave heights and wave periods for all the locations needed for this study. Additional inputs into the overtopping calculations include levee geometry parameters including wave berm elevation, levee slope and crest elevations. Levee and floodwall surveyed elevations were mapped to each of the 415 segment profiles.

A specialized Matlab function was written to estimate overtopping for levees or floodwalls and for surge and wave overtopping. If the surge level is less than the crest elevation, wave overtopping formulae are used. If the surge is greater than the crest elevation, the weir equation is combined with the wave overtopping formulae, and the relative freeboard value is set to 0. Overtopping rates were calculated at each survey point along each of the 415 design segments.

The resulting overtopping rates at each survey point were then summed to produce a total for each segment. The width between each survey point is factored into the calculations. The overtopping time-series at each segment was then summed to the corresponding RAS 2D flow boundary. In total, 81 flow boundary conditions were assigned to the RAS 2D geometry.

HEC-RAS simulations were computed for all 152 JPM-OS synthetic storms. Once all 152 synthetic storms were evaluated, surge statistics could be completed using the latest JPM-OS code. The code was supplied by Engineer Research and Development Center's (ERDC's) Coastal Hydraulics Lab. The code combines the meteorological probability and the peak surge elevation of all 152 storm events to estimate the 5%, 2%, 1%, 0.5%, 0.2% and 0.1% AEP surge elevation. Figure 3-2 displays the 1% AEP water depth for existing conditions. Figure 3-3 displays the 0.2% AEP water depth for existing conditions. The 0.2% AEP inundation is much more extensive than the 1%. The water surface profile and depths for each return period was provided to the economics team for evaluation of damages (refer to Section 3.3 for economic analysis).

Figure 3-2. 1% AEP Peak Depths (ft.) for Existing Conditions

Figure 3-3. 0.2% AEP Peak Depths (ft.) for Existing Conditions

3.2.3 OVERTOPPING LOCATIONS AND RATES

Modeled storm surge elevations were plotted against the levee and floodwall elevation data to determine potential locations for surge overtopping. Additionally, in areas where surge or waves were estimated to overtop the levees or floodwalls, overtopping rates were calculated.

3.3 EXISTING ECONOMIC DAMAGES

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) program version 1.4.2 was utilized to evaluate flood damages using risk-based methods. The key economic inputs for the analysis are the structure inventory, depth-damage functions, content-to-structure value ratios, and the associated quantified risk and uncertainty parameters associated with these inputs.

Structure Inventory

The structure inventory used for this study is the National Structure Inventory (NSI) version 2. This updated version of the inventory uses Zillow data, ESRI map layer data, and CoreLogic data to improve structure placement over the previous version of the NSI. RS Means was used to calculate the depreciated replacement value of structures. An extensive survey was

conducted to estimate foundation heights for different sectors within the Metro New Orleans area. Structure counts by occupancy types are shown in Table 3-1.

Table 3-1. Structure Counts by Occupancy Type

Lake Pontchartrain and Vicinity Structure Counts by Occupancy Type NSI 2019			
Residential		**Non-Residential**	
One-Story Slab	73,761	Eating and Recreation	3,718
One-Story Pier	67,339	Professional	12,065
Two-Story Slab	26,600	Public and Semi-Public	3,293
Two-Story Pier	23,478	Repair and Home Use	4,211
Mobile Home	3,420	Retail and Personal Services	7,666
		Warehouse	5,016
		Multi-Family Occupancy	2,795
Total Residential	194,598	Total Non-Residential	38,764

Depth-Damage Relationships and Content-to-Structure Value Ratio (CSVR)

Depth-damage relationships define the relationship between the depth of flooding and the percent of damage at varying depths that occurs to structures and contents. These mathematical functions are used to quantify the flood damages to a given structure. The content-to-structure value ratio (CSVR) is expressed as a ratio of two values: the depreciated replacement cost of contents and the depreciated replacement cost of the structure.

One method to derive these relationships is the “Expert Opinion” method described in the Handbook of Forecasting Techniques, IWR Contract Report 75-7, December 1975 and Handbook of Forecasting Techniques, Part II, Description of 31 Techniques, Supplement to IWR Contract Report 75-7, August 1977. A panel of experts was convened to develop site-specific depth-damage relationships and CSVRS for feasibility studies associated with Jefferson and Orleans Parishes. The results of this panel were published in the report Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-To-Structure Value Ratios (CSVRS) In Support Of the Jefferson and Orleans Flood Control Feasibility Studies, June 1996 Final Report. Table 3-2 displays the content-to-structure value ratios and their respective standard deviations used for LPV.

Table 3-2. Content to Structure Ratios and Standard Deviations

Content-to-Structure Value Ratios (CSVRs) and Standard Deviations (SDs)		
Structure Category		**(CSVR,SD)**
Residential	One-story	(0.69, 0.37)
	Two-story	(0.67, 0.35)
	Mobile home	(1.14, 0.79)
Non-Residential	Eating and Recreation	(1.70, 2.93)
	Groceries and Gas Stations	(1.34, 0.78)
	Professional Buildings	(0.54, 0.54)
	Public and Semi-Public Buildings	(0.55, 0.80)
	Multi-Family Buildings	(0.28, 0.17)
	Repair and Home Use	(2.36, 2.95)
	Retail and Personal Services	(1.19, 1.05)
	Warehouses and Contractor Services	(2.07. 3.25)

Vehicle Inventory

Based on 2010 Census information for the New Orleans Metropolitan area, there are an average of 2.0 vehicles associated with each household (owner occupied housing or rental unit). According to the Southeast Louisiana Evacuation Behavioral Report published in 2006 following Hurricanes Katrina and Rita, approximately 70 percent of privately owned vehicles are used for evacuation during storm events. The remaining 30 percent of the privately owned vehicles remain parked at the residences and are subject to flood damages. Only vehicles associated with residential structures were included in the analysis. Vehicles associated with non-residential properties were not included in the evaluation.

First Floor Elevations

Topographical data based on NAVD88 was used to assign ground elevations to structures and vehicles in the study area. The assignment of ground elevations and the placement of structures were based on a digital elevation model with a fifteen foot by fifteen foot grid resolution developed by the USGS. The ground elevation was added to the height of the foundation of the structure above the ground in order to obtain the first floor elevation of each structure in the study area. Vehicles were assigned to the ground elevation of the adjacent residential structures.

Levee Fragility

One possible input to the economic model is the inclusion of fragility curves. Fragility curves relate the levee loading to the probability of failure and account for the possibility of damages occurring prior to levee overtopping. There were no levee fragility curves available during this initial analysis. Therefore the economic model assumes that the levees never fail and all damages are caused by water simply flowing into the system over the top of the levee. This is a

conservative assumption because there is always some probability (however small) that the levee could fail prior to overtopping, which would introduce more water into the system and increase flood damages. This uncertainty is discussed further in Section 9.6.1. It should be noted that the life safety model (see Section 3.4) does not use fragility curves and is able to estimate life safety risk related to the potential for levee failure.

Existing Conditions Damages

The existing conditions damages by probability event are displayed in Table 3-3 and the expected annual damages are displayed in Table 3-4 (by sub-basin).

Table 3-3. Existing Conditions Damages by Probability Event

Lake Pontchartrain and Vicinity Damages by Probability Event 2023 $1,000s	
100%	$0
10%	$0
5%	$0
2%	$0
1%	$110,000
0.5%	$1,337,000
0.2%	$18,080,000
0.1%	$36,550,000

Table 3-4. Existing Conditions Annualized Economic Damages

Lake Pontchartrain and Vicinity Expected Annual Damages by Probability Event 2023 $1,000s	
Sub-basin	**Expected Annual Damages**
Chalmette Loop	6,199
Jefferson East Bank	67,037
Orleans East Bank	8,564
New Orleans East	9,520
St. Charles	6,842
Total	98,162

3.4 EXISTING CONDITIONS RISK

There is a significant risk to human health, safety, and property associated with hurricane storms in the Greater New Orleans area, demonstrated by the documented impacts as early as the 1920s. During many of these hurricane storm events, residents are evacuated from their homes, occasionally for extended periods of time. Structures experience major damage and evacuation routes are shut down by floodwaters. In addition, access to critical infrastructure such as hospitals, fire departments, police departments, and schools are cut off. This chapter

describes the current probability of levee overtopping (with and without breach) during hurricane storm events and the associated life safety consequences.

3.4.1 RISK IDENTIFICATION

A Semi-Quantitative Risk Assessment (SQRA) was performed to identify the magnitude of the risk associated with levee system overtopping. In this context, risk is defined as a measure of the probability (or likelihood) and consequences of uncertain future events. The SQRA considered the probability of overtopping (with and without breach) along with the economic and life safety consequences associated with overtopping. This chapter discusses the existing risk, while Chapter 5 (Future Without Project Condition) discusses the estimated risk in the future as a result of the combined effects of settlement, subsidence, and sea level rise over the period of analysis.

Tolerable risk guidelines (TRGs) are used in risk management to help inform the process of characterizing and judging the significance of estimated risks developed during the risk assessment process. Tolerable risks are those that society is willing to live with to achieve or obtain certain benefits. Within the USACE framework, risks that are above these tolerable limits are determined to warrant some form of management action to reduce the risk. USACE draft Planning Bulletin 2019-04 (Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies) establishes a guideline which displays the societal tolerable risk limit for average annualized life loss (AALL). Additionally, the Planning Bulletin provides a chart (Figure 3-4) that relates AEP to the average incremental life loss. This chart is also referred to as the "risk matrix". This chart is used to help identify which probable failure modes (PFMs) provide the greatest contribution to the total risk. It allows assessors and managers to target and tailor specific actions for risk management. The line on the chart which defines the societal tolerable risk limit is referred to in this report as the Societal Life Risk Line and is also known as the average annualized life loss guideline.

USACE has chosen to use 1 in 10,000 (1E-04) per year for the probability of life loss for an individual or group of individuals most at risk (see Table 3-5 for number conversions). The goal is to keep the risks associated with USACE program levees from increasing the probability of death for an individual above the background levels any individual would typically be exposed to over their lifetime. The individual life risk is represented by the probability of life loss for the identifiable person or group by location that is most at risk of loss of life due to a levee breach. Individual life risk is influenced by location, exposure, and vulnerability within a leveed area.

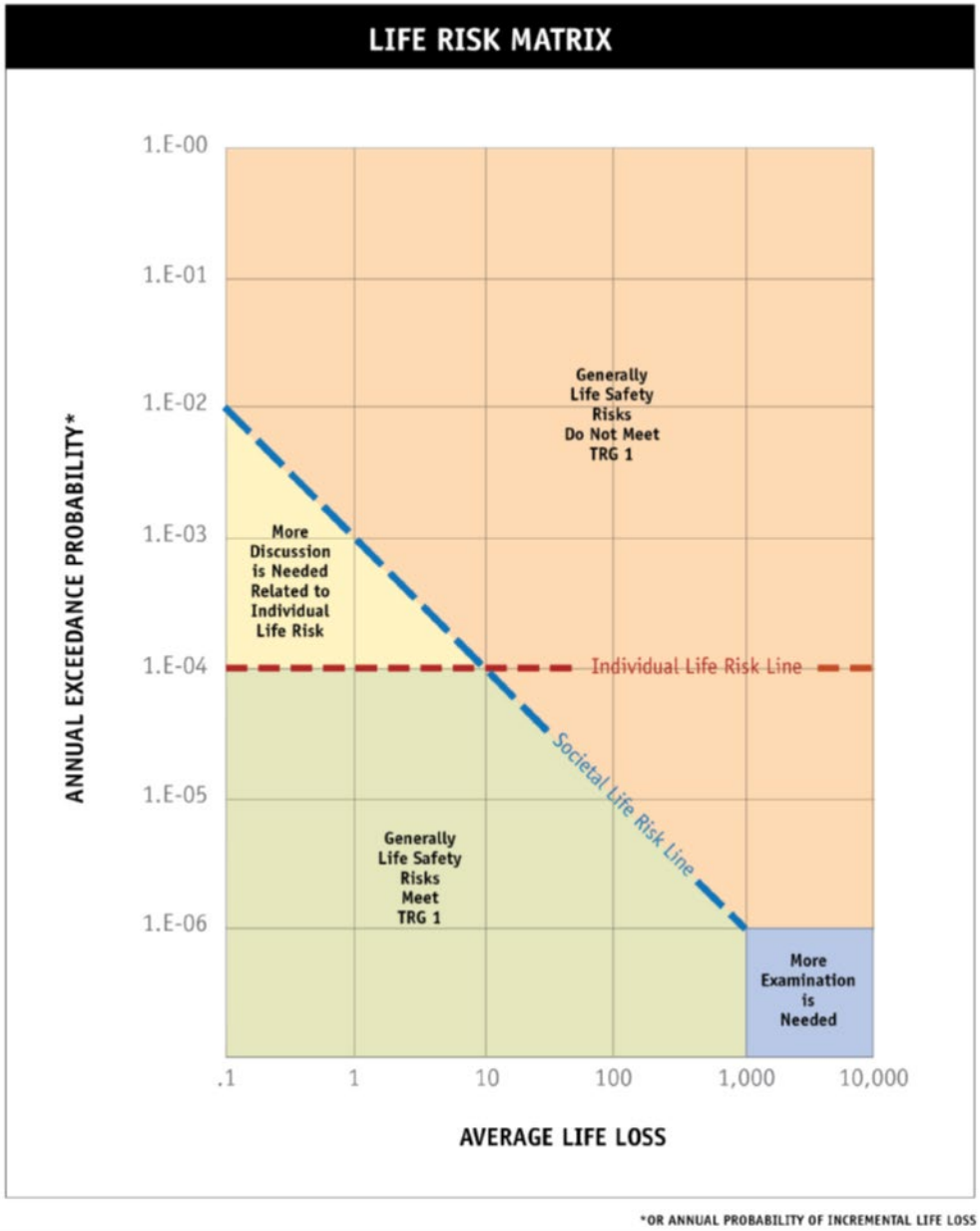

Figure 3-4. Risk Matrix

Table 3-5. Example Number Equivalents

Scientific Notation	Decimal Equivalent	Text Equivalent
1E-01	0.1	1 in 10
1E-02	0.01	1 in 100
1E-03	0.001	1 in 1,000
1E-04	0.0001	1 in 10,000
1E-05	0.00001	1 in 100,000

3.4.2 PROBABLE FAILURE MODES

A probable failure mode (PFM) is a mechanism that, once initiated, potentially could progress to breach of a levee system. A PFM analysis results in an estimate of the likelihood of failure in a given loading situation. This information is used conjunction with consequences information to estimate life safety risk. This differs from the economic analysis described in Section 3.3 which, due to different modeling requirements, assumes that the levees do not breach under any loading scenario.

The risk assessment team identified three potential failure modes as critical to the study's purpose to address the effects of settlement, subsidence, and sea level rise.

- PFM 1 Overtopping w/waves of Armored Levee leads to breach
- PFM 2 Overtopping w/waves of Unarmored Levee leads to breach
- PFM 3 Overtopping w/waves of Wall Levee Tie-in leads to breach

PFMs 1 and 2 are overtopping of the levees in armored and unarmored reaches. Armoring changes the probability of failure due to overtopping. LPV levees are armored and MRL levees above the crossover are unarmored.

PFM 3 is for overtopping near/at a floodwall/levee tie-in, which was an area that experienced problems during Hurricane Katrina. Modifications were made post-Katrina and this PFM evaluates those modifications.

3.4.3 LEVEE RISKS

The term "levee risk", sometimes referred to as "incremental risk", is used to refer to the risk posed by the levee system itself. The 'levee risk' associated with this project is the risk (probability of failure and associated consequences) to the landside area and floodplain occupants that can be attributed to the presence of the levee should the levee breach prior or subsequent to overtopping, where the consequences considered are over and above those that would occur without levee breach.

In many levee systems, each risk-driving PFM would be evaluated for two scenarios: with and without intervention. Intervention is considered to be any human activity that takes place prior to or during a flood with the intent of increasing the probability that a levee system will successfully function during a given flood. The risk team determined that there were no intervention activities that could be taken during a hurricane event. Therefore, the only scenario considered is "without intervention."

In order to model levee breach scenarios, the risk assessment team performed breach modeling at 5 locations on the LPV levees plus 1 more on the east bank of the Mississippi River upstream of the current crossover point to establish a PFM in an unarmored reach. These breach modeling locations are chosen as representative design and loading locations and are not reflective or any known or perceived deficiency in the system. Each breach location was loaded with the surge and wave outputs from the ADCIRC model for the 2%, 1%, 0.5%, and 0.2% AEP events in the existing condition. The model then estimated the hydraulic characteristics of depth, velocity, and associated arrival times of those flood water. Those were the inputs to the LifeSim

model, which is a tool used to estimate life loss and direct damage during a flood or storm event.

3.4.4 NON-BREACH RISKS

Non-breach risks are risks associated with overtopping of the levee system that does not result in a failure (breach). These were also estimated by the LifeSim model using the surge overtopping estimates. The non-breach consequences are subtracted from the breach consequences to determine the incremental risk. It must be noted that the risk team did not run the non-breach scenario for the existing 1% or 0.2% AEP event, since the hydrology and hydraulics (H&H) modeling showed no stillwater overtopping of the levee in those cases. There was special modeling performed, which is contained in the H&H appendix that outlines non-breach wave overtopping inundation for all conditions of the study.

3.4.5 CONSEQUENCES

The LifeSim model estimates life safety risk for the existing conditions for the 1% AEP and 0.2% AEP events. The model then uses the hydraulic characteristics of depth, velocity, and associated arrival times of those flood waters from breach modeling as the inputs to the LifeSim model. The LifeSim model also uses a structure database to distribute population within the model. There are also a number of variables entered into the LifeSim model, such as relative warning issuance, hazard communication delay, warning issuance delay, warning diffusion time, and protective action initiation. The LifeSim model then utilizes Monte Carlo analysis and computes multiple iterations in order to obtain a range of possible life loss outcomes. Due to the long warning times for the area, traffic simulations were not used for evacuations. However, it must be noted that the risk team did not run the non-breach scenario for the 1% AEP event consequences. Based on the modeling for LPV, the incremental life loss estimates range from low to extremely high.

3.4.6 RISK CHARACTERIZATION

The total incremental risk, which combines the risks and consequences of all of the PFMs considered for the study, helps portray an overall levee risk picture. The estimated total annual probability of failure for LPV existing conditions is between 1E-06 and 1E-05 failures per year and the best estimate of the average annual incremental life loss is 1E-03 lives per year. In the existing condition, all overtopping PFMs are below tolerable risk and the total risk is below the societal tolerable risk line.

4 AFFECTED ENVIRONMENT*

This section assesses the historic (if relevant), existing, and future conditions of resources within the study area and is organized by resource topic. This section is not a comprehensive discussion of every resource within the study area but rather focuses on those resources described as significant by laws, executive orders, regulations, and other standards of national, state, or regional agencies and organizations, technical or scientific agencies, groups, or individuals, and the general public. The relevant resources include the following: geology and soils, water resources, forest and wetland resources, upland resources, fisheries resources, wildlife resources, invasive species, Federally-listed species, cultural and historical resources, ecological, scenic, and aesthetic resources, recreational resources, air quality, noise, transportation, socioeconomic resources and environmental justice, and HTRW.

4.1 ENVIRONMENTAL SETTING

4.1.1 STUDY AREA

The study area is located on the east bank of the Mississippi River south of Lake Pontchartrain within St. Charles, Jefferson, Orleans, and St. Bernard Parishes in southeast Louisiana. The western end of the study area abuts the Bonnet Carré spillway. The eastern end of the study area is located in the Bayou Sauvage National Wildlife Refuge and along the now deauthorized Mississippi River Gulf Outlet (MRGO). The study area includes the communities of New Orleans, Norco, Kenner, Elmwood, Metairie, Chalmette, Poydras, and St. Bernard. Numerous canals and waterways dissect the study area. Numerous sensitive environmental resources are located near the study area including Bayou Sauvage National Wildlife Refuge, Lake Pontchartrain, Lake Borgne, the central wetlands area, the Gulf of Mexico, and the Mississippi River. In general, these environmental resources are largely comprised of bottomland hardwood forests, cypress-tupelo swamps, and various scrub-shrub, forested wetland, and marsh habitats.

The study team considered the affected environment to be the five sub-basins or polders in the study area. Refer to Table 4-1 and the corresponding location map (Figure 4-1).

Table 4-1. Study Area Overview

Sub-basin (Polder)	Parish	Sub-Basin Area (acres)	Cities and Areas of Interest	Previous Improvement Efforts
St. Charles	St. Charles	13,064	Norco, Destrehan	Mississippi River Levees
Jefferson East Bank	Jefferson	28,529	Kenner, River Ridge, Elmwood, Harahan, Metairie	17th St. Canal
Orleans East Bank	Jefferson, Orleans	27,935	New Orleans, Metairie, Port of New Orleans	17th St. Canal, Orleans Ave. Canal, London Ave. Canal, IHNC
New Orleans East	Orleans	35,322	Bayou Sauvage NWR	IHNC Surge Barrier, GIWW
Chalmette Loop	Orleans, St. Bernard	49,295	Lower Ninth Ward, Arabi, Chalmette, Meraux, Violet, Poydras, St. Bernard, central wetlands area	IHNC Surge Barrier, GIWW

Figure 4-1. Sub-basins of the Lake Pontchartrain and Vicinity Study Area

4.1.2 PHYSICAL GEOGRAPHY & LAND USE

4.1.2.1 PHYSICAL GEOGRAPHY

The study area is located on the northeastern flank of the Deltaic portion of the Mississippi River Alluvial Plain. The area is located on the southern edge of the Pontchartrain Basin on the eastern side of the Mississippi River between RM 82 to 127 above Head of Passes. The Pontchartrain Basin is a shallow depression that lies between the alluvial ridge of the Mississippi River and the gulfward-sloping uplands on the north and west. The area is of extremely low relief with land elevations highest adjacent to the Mississippi River. Elevations within the study area vary from 31 feet NAVD88 on levees and floodwalls to near sea level in the back swamp and lake areas to below sea level in many of the urbanized areas that are under forced drainage.

4.1.2.2 LAND USE

The 2011 National Land Cover Database includes the most up-to-date data concerning the study area. Table 4-2 and Figure 4-2 identify various land uses within the study area.

Table 4-2. Land Use Acreage in Study Area by Sub-Basin

Land Use	St. Charles	Jefferson	Orleans East Bank	New Orleans East	Chalmette Loop	Study Area Total
Open Water	64	72	241	4,375	5,319	10,071 (6.6%)
Developed	7,538	28,324	27,478	13,726	11,650	88,716 (57.9%)
Barren Land	107	37	0	744	554	1,442 (0.9%)
Deciduous Forest	50	30	23	24	120	247 (0.2%)
Evergreen Forest	22	0	1	0	69	92 (0.1%)
Mixed Forest	20	1	2	0	438	461 (0.3%)
Shrub/Scrub	48	8	6	29	195	286 (0.2%)
Herbaceous	35	9	0	144	99	287 (0.2%)
Hay/Pasture	79	10	3	43	360	495 (0.3%)
Cultivated Crops	123	0	0	116	544	783 (0.5%)
Woody Wetlands	4,358	13	3	6,342	9,594	20,310 (13.3%)
Emergent Herbaceous Wetlands	601	20	0	9,105	20,255	29,981 (19.6%)

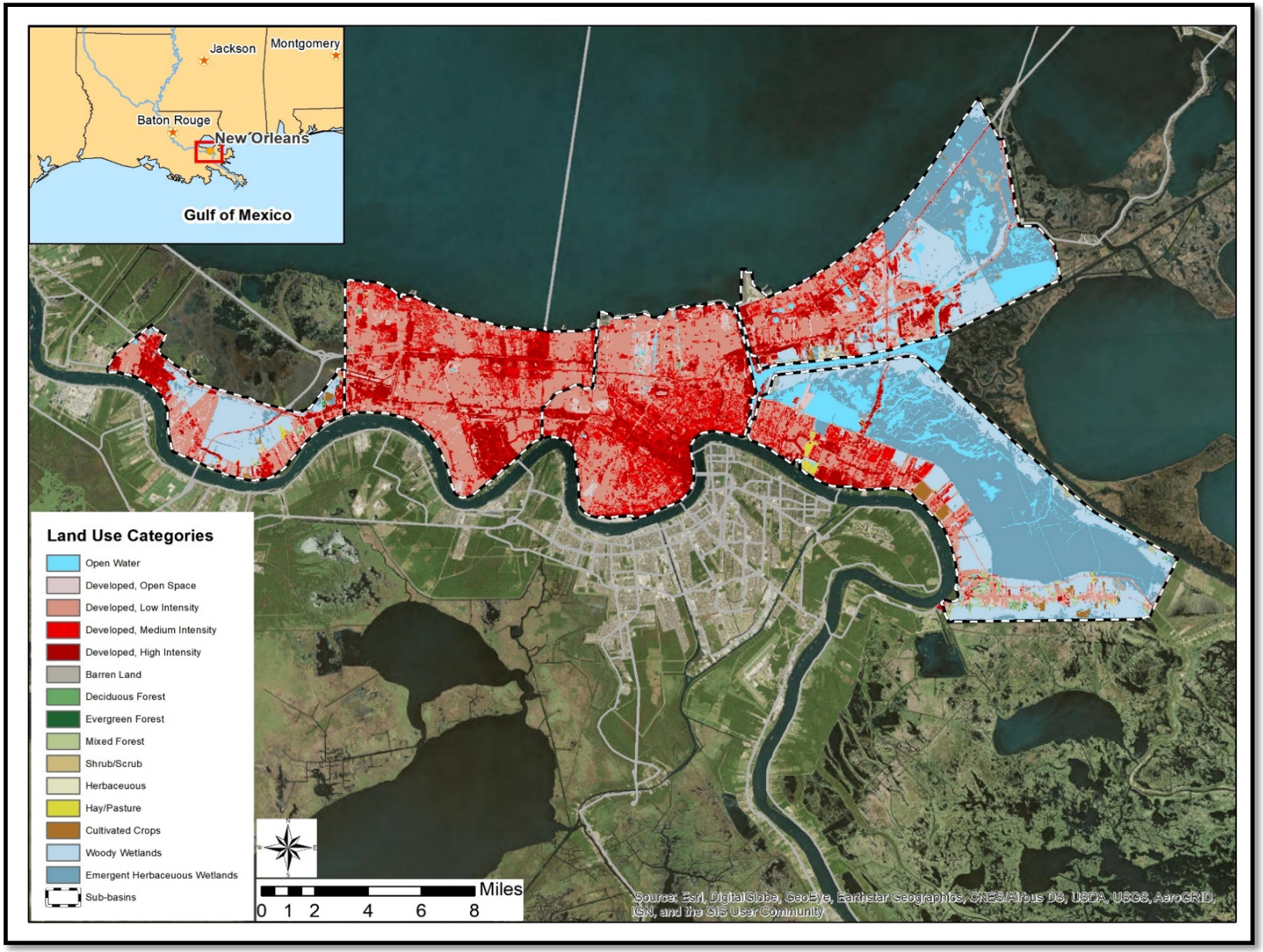

Figure 4-2. Land use categories within the Lake Pontchartrain and Vicinity Study Area

4.1.3 CLIMATE

Regional climate trends show Louisiana has been subject to increasing temperatures and humidity, increasing precipitation, more intense precipitation events, stronger tropical storms, and rising sea levels (Ning, Turner, Doyle, & Abdollahi, 2003).

4.1.3.1 PRECIPITATION & TEMPERATURE

The study area has a subtropical climate, with tropical air masses dominating the weather during the spring and summer and cold continental frontal passages causing substantial temperature changes during the fall and winter. The climate is influenced by the many water surfaces of the lakes, streams, and the Gulf of Mexico. Precipitation generally is heavy in two fairly definite rainy periods. Summer showers last from mid-June to mid-September, and heavy winter rains generally occur from mid-December to mid-March. Table 4-3 provides a summary of weather averages. For additional information on past climate see USACE (1994).

Table 4-3 Study Area Climate Averages at New Orleans[1]

Weather Variable	Average
Annual High Temperature	77.1°F
Annual Low Temperature	62.3°F
Average Annual Temperature	69.7°F
Average Annual Precipitation – Rainfall	63.5 inches
Days Per Year with Precipitation - Rainfall	119 days

4.1.3.2 WINDS

Average wind speed and direction in New Orleans experiences seasonal variation through the year. The windiest months occur between September and May with an average wind speed estimated at 8.9 miles per hour. Southerly winds often occur from February through July while Northerly winds are most common from November to February[2]. For additional information on historic wind speeds see USACE (1994).

4.1.3.3 STORM SURGE

Storm surge associated with hurricanes occurs when winds push water up onto land. Storm surge flooding across southeast Louisiana is greater than surrounding areas due to its orientation of being a “corner” along the coast. This means that the approximate angle made by the Mississippi Delta with the Gulf Coast to the east is ninety degrees, which would amplify the piling up of water. In this case, Lakes Pontchartrain and Borgne are the targets.

[1] Available at: https://www.usclimatedata.com/cli3mate/new-orleans/louisiana/united-states/usla0338. Accessed 8 January 2019

[2] Available at: https://weatherspark.com/y/11799/Average-Weather-in-New-Orleans-Louisiana-United-States-Year-Round. Accessed 8 January 2019

4.1.3.4 TROPICAL STORMS AND HURRICANES

Several tropical storms and hurricanes have passed through or near the study area. The frequency of hurricanes is greatest between August and October; however, hurricane season extends from June through November. Tropical storm events typically produce the highest wind speeds and greatest rainfall events along the Gulf Coast. High winds are typically accompanied by massive storm surge, and in the case of the most powerful storms, these surges can be as high as 28 feet when they strike the Louisiana Coast (NOAA, Storm Surge Overview, 2019). Heavy rains and flooding are the primary problem associated with tropical storms. Hurricanes have flooded New Orleans six times: 1915, 1940, 1947, 1965, 1969, and 2005.

Table 4-4 provides a summary of the recent storms of record.

Table 4-4. Recent Storms of Record

Storm Name	Date	Landfall Location	Sustained Winds (mph)	Storm Surge (feet)
Lili	3 Oct 2002	Vermilion Parish, LA	92	11
Katrina	29 Aug 2005	New Orleans, LA	125	24-28
Rita	24 Sept 2005	TX/LA border	115	14
Gustav	01 Sept 2008	Cocodrie, LA	105	9-13
Ike	13 Sept 2008	Galveston, TX	110	15
Online Sources (Accessed 9 Jan 2019): https://coast.noaa.gov/hes/docs/postStorm/Lili_%20final.pdf; https://pubs.usgs.gov/circ/1306/pdf/c1306_ch7_j.pdf; http://www.hurricanescience.org/history/storms/2000s/ike/; http://www.hurricanescience.org/history/storms/2000s/rita/ ; http://www.hurricanescience.org/history/storms/2000s/gustav/; http://www.hurricanescience.org/history/studies/katrinacase/; https://www.wunderground.com/hurricane/Katrinas_surge_contents.asp				

4.1.4 EXISTING INFRASTRUCTURE

The physical and topographic characteristics of the study area have created the need for levees, drainage canals, and pumping stations. The initial development within the study area occurred along the banks and natural ridges of the present and abandoned channels and distributaries of the Mississippi River. As development continued to expand away from the river and into the lower more vulnerable areas, the need for levees, drainage canals, and pumping stations became apparent. As a result, both Federal and non-Federal projects providing flood risk reduction, hurricane and storm damage risk reduction, and navigation are located within the study area. See Section 1.6 above for further details of the existing infrastructure within the study area.

4.2 GEOLOGY AND SOILS

4.2.1 EXISTING CONDITIONS

4.2.1.1 GEOLOGY

The geologic history since the end of the Pleistocene Epoch is pertinent to the study area. At the close of the Pleistocene, sea level was approximately 360 to 400 feet below the present sea level and the Mississippi River was entrenched into the older Pleistocene sediments. As sea level rose to its present stand, the entrenched valley was filled with sediment by the Mississippi River, resulting in an increase in meandering and channel migration. This meandering and channel migration resulted in a series of deltas extending into the Gulf of Mexico. Seven Holocene deltas are recognized in the lower Mississippi River Valley. For further details on the delta formation see USACE (1994). Overall, development of the deltas resulted in the gradual degradation of the study area through subsidence and shoreline retreat.

The deepest formations in the study area are Pleistocene deposits, consisting of somewhat hardened fluvial sands, silts, and mud at a depth of 40 to 60 feet below the ground surface to depths around 180 feet below the ground surface. These sediments were exposed and weathered during low sea-level stands as a result of Pleistocene glaciation, resulting in relatively higher cohesive strengths than would normally be expected. Holocene deposits found above the Pleistocene deposits are the results of gradual deposition of organic peat mixed with fluvial silt and mud deposited as overbank deposits and inter-distributary deposits of the Mississippi River in cypress swamps around Lake Pontchartrain (Kolb, Smith, & Silvia, 1975).

The existing near-surface geology of the area surrounding the HSDRRS project area can best be explained as the result of a subsiding Mississippi River delta lobe that has been drained, diked, and filled with various types and vintages of dredged material derived from nearby water bodies (e.g., Lake Pontchartrain) and adjacent drainage canals. Beneath the artificial deposits lie swamp deposits composed of organic clays, fat clays, and peats with occasional sand and silt layers. Swamp deposits are generally between 10 to 20 feet thick. Natural levee deposits composed of clays and silts are adjacent to abandoned distributaries.

4.2.1.2 SOILS

Much of the study area was formerly wetlands (cypress swamps and marshes). As the Greater New Orleans Metropolitan Area grew and the constructed levees were built even higher, water was drained from swamps and marshes by canals and pumps and dredged materials, including peat and mud, were used to elevate the area for habitation. Resulting surface soils are classified as dredged material or muck. Land inside the levees is continually subsiding due to dewatering of peat deposits, often resulting in surface elevations below sea level. Water content in the soils is generally high and decreases with depth.

Soils within the study area were generally formed from Mississippi River sediments deposited as river floodwaters spread over the river banks during flood events. Soils in the study area are usually fine-grained sand, silt, and clay and contain abundant organic material.

The study area can be divided into three main soil categories: (1) soils found on naturally occurring levees that are protected from flooding; (2) soils frequently ponded in marshes and swamps that experience frequent flooding; and (3) soils previously ponded, but which have been drained and are protected from flood (Trahan, 1989; Mathews, 1983). Table 4-5 summarizes these groups.

Table 4-5. Summary of Soils within the Study Area

Group	Soil Name	Location	Type	Drainage	Primary Land Use
Naturally occurring levees, protected	Sharkey-Commerce	Natural levees adjacent to Mississippi River and at the northern end of the Harvey Canal	Clayey/ Loamy	Somewhat poorly to poorly drained	Urban
Ponded soils in marshes, frequently flooded	Barbary and Kenner-Allemands	Flooded swamps and marshes	Layers of much with underlying clay	Consistently flooded/ ponded	Heavily vegetated with marshes and forested plant communities; wildlife habitat
Soils previously ponded, drained and protected	Harahan-Westwego; Drained Kenner-Allemands	Protected areas of natural and man-made levees and in broad inter-levee basins; between the Harvey and Algiers Canals, and directly west of the Harvey, Algiers, and Hero Canal junctions	Surface layer of muck over a clay base	Naturally poorly drained and previously accustomed to frequent flooding events; significant rates of subsidence	Agricultural and urban; drained wetlands

4.2.1.3 PRIME AND UNIQUE FARMLANDS

The U.S. Department of Agriculture (USDA) defines prime farmland as land with the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and which is available for these uses. Since the supply of high-quality farmland is limited, the USDA encourages responsible governments and individuals to use the Nation's prime farmland wisely. The Farmland Protection Policy Act (FPPA) is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. USACE prepared an AD-1006 application to evaluate the prime farmland in the study area during feasibility level design and will be included in Appendix G, Environmental Compliance, prior to final report submittal. The assessment is completed on form AD-1006, Farmland Conversion Impact Rating, to establish a farmland conversion impact rating score which can be used as an indicator of the potential to convert farmland to non-farm use.

Prior to final report approval and final public review, this evaluation will be included for the proposed construction footprint and updated during the Planning, Engineering, and Design phase upon identification of borrow sites. Farmlands subject to FPPA requirements do not have to be currently in use for crop production. The land can be in use as pasture or cropland, forest land, or other wildlife habitat. Areas of water, wetlands, or urbanized land are not considered subject to FPPA requirements. Farmlands previously impacted by development or other hard structures, such that they are no longer viable for crop production, are not regulated under FPPA.

Cancienne silt loam, Cancienne silty clay loam, Gramercy silty clay, Harahan clay, Shriever clay, Schriever silty clay loam, Thibaut clay, and Vacherie silt loam are designated prime and unique farmland soils in the study area (USDA, 2019). Areas of prime and unique farmland soils are shown in Figure 4-3. Many designated prime and unique farmland soils within the study area near the proposed action have been previously developed or contain existing levees and rights-of-way; however, some potentially impacted areas fall under jurisdiction of the FPPA. Table 4-6 provides acres of prime and unique farmland soils by sub-basin and acres previously potentially impacted by HSDRRS.

Figure 4-3. Prime and Unique Farmland Locations within the Study Area

Table 4-6. Acres of Prime and Unique Farmland Soils within the Study Area Sub-Basins

Sub-Basin	Total Prime Farmland (acres)	Total Potentially Impacted Prime Farmland Soils from previous HSDRRS projects (acres) (USACE, 2013)
St. Charles	322	0.0
Jefferson East Bank	2	0.0
Orleans East Bank	20	0.0
New Orleans East	224	29.7
Chalmette Loop	1,431	452.5
Total	1,999	482.2

4.2.1.4 SUBSIDENCE

The study area lies in a region of active subsidence that is allowing transgression of Gulf waters. Subsidence and land loss are caused by four major natural processes:

1) Consolidation of soft, compressible sediments;
2) Global sea level rise;
3) Decrease in suspended sediments reaching the marsh area from the Mississippi River; and
4) Erosion of coastal areas by wave action.

Section 5.2.1 provides information on subsidence rates in the study area, as well as three regional sea level change values calculated for this study: low (1.3 feet), intermediate (1.8 feet), and high (3.4 feet) over the next 50 years (See Appendix C, *Hydrology and Hydraulics* for more information).

4.2.2 FORECASTING OF FUTURE CONDITIONS

Future conditions information regarding geology and soils is included in Section 5.1.

4.3 HYDROLOGY & HYDRAULICS

4.3.1 EXISTING CONDITIONS

Existing conditions information regarding relevant hydrology and hydraulics is included in Section 3.2.

4.3.2 FORECASTING OF FUTURE CONDITIONS

Future conditions information regarding relevant hydrology and hydraulics is included in Section 5.3.

4.4 WATER RESOURCES

4.4.1 EXISTING CONDITIONS

4.4.1.1 GROUNDWATER & SURFACE WATER

Groundwater and surface water quantities have not been identified as resources of issue in southeast Louisiana. The primary groundwater resources within the study area include Norco and Gonzales-New Orleans aquifers (Prakken & Lovelace, 2014). The Mississippi River is the primary source of fresh surface water in the study area. There is adequate surface water quantity available for all uses in the majority of the region, primarily because surface water for drinking, commercial, and industrial uses is derived from the Mississippi River and its tributaries. Groundwater is typically not extracted in any substantial quantities for residential or commercial use.

Although water quantity is not a resource issue in the study area, water quality is a significant resource and is further described below.

4.4.1.2 WATER QUALITY

Section 303(d) of the Clean Water Act (CWA) requires that states develop a list of waters that do not meet water quality standards and do not support their Designated Uses. In response to this mandate, the Louisiana Department of Environmental Quality (LDEQ) prescribed water quality standards for surface waters within the State of Louisiana in order to promote a healthy and productive aquatic system. Surface water standards are set to protect the quality of all waters of the state, including rivers, streams, bayous, lakes, reservoirs, wetlands, estuaries, and many other types of surface water. Standards apply to pH, temperature, bacterial density, dissolved oxygen (DO), chloride concentration, sulfate concentration, metals and toxics concentrations, turbidity, color, and total dissolved solids (TDS). Established by the state, the Designated Use articulates the vision for the activities that each water resource can support. The Designated Use establishes the water quality management goals for the water body and determines the associated water quality standards to use to determine if the water body supports the Designated Use (USEPA, 2019). Designated Uses of water bodies in and adjacent to the study area include Primary Contact Recreation (PCR), Secondary Contact Recreation (SCR), Fish and Wildlife Propagation (FWP), Drinking Water Supply (DWS), and Oyster Propagation (OYS).

PCR covers any recreational activity that involves prolonged body contact with water, such as swimming, water skiing, tubing, snorkeling, and skin diving. Parameters measured to determine a water body's support of PCR include bacterial density, temperature, and metals and toxics concentrations. SCR covers any recreational activity that may involve incidental or accidental body contact with water and that involves a low probability of ingesting water, such as fishing, wading, and recreational boating. Parameters measured to determine a water body's support of SCR include bacterial density and metals and toxics concentrations. FWP covers the use of water for preservation and reproduction of aquatic biota and includes maintenance of water quality at a level that prevents contamination of aquatic biota consumed by humans. Parameters measured to determine a water body's support of FWP include DO, temperature,

pH, chloride, sulfate, TDS, turbidity, and metals and toxics concentrations. DWS covers a surface or groundwater source that, after conventional treatment, will provide safe, clear, potable, and aesthetically pleasing water for uses such as human consumption and food processing and cooking. Parameters measured to determine a water body's support of DWS include color, bacterial density, and metals and toxics concentrations. OYS covers the use of water to maintain biological systems that support species such as oysters, clams, and mussels so that their productivity is preserved and human consumers are protected. Bacterial density is measured to determine a water body's support of OYS (LDEQ, 2018).

The study area includes or is adjacent to numerous LDEQ sub-watersheds (Figure 4-4), some of which are on the LDEQ Water Quality Inventory Integrated Report (Section 305(b) and 303(d)) list for 2018 for violating pollution criteria (LDEQ, 2018). Table 4-7 presents the water quality attainment status, designated uses that are in nonattainment, suspected causes of impairment, and suspected sources of impairment of the LDEQ sub-watersheds associated with the LPV study area.

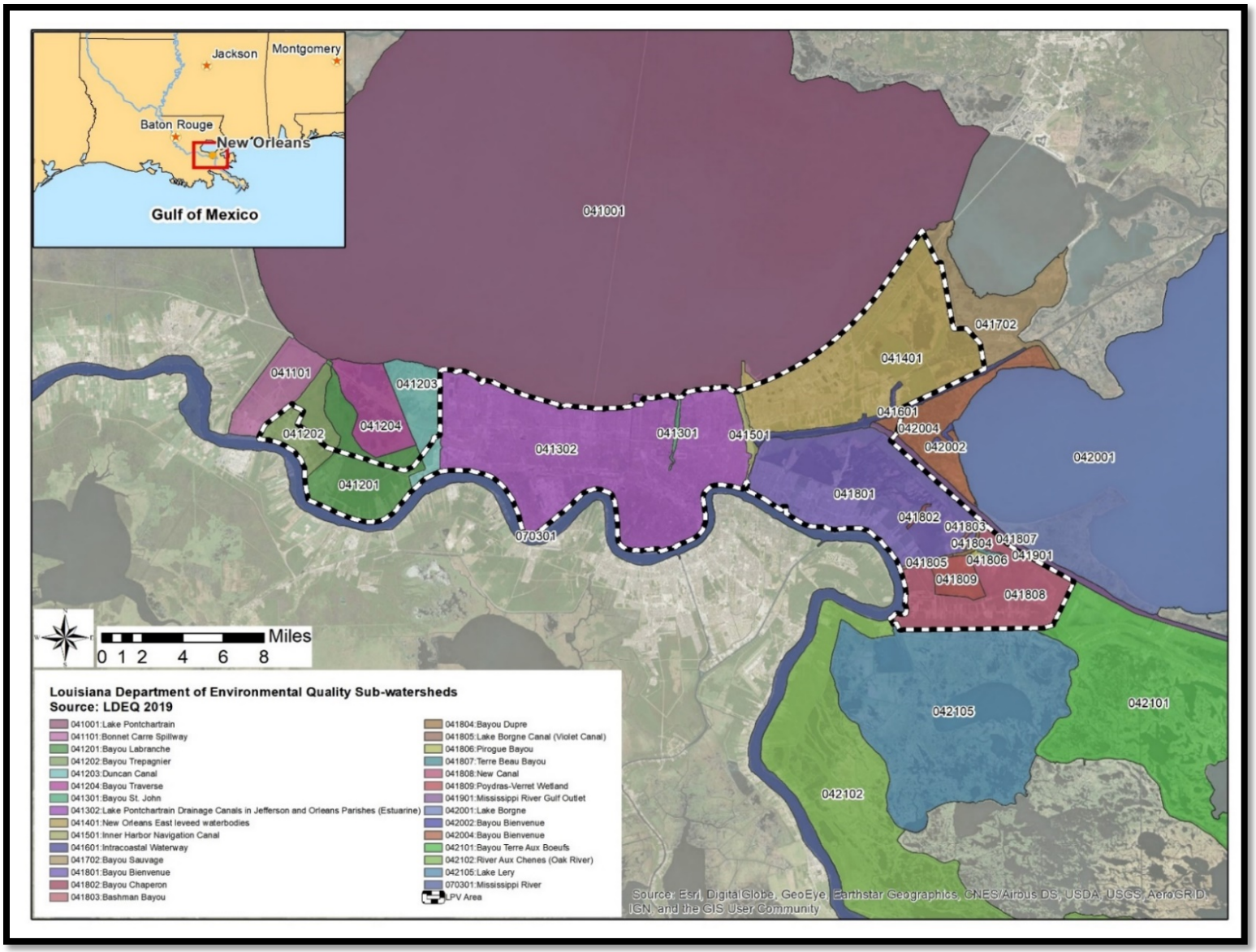

Figure 4-4. LDEQ Sub-watersheds within and adjacent to the Study Area

Table 4-7. Water Quality Attainment Status of LDEQ Sub-Watersheds in and near the Study Area

ID#	Sub-Watershed Name	Water Quality Attainment Status	Suspected Causes of Impairment	Suspected Sources of Impairment
041001	Lake Pontchartrain	Fully Supporting All Designated Uses	NA	NA
041101	Bonnet Carre Spillway	Not Supporting FWP	Chloride, Sulfate, TDS	Natural Sources
041201	Bayou Labranche	Fully Supporting All Designated Uses	NA	NA
041202	Bayou Trepagnier	Not Supporting FWP	DO	Natural Sources
041203	Duncan Canal	Not Supporting FWP	DO	Municipal Point Source Discharges; Natural Sources
041204	Bayou Traverse	No Data	No Data	No Data
041301	Bayou St. John	Not Supporting Primary Contact Recreation	Temperature	Natural Sources
041302	Lake Pontchartrain Drainage Canals in Jefferson and Orleans Parishes (Estuarine)	Not Supporting FWP	DO	Municipal (Urbanized High Density Area); Sanitary Sewer Overflows (Collection System Failures)
041401	New Orleans East Leveed Water Bodies	Fully Supporting All Designated Uses	NA	NA
041501	Inner Harbor Navigation Canal	Fully Supporting All Designated Uses	NA	NA
041601	Intracoastal Waterway	Not Supporting FWP	pH (low)	Transfer of Water from an Outside Watershed
041702	Bayou Sauvage	Fully Supporting All Designated Uses	NA	NA
041801	Bayou Bienvenue	Fully Supporting All Designated Uses	NA	NA
041802	Bayou Chaperon	Not Supporting FWP	DO	Natural Sources
041803	Bashman Bayou	Fully Supporting All Designated Uses	NA	NA
041804	Bayou Dupre	Fully Supporting All Designated Uses	NA	NA
041805	Lake Borgne Canal (Violet Canal)	Not Supporting FWP	DO	Natural Sources
041806	Pirogue Bayou	Not Supporting FWP	DO	Natural Sources
041807	Terre Beau Bayou	Not Supporting FWP	DO	Natural Sources
041808	New Canal	Not Supporting FWP	DO	Natural Sources
041809	Poydras-Verret Wetland	No Data	No Data	No Data
041901	Mississippi River Gulf Outlet	Not Supporting FWP	DO	Source Unknown
042001	Lake Borgne	Fully Supporting All Designated Uses	NA	NA
042002	Bayou Bienvenue	Not Supporting FWP, OYS	pH (low), Fecal Coliform	Source Unknown
042004	Bayou Bienvenue	Not Supporting OYS	Fecal Coliform	Wildlife Other Than Waterfowl
042101	Bayou Terre Aux Boeufs	Fully Supporting All Designated Uses	NA	NA
042102	River Aux Chenes (Oak River)	Fully Supporting All Designated Uses	NA	NA
042105	Lake Lery	Fully Supporting All Designated Uses	NA	NA
070301	Mississippi River	Fully Supporting All Designated Uses	NA	NA

4.4.2 FORECASTING OF FUTURE CONDITIONS

Without the proposed action, the study team expects the water quality in and near the study area to continue in a fashion similar to current conditions. Natural and human-influenced activities affecting water quality would have both potentially beneficial and detrimental effects into the future. Some water bodies in and adjacent to the study area would likely continue to violate LDEQ pollution criteria for their designated uses due to natural and human-influenced causes. Those with known or suspected sources of impairment may show improvement through time as controls are put in place to address the impairment.

4.5 FOREST AND WETLAND RESOURCES

4.5.1 EXISTING CONDITIONS

Vegetation found within the study area are typical of the Bottomland Hardwood Region of the Lower Mississippi River Alluvial Plain and are considered forested or non-forested wetlands. Habitat types include oak-dominated bottomland hardwood forests, cypress-tupelo swamps, various fresh and saltwater emergent marsh, shrub-scrub and forested wetlands, tidal channels, creeks, and estuaries.

The maintenance of habitat types in the region was historically dependent upon sediment input from freshwater flooding events producing a slow and gradual elevation transition. The gradual elevation change provides a highly elongated freshwater to saltwater transition zone capable of supporting a high diversity of wetland and marsh vegetation communities. Currently, these coastal areas are in a transgressive phase resulting in the rapid replacement of freshwater marsh and swamp habitat within increasingly marine-dominated habitats (Roberts H. H., 1997). Historically, the coastal region encompassing the study area would receive freshwater and sediment inputs during frequent flooding events from the Mississippi River. These flooding events would act to maintain the freshwater habitat characteristics and negate the effects of tidal outwash through silt deposition; however, the construction of levees and other flood reduction measures have significantly altered the freshwater, nutrient, and sediment inputs. Levees and water pumping have decreased the flooding necessary to maintain the natural forest and wetland by both subsidence and conversion of existing bottomland forest to more upland-like habitats.

Natural wetland functions produce benefits to humans and provide important ecosystem services as described in Table 4-8[3].

[3] More information available at: https://lacoast.gov/reports/rtc/1997/4.htm; Accessed on 10 January 2019

4.5.1.1 FOREST

The study area is in the southern portion of the Lower Mississippi Alluvial Valley, which extends from Cairo, IL, to the confluence of the Mississippi River with the Gulf of Mexico in Louisiana. Based on a recent forest inventory by the U.S. Forest Service, 28 percent of the land area within the Mississippi Alluvial Valley is in forest cover, with the least forest cover in the northern portions adjacent to the Mississippi River and the coastal parishes of Louisiana (which includes the study area) (see Figure 4-5).

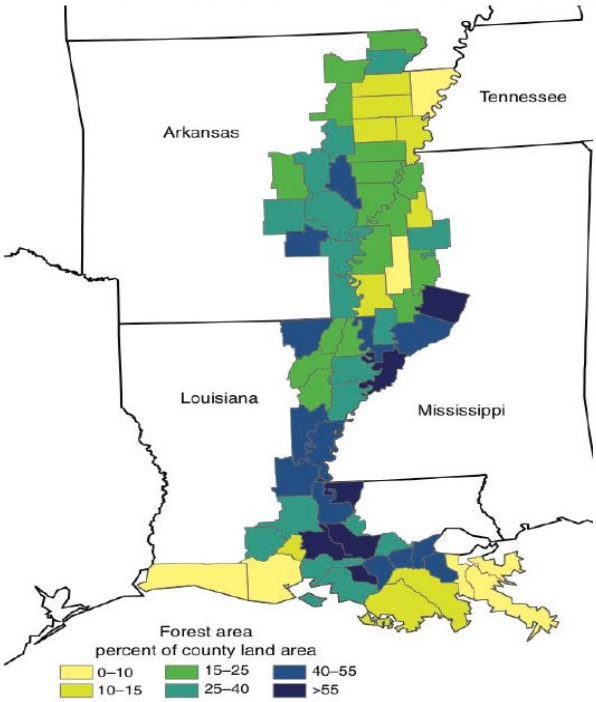

Figure 4-5. Percent of land area classified as forest by county in the Lower Mississippi Alluvial Valley, 2010 (Graphic from (Oswalt, 2013))

4.5.1.2 WETLANDS

Wetlands are areas where water saturation is the dominant factor determining the characteristics of soil development and types of plant and animal communities living in the area. Water is present either at or near the surface of the soil or within the root zone all year or at various durations throughout the year, including the growing season. The prolonged presence of water results in the selection of plants that are adapted to survive under saturated conditions and can grow in the soils that form under flooded and saturated conditions (hydric soils). Marshes, swamps, bogs, and BLH habitats are wetland habitats.

Louisiana has lost land at an average rate of approximately 22 square miles per year since 1932 (Couvillion, Beck, Schoolmaster, & Fischer, 2017). From 1932 to 2016, approximately 1,866 square miles of land was lost in coastal Louisiana, representing a decrease of approximately 25 percent (Couvillion, Beck, Schoolmaster, & Fischer, 2017). Louisiana

experiences greater coastal wetland loss than all other states in the contiguous United States combined (Couvillion, Beck, Schoolmaster, & Fischer, 2017). The high rate of wetland loss in coastal Louisiana is directly related to the high rates of subsidence, as well as development of human infrastructure (USACE, 2007) (Boesch, et al., 1994). Some of the wetland loss is due to canalization or filling of wetlands for development. Hurricanes Rita and Katrina directly converted 198 square miles of marsh into open water in Louisiana during the 2005 hurricane season (Barras, Bernier, & Morton, 2008). Figure 4-6 provides information on land change in the vicinity of the study area from 1932 to 2016.

Historically, a balance was maintained between wetland formation and loss in the Louisiana deltaic plain from overbank sediment deposition in actively forming delta lobes and subsidence and deterioration processes in abandoned delta lobes. The coastal wetlands balance has been interrupted by changes to the Mississippi River. The river's suspended sediment load has been reduced by 80 percent since 1850 (Kesel R. , 1987) due to dams on major tributaries, land use changes in the watershed, overbank storage and channel bed aggradation, and alterations to the landscape such as flood risk reduction projects and navigation channels (Allison, et al., 2012) (USACE, 2004). Overbank flooding of the Mississippi River and its tributaries has been greatly restricted, and in many cases eliminated, removing the source of sediment and freshwater that built and maintained coastal marshes relative to subsidence and sea level rise (Roberts, Adams, & Cunningham, 1980). The maintenance of the Mississippi River in its current course and subsequent changes to the delta cycle now because the majority of sediment and fresh water to be discharged off the continental shelf. Another problem is the intrusion of saltwater into historically less saline marshes.

Cypress-tupelo swamps and bottomland hardwood forests once were more common in the study area than they are today. The loss of these habitats due to wind, storm surge damage, and saltwater intrusion into previously freshwater or brackish marshes has greatly impacted the regional habitat and biological resources in the study area (USACE, 2007). Most of the cypress-tupelo swamps were removed from Louisiana between 1876 and 1956, a period of intense logging (Keddy, et al., 2007). Other areas such as the Central Wetlands Area experienced a dramatic change in vegetation in the early 1960s as a result of the construction of the MR&T and MRGO and associated saltwater intrusion. In the last 100 years, a large portion of historical BLH habitat has been logged and converted into agricultural and urban lands (Dahl T. C., 1991). Approximately 200 years ago, 30 million acres of BLH covered the southeastern U.S., but it is estimated that loss rates were as high as 431,000 acres per year from 1965 to 1975. As a result, very little original BLH habitat exists in the southeastern U.S. (USEPA, 2019). Any remaining BLH forest within the study area has been dramatically impacted by alteration of natural hydrology due to extensive water control measures and development. This has led to the gradual deterioration of BLH habitat and colonization by upland species (CWFCUSWG, Conservation, Protections and Utilization of Louisiana's Coastal Wetland Forests. Final Report to the Governor of Louisiana, 2005). Although numerous wetland restoration projects have been implemented in coastal Louisiana, to date these projects have had little effect on the overall rate of wetland loss in the system (Barras, Bernier, & Morton, 2008).

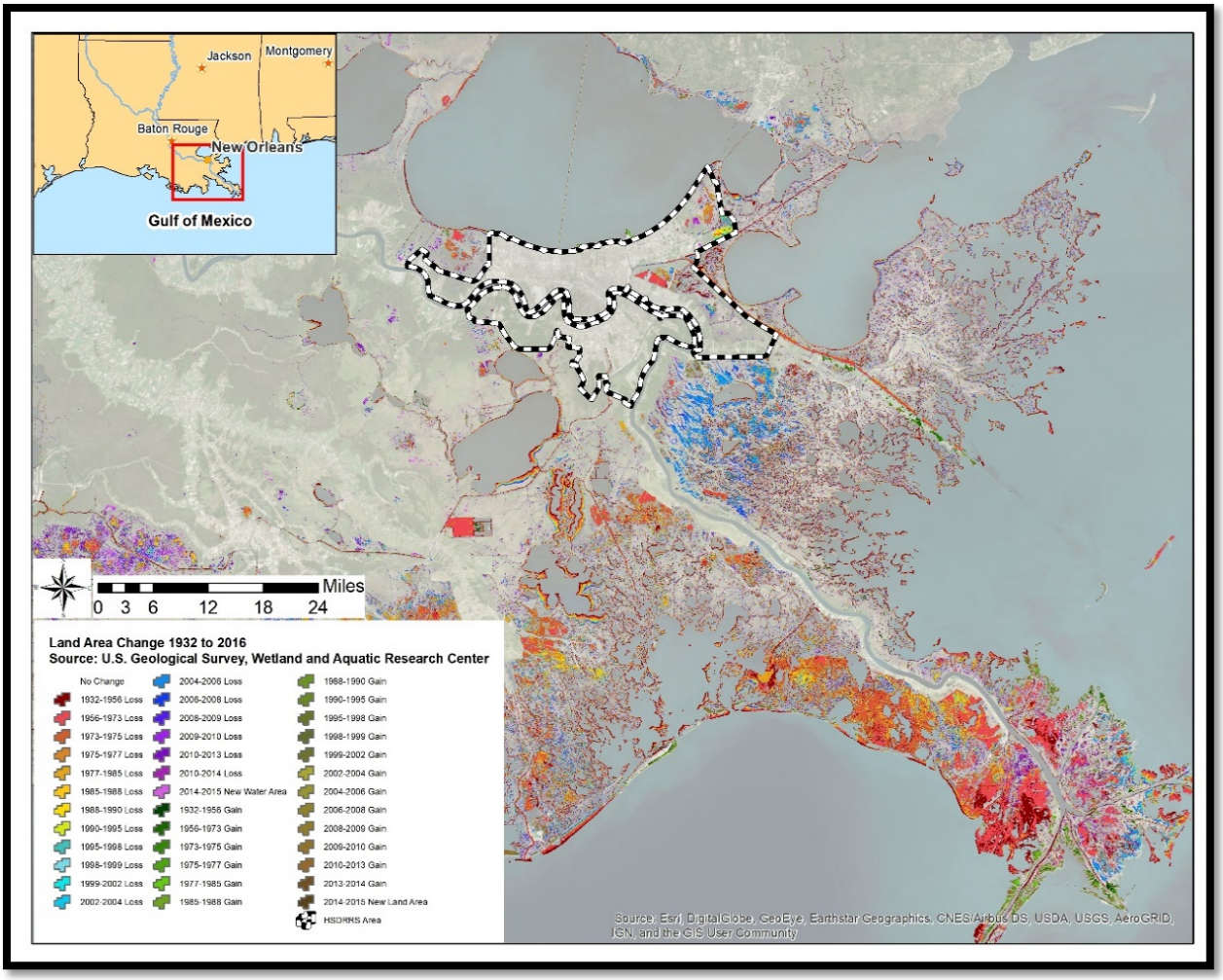

Figure 4-6. Land change in the vicinity of the Study Area from 1932 to 2016

The study area is located primarily at the confluence between the urban, developed portions of the Greater Metropolitan New Orleans Area and the surrounding coastal wetlands and estuaries. Large wetland areas located within the study area include the Bayou Sauvage NWR in New Orleans East, the Central Wetlands Area in the Lower Ninth Ward of Orleans Parish and St. Bernard Parish, and the LaBranche Wetlands in St. Charles Parish. Wetlands within the project area provide plant detritus to adjacent coastal waters and thereby contribute to the production of commercially and recreationally important fishes and shellfishes. Wetlands provide valuable water quality functions such as reducing excessive dissolved nutrient levels, filtering waterborne contaminants, and removing suspended sediment. In addition, coastal wetlands buffer storm surges and reduce damaging effects on man-made infrastructure within the coastal area (USFWS, 2008). Wetland habitats are categorized in the following discussion and can be seen in Figure 4-7.

4.5.1.3 MARSH

Marshes are land masses that are frequently or continually inundated by water and are characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions

(USEPA, 2019). Marsh types within the study area include fresh, intermediate, brackish, and saline marsh. Fresh and intermediate marshes are generally found upstream from brackish waterways, where there is minimal tidal action and a reduced level of saltwater in the systems. Common vegetation includes arrowhead (*Sagittaria* spp.), pickerelweed (*Pontedaria* spp.), pennywort (*Hydrocotyle* spp.), maidencane (*Panicum hemitomon*), and cattail (*Typha* spp.). Intermediate marshes generally have low salinities throughout the year, but salinity peaks during the late summer and early fall. Vegetation may include saltmeadow cordgrass (*Spartina patens*), bulltongue (*Sagittaria lancifolia*), and wild millet (*Echinochloa* spp.). Some areas of freshwater and intermediate marshes in the project area are flotant marsh. Flotants are floating marshes that are entirely floating or poorly anchored to the underlying substrate and are composed of very little mineral matter.

Brackish and saline marshes in the vicinity of the study area, such as the wetland communities near the Central Wetlands and the Golden Triangle areas, consist of emergent, herbaceous vegetation with areas of shallow open water and numerous canals and creeks. Brackish marshes experience low to moderate daily tidal action. Vegetation is typically dominated by smooth cordgrass (*Spartina alterniflora*), but also includes saltgrass (*Distichlis spicata*), black rush (*Juncus roemerianus*), and bulrush (*Schoenoplectus* spp.). Brackish marsh is found mainly within the Chalmette Loop sub-basin and extends northward into the eastern edge of the New Orleans East sub-basin (USFWS, 2019). Saline marshes are less floristically diverse, as they are dominated by only a few plant species that are tolerant of increased salinity levels, such as smooth cordgrass, saltgrass, and glasswort (*Salicornia virginica*) (USACE, 2004). There are relatively few saline marshes near the study area, and these are limited to the southern coastal areas.

4.5.1.4 BOTTOMLAND HARDWOOD

BLH are defined as forested alluvial wetlands typically occupying floodplain regions of large flooding water bodies and rivers (Cowardin, Carter, Golet, & LaRoe, 1979). They occur in areas where the natural hydrologic regime alternates between wet and dry periods. Common tree species found within these habitats include American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), water hickory (*Carya aquatica*), nuttall oak (*Quercus nutallii*), Chinese tallow (*Triadica sebifera*), and red maple (*Acer rubrum*). Understory species may include dwarf palmetto (*Sabal minor*), waxmyrtle (*Myrica cerifera*), deciduous holly (*Ilex decidua*), and swamp dogwood (*Cornus foemina*). Other common species that may be present include poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), pepper-vine (*Ampelopsis arborea*), and greenbrier (*Smilax* spp.). BLH provide important foraging areas and habitat for a variety of wildlife, but because of the fragmented, disturbed, and secondary nature of the BLH within the study area, it is unlikely that many species would utilize the project area as a more expansive primary growth forest. Some areas classified as BLH in the study area are scrub/shrub habitat, and are dominated by waxmyrtle, eastern baccharis (*Baccharis halimifolia*), rattlebox (*Sesbania* spp.) and black willow (*Salix nigra*). Most of the BLH in the study area, including scrub/shrub habitat, are disturbed and contain large concentrations of invasive Chinese tallow trees.

In the study area, BLH occurs as both jurisdictional BLH habitat (i.e., regulated under Section 404 of the CWA) and non-jurisdictional (i.e. upland) BLH habitat. USACE mitigates for impacts on both jurisdictional and non-jurisdictional BLH habitat as required under WRDA 1986, Section 906, as amended.

4.5.1.5 CYPRESS-TUPELO SWAMPS

Cypress-tupelo swamps are located in transitional zones between BLH and lower-elevation marsh or scrub/shrub habitats and flood on a regular basis. Cypress-tupelo swamps exist where salinities are very low (near zero), where there is minimal daily tidal action, and where it is usually flooded throughout most of the growing season. Bald cypress (*Taxodium distichum*) and water-tupelo (*Nyssa aquatica*) are the dominant vegetation within this habitat type, but Drummond red maple (*Acer rumbrum var drummondii*), green ash, and black willow also occur. Water lily (*Nyphaea odorata*), pickerelweed, smartweed (*Polygonum punctatum*), and non-native alligator weed (*Alternanthera philoxeroides*) are also common.

4.5.1.6 OPEN WATER HABITAT

Lake Pontchartrain, borrow ditches on either side of the levees, the GIWW, the Mississippi River, and smaller bayous are all open water bodies classified as jurisdictional waters of the U.S. Any dredging or deposition of fill material within Lake Pontchartrain or wetland areas would require compliance with CWA Section 404 and Section 401 authorization from LDEQ. Lake Pontchartrain, a large, brackish shallow estuary located north of the study area does support submerged aquatic vegetation (SAV), including wild celery (*Vallisneria americana*), widgeongrass (*Ruppia maritima*), slender pondweed (*Potamogeton perfoliatus*), Eurasian milfoil (*Myriophyllum spicatum*), and southern naiad (*Najas guadalupensis*) (Duffy & Baltz, 1998). Salinity in the Lake Pontchartrain estuary ranges from 0.5 to 15 parts per thousand (ppt).Historically, SAV was abundant on all shores of Lake Pontchartrain; however, the total area of SAV within Lake Pontchartrain decreased by approximately 90 percent between 1954 and 1998 (Darnell, 1961) (Burns, Poirrier, & Preston, 1993). Shoreline modification, increased water turbidity, and algal overgrowth contributed to this decline (Cho & Poirrier, 2000). A La Niña drought from 1998 to 2001 increased SAV densities to 80 percent of the 1953 level, but SAV declines occurred after the drought and Katrina and other hurricanes between 2005 and 2012 caused extensive damage to Lake Pontchartrain SAV (Poirrier, Caputo, & Franze, 2017). Coverage in 2016 was about 10 percent of the 1953 level (Poirrier, Caputo, & Franze, 2017). Some isolated SAV beds existed on the south shore of Lake Pontchartrain in 2016 in the Lincoln Beach area to maximum depths of 1.2 meters (Poirrier, Caputo, & Franze, 2017).

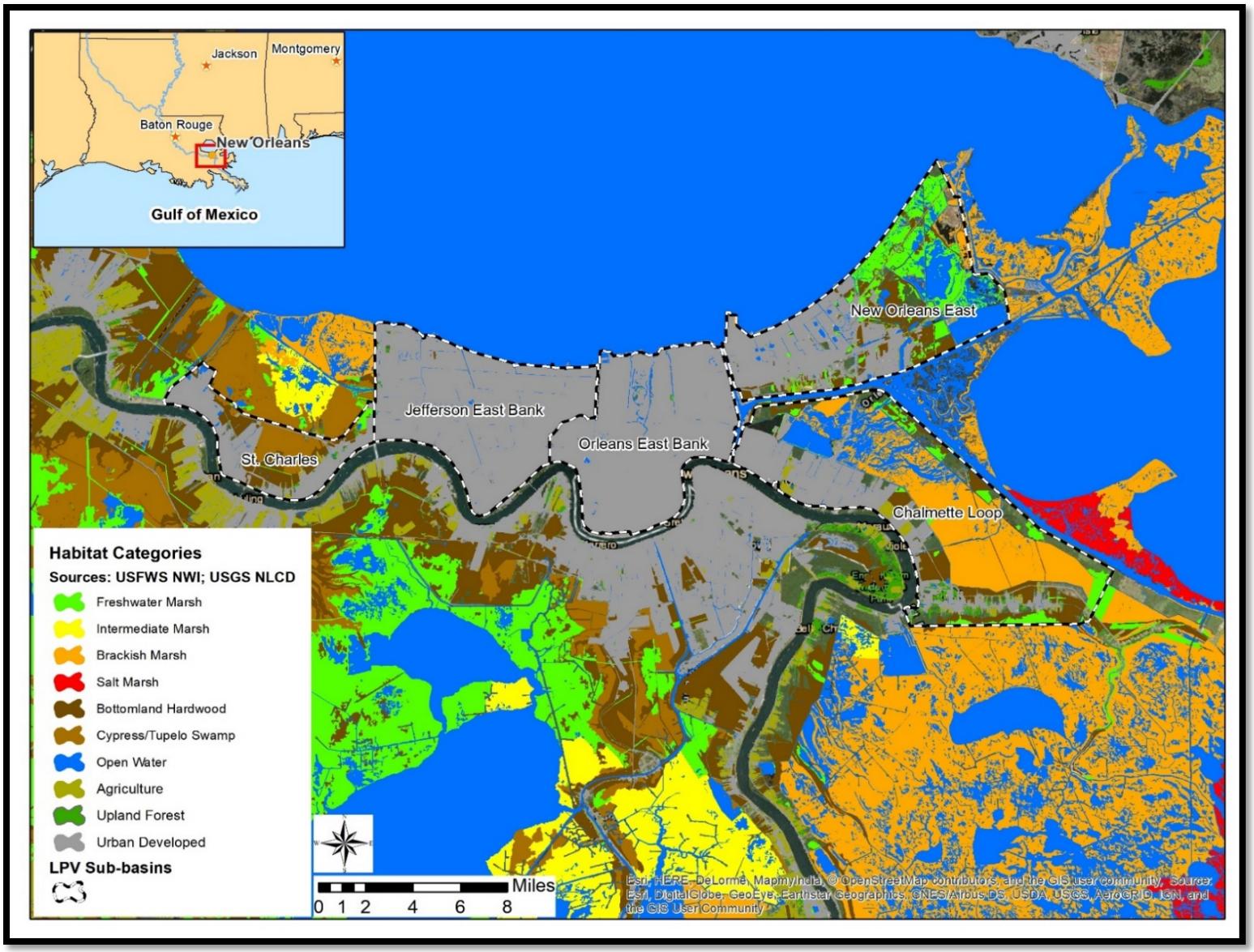

Figure 4-7. Wetlands in and around the Study Area

4.5.2 FORECASTING OF FUTURE CONDITIONS

The study team assumes the loss of coastal marsh habitat would continue in the future. CPRA 2017 Master Plan data indicate that large expanses of coastal marsh may be lost over the next 50 years, even with implementation of the Master Plan (Figure 4-8).

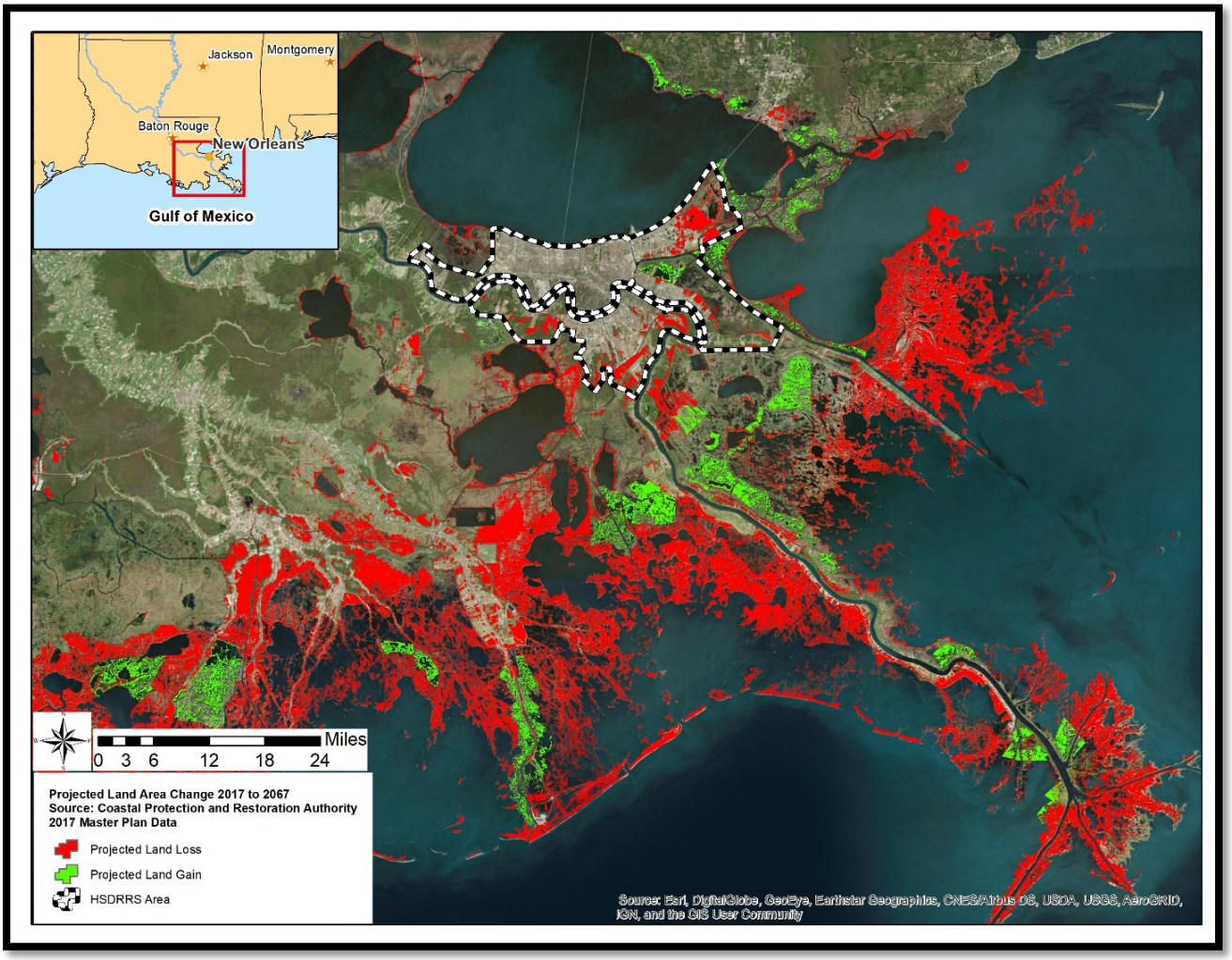

Figure 4-8. Projected Land Area Change from 2017 to 2067 based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation)

4.6 UPLANDS

4.6.1 EXISTING CONDITIONS

The study team considered areas within the study area that are not wetlands or open water as upland resources. Non-wetland areas within the study area consist of cleared and drained bottomland hardwood forest lands used primarily as pasture lands, levees, roads, and commercial or residential use. Although many of these areas within the vicinity of the study area could be classified as wetlands, some areas exhibit more upland characteristics. The existing levees within the study area are the only areas resembling any substantial upland habitat

characteristics. Naturally occurring non-wetland upland resources are defined in areas naturally containing: (1) a prevalence of facultative or obligate upland plant species; (2) non-hydric soils; and (3) few or no occurrences of periodic inundation or soil saturation throughout the growing season.

The areas considered uplands are mostly converted wetlands due to deposition of soil fill for construction of infrastructure and residential and commercial development, spoil from dredging of waterways, landfill material, or the result of draining wetland habitat. Therefore, naturally occurring uplands are not a significant resource in the study area. Although natural uplands and non-wetlands are not a significant resource, there are significant land uses in the study area that are typically associated with upland habitats. Within the study area, these land uses are limited to agricultural production (e.g., cattle grazing and citrus orchards) on previously cleared and drained bottomland hardwood forest lands.

4.6.2 FORECASTING OF FUTURE CONDITIONS

The study team anticipates that upland resources in the study area would remain similar to the existing condition into the future.

4.7 FISHERIES

4.7.1 EXISTING CONDITIONS

Coastal wetlands provide essential habitat for commercially important marine and freshwater species and game species that are wetland-dependent at some stage in their life-cycle. Areas in and adjacent to the study area are important contributors to the local and regional fisheries. Freshwater fisheries within the HSDRRS are highly valued by sport fishermen who pursue freshwater species such as largemouth bass (*Micropterus salmoides*), alligator gar (*Atractosteus spatula*), channel catfish (*Ictalurus punctatus*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), various species of sunfish (*Lepomis* spp.), blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), spotted gar (*Lepisosteus oculatus*), and red swamp crawfish (*Procambarus clarkii*).

Lake Borgne and Lake Pontchartrain are brackish estuaries and provide habitat to a wide variety of economically important invertebrates such as brown shrimp (*Farfantepenaeus aztecus*), pink shrimp (*Farfantepenaeus duorarum*), white shrimp (*Litopenaeus setiferus*), blue crab (*Callinectes sapidus*), and oyster (*Crassostrea virginica*). Estuarine fish such as red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), sheepshead (*Archosargus probatocephalus*), speckled trout (*Cynoscion nebulosus*), and Atlantic croaker (*Micropogonias undulatus*) also inhabit the brackish water habitat. Additionally, estuarine habitat produces many species of fish that are not harvested for recreation or as commercial seafood, but contribute to the food web by serving as prey species for predators along the coast and offshore. These prey species include rainwater killifish (*Lucania parva*), naked goby (*Gobiosoma bosc*), Gulf pipefish (*Syngnathus scovelli*), clown goby (*Microgobius gulosus*), pinfish (*Lagodon rhomboides*), bay anchovy (*Anchoa mitchilli*), speckled worm eel (*Myrophis punctatus*), striped mullet (*Mugil cephalus*), Gulf menhaden (*Brevoortia patronus*), and Gulf killifish (*Fundulus grandis*).

Bay anchovy are the most abundant fish in Lake Pontchartrain and serve an important ecological function as a prey species for many commercial fisheries (O'Connell, Cashner, & Schieble, 2004). The diversity of aquatic species makes the protection of Lake Pontchartrain fisheries important to Louisiana's economic future. Due to the extensive decline of Louisiana's coastal marsh, protection of fragile aquatic habitat is a concern for all large construction activities.

4.7.1.1 COMMERCIAL AND RECREATIONAL FISHING

The estuarine area surrounding the study area creates prolific nursery grounds for white shrimp and brown shrimp (*Crangon crangon*), blue crab, oysters, and menhaden. These important fisheries contribute a significant portion of the annual commercial fish landings in Louisiana. Commercial fish landing data for Louisiana from 2008 through 2017, the most recent year for which data are available, were downloaded from NOAA Fisheries (NOAA, 2019) and used for the following analyses. Commercial fisheries landings in Louisiana averaged 1.02 billion pounds per year with an average value of $351 million. Table 4-9 presents the five species of fish and invertebrates that provided the greatest economic impact on Louisiana fisheries.

Table 4-9. Average Annual Value of Commercial Landings of Top Five Species in Louisiana from 2008 to 2017

Species	Average Annual Landings 2008 to 2017 (Millions of Pounds)	Average Annual Landings Value 2008 to 2017 (Millions of Dollars)
White Shrimp	65.3	$109.4
Menhaden	829.9	$70.9
Blue Crab	42.2	$45.6
Brown Shrimp	30.9	$34.8
Eastern Oyster	6.1	$27.5

Source: (NOAA, Office of Science and Technology Fisheries Information Query, 2019)

In Louisiana, coastal and offshore recreational fishing stimulates $757 million in economic output and creates 7,733 jobs (Southwick Associates, 2008). NOAA Fisheries recreational fishing data for Louisiana from 2008 through 2017, the most recent year for which data are available, indicate that the largest catch of marine recreational fish species by number in Louisiana were spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellata*), hardhead catfish (*Arius felis*), Atlantic croaker (*Micropogonias undulatus*), sand seatrout (*Cynoscion arenarius*), black drum (*Pogonias cromis*), and sheepshead (*Archosargus probatocephalus*). These seven species represented approximately 88% of the recreational catch, by number, for the period analyzed (NOAA, 2019).

4.7.1.2 ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act, amended in 1996 by the Sustainable Fisheries Act and as reauthorized and amended in 2007 by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, requires the eight regional fishery management councils to describe and identify Essential Fish Habitat (EFH) in their respective regions, to specify actions to conserve and enhance that EFH, and to minimize the

adverse effects of fishing on EFH. Congress defined EFH as “those waters and substrate necessary to marine fish for spawning, breeding, feeding, or growth to maturity” (PL 94-265, as amended PL 109-479). The Magnuson-Stevens Fishery Conservation and Management Act requires the NMFS to assist the regional fishery management councils with their respective Fishery Management Plans (FMP). The EFH descriptions and identifications for Gulf of Mexico FMPs were approved on February 8, 1999, for 26 selected species and coral complexes. Today the Gulf of Mexico Fisheries Management Council (GMFMC) manages EFH for 28 species of marine fish and invertebrates within their respective FMPs.

Much of the study area is surrounded by brackish estuary systems that are designated as EFH. Aquatic organisms that inhabit this highly diverse ecosystem are generally tolerant of a wide range of salinities. The landward boundary of estuarine EFH is the limit of permanent freshwater bottom and the seaward limits are the terminus of the U.S. exclusive economic zone. EFH includes all waters and habitats or substrates within these estuarine boundaries. The habitats are water bodies where Federally-managed fish, and the organisms they prey upon, live during the various stages of their life history. Specific categories of EFH include all estuarine waters and their mud, sand, shell, and rock substrate. Artificial reefs, oyster beds, and the associated biological communities, SAV, and adjacent intertidal vegetation (marshes and mangroves) are considered EFH. The EFH designation does not generally extend into the freshwater portions of rivers discharging to the estuarine system (GMFMC, 1998). Vegetated areas are emphasized because of their importance to fish production and because of their vulnerability to human activities. Marsh, oyster shell, SAV, and unvegetated bottom habitats that constitute EFH are found in the study area. Figure 4-9 displays water bodies in the vicinity of the study area that are categorized as EFH.

4.7.1.3 FEDERALLY MANAGED FISH AND SHELLFISH EFH

EFH regulations protect the habitats of fish and shellfish managed by the GMFMC. The most common Federally managed species in the project area is shrimp. The GMFMC lists brown shrimp, white shrimp, pink shrimp, red drum, and Spanish mackerel (*Scomberomorus maculatus*) as known to exist in the estuaries near the project area. Table 4-10 presents a list of managed species found in the study area.

Table 4-10. Federally managed species in and near the Study Area

Managed Species	Life Stages	Designated EFH	Prey Species
Brown shrimp	Eggs, larvae, juveniles	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Some zooplankton, various fish species, polychaetes, amphipods, benthic infauna
White shrimp	Eggs, larvae, adults	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Phytoplankton, zooplankton, detritus, annelid worms, pericarid crustaceans, caridean shrimp, diatoms, gastropods, copepods, bryozoans, sponges, corals, filamentous algae, vascular plants
Pink shrimp	Eggs, larvae, juveniles	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Copepods, small mollusks, benthic diatoms, blue-green algae, filamentous green algae, vascular plant detritus, bacterial films, slime molds, yeast
Red drum	Eggs, larvae, adults	SAV, emergent marsh, oyster reef and sand, shell, and soft bottom	Copepods, mysids, amphipods, shrimp, polychaetes, insects, small fish, isopods, bivalves, crabs, shrimp
Spanish mackerel	Adult	Water column	Various fish species, crustaceans, gastropods, and squid

Source: GMFMC 1998

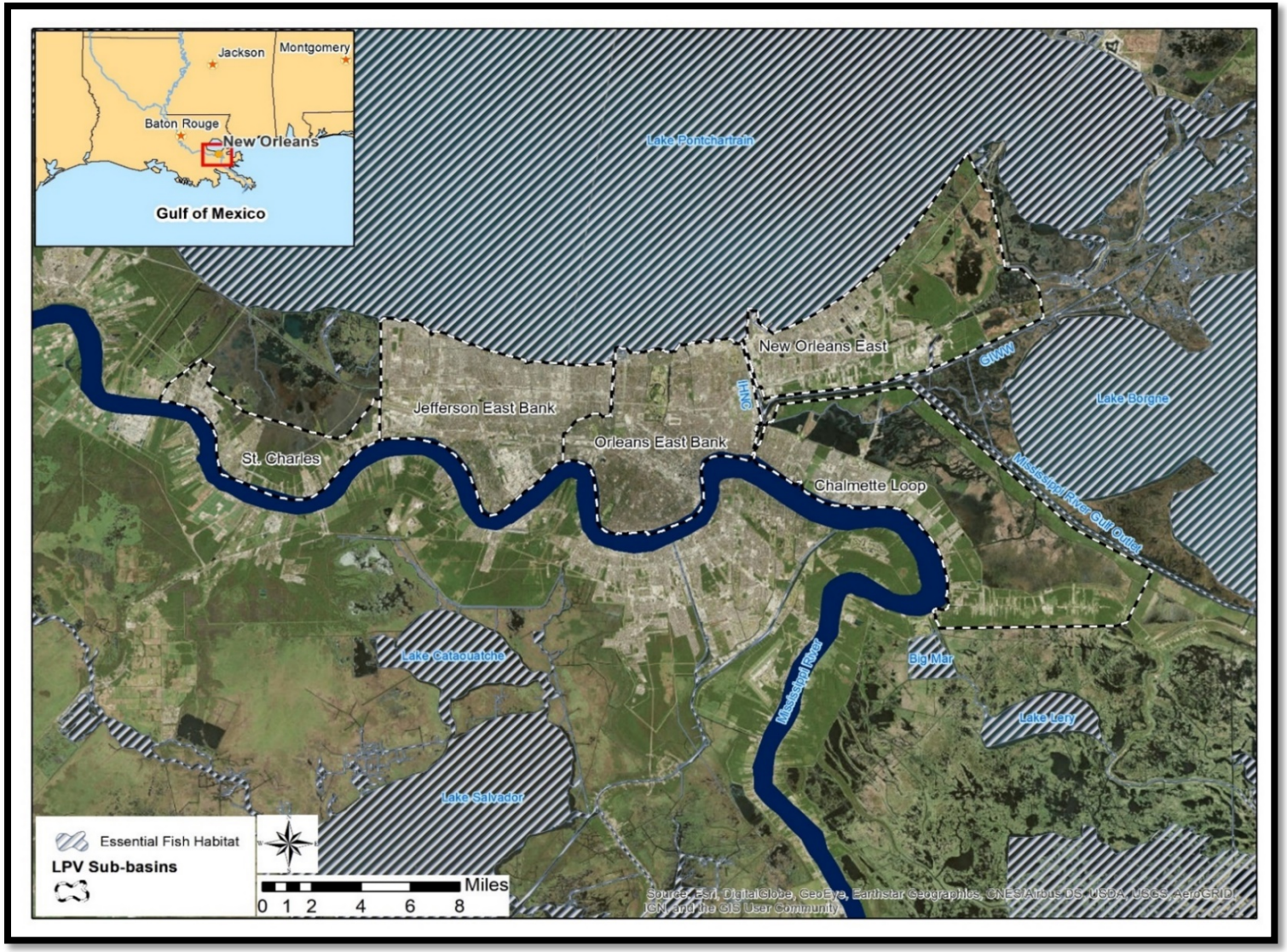

Figure 4-9. Essential Fish Habitat in the vicinity of the Study Area

Source: https://www.habitat.noaa.gov/application/efhinventory/index.html accessed 19 February 2019.

4.7.1.4 ABUNDANCE OF FEDERALLY MANAGED SPECIES IN THE STUDY AREA

Spawning of shrimp occurs in offshore waters of the Gulf of Mexico. The larval populations are driven inshore by winds and currents. The various species have similar estuarine-dependent life history stages and vary seasonally in abundance. Adult white shrimp begin to appear in Lake Pontchartrain and Lake Borgne with a major peak of abundance beginning in August during the high salinity season and extending through the end of January. They are common in the spring as salinity decreases, and then begin to migrate back to the sea during June when bay salinities begin to increase. In non-vegetated areas, post-larval and juvenile white shrimp inhabit mostly muddy substrates that contain large quantities of detritus. Sub-adult white shrimp move from the estuaries to coastal areas in late August and September (GMFMC, 1998).

Brown shrimp utilize the same nursery grounds as white shrimp during the juvenile growth period from the post-larval stage to the adult stage. Adult brown shrimp move offshore to reproduce. The juvenile brown shrimp population is highly abundant in Lake Pontchartrain and Lake Borgne throughout the year; however, adult brown shrimp are rarely seen all year in the estuarine habitats. Adult pink shrimp are rarely found in Lake Pontchartrain and Lake Borgne; however, juveniles are common in the region year-round (GMFMC, 1998).

Adult and juvenile red drum are common in the study area throughout the year. Most of the population spawns offshore and then moves inshore to fertile estuarine waters. Juveniles and young adults are common in Lake Pontchartrain; however, fully grown adults prefer the higher salinities along the coast. Seagrass and coastal marsh habitats typically serve as nursery areas for juvenile red drum (GMFMC, 1998).

Adult Spanish mackerel are not present in the study area, although juveniles have been identified in the region. It is likely that larval and post-larval fish are driven inshore by wind and currents.

4.7.2 FORECASTING OF FUTURE CONDITIONS

Relative sea level rise will likely increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water resulting in loss of existing estuarine fish habitats. Relative sea level rise could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there will likely be a corresponding reduction in overall species diversity and abundance as well as a loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats.

Although fisheries productivity has remained high (Caffey & Schexnayder, 2002) as Louisiana has experienced tremendous marsh loss, this level of productivity may be unsustainable. As marsh loss occurs, a maximum marsh to water interface (i.e., edge) is reached (Browder, Bartley, & Davis, 1985). A decline in this interface will follow if marsh loss continues and the overall value of the area as fisheries habitat will decrease (Minello, Able, Weinstein, & Hays, 2003). Because fishery productivity is related to the extent of the marsh to water interface (Faller, 1979) (Dow, Herke, Knudsen, Marotz, & Swenson, 1985) (Zimmerman, Minello, & Zamora, 1984), it is reasonable to expect fishery productivity to decline as the amount of this interface decreases.

4.8 WILDLIFE

4.8.1 EXISTING CONDITIONS

The diversity and abundance of wildlife in the study area are dependent on the quality and extent of suitable habitat present. Much of the study area is located in urban areas. Areas along the current floodwalls, canals, shoreline, and inshore areas of the lakes present a different habitat for wildlife as compared to previously disturbed urban areas and borrow sites. The bottomland forests, cypress-tupelo swamps, marshes, and tidal channels provide habitat for an abundance of birds, mammals, amphibians, and reptiles. The wetlands of coastal Louisiana fall within the Mississippi Flyway, a major migration corridor for the majority of all bird species found in North America, and provide critical nesting and breeding habitat for resident species. Table 4-11 describes the habitat types found in and near the study area.

4.8.2 BIRDS

Wetland game birds that occur in the study area include the wood duck (*Aix sponsa*), common snipe (*Gallinago gallinago*), and American woodcock (*Scolopax minor*). Non-game birds in the study area include many species of shorebirds, songbirds (both migratory and non-migratory), and wading birds.

Numerous rare migratory birds utilize study area habitats as stop-over points during migration (e.g., peregrine falcon). Other species of concern utilize the habitat for breeding and raising young (e.g., bald eagles).

The Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA) protect migratory birds. Any activity resulting in the “take” of migratory birds or eagles is prohibited unless authorized by USFWS. Birds of conservation concern may be found within the study area.

Although the Bald Eagle (*Haliaeetus leucocephalus)* was removed from the Federal list of threatened and endangered species in 2007, it continues to be protected under the Migratory Bird Treaty Act and the BGEPA. The BGEPA prohibits unregulated take of bald eagles, including disturbance. The National Bald Eagle Management Guidelines (USFWS, 2007) provide landowners, land managers, and others with information and recommendations regarding how to minimize potential project impacts to bald eagles, particularly where such impacts may constitute disturbance.

In Louisiana, the bald eagle typically nests from October to mid-May. Following nesting activities in autumn, egg laying/incubation and hatching/rearing of young typically occur between autumn and spring, with fledging of young as early as January and typically by mid-May. Bald eagle nests typically are in bald cypress trees near fresh and brackish marshes or open water in southeastern Louisiana parishes.

Table 4-81. Habitat types found in and near the Study Area

Habitat Type		Sub-basin				
		St. Charles	Jefferson East Bank	Orleans East Bank	New Orleans East	Chalmette Loop
Cypress-Tupelo Swamp	Cypress swamp and cypress-tupelo swamp habitat provide nesting, foraging and cover habitat to support a diversity of animals. Common wildlife species include: North American beaver (*Castor canadensis*), North American river otter (*Lontra canadensis*), nutria (*Myocastor coypus*), mud turtles (*Kinosternon* spp.), American alligator (*Alligator mississippiensis*), dabbling ducks, wading birds, and many other bird species (Conner & Buford, 1998).	X			X	
Bottomland Hardwood	BLH forests provide valuable habitat for a diversity of wildlife species. The BLH forested wetlands within the study area provide feeding, resting, nesting, and escape habitat to numerous species of game and non-game mammals and commercially important furbearers, as well as songbirds, raptors, migratory and resident waterfowl, wading birds, woodpeckers, and species of amphibians and reptiles. Most of the BLH in the study area are disturbed and contain large concentrations of invasive Chinese tallow.	X	X		X	X
Freshwater Marsh / Intermediate Marsh	These marsh types provide important nesting and foraging habitat for wintering waterfowl, American alligator, wading birds, and fish.	X	X	X	X	X
Brackish Marsh	Shrimp, crab, redfish, seatrout, and menhaden all use brackish marshes for nursery areas, and like freshwater/intermediate marshes, brackish marshes are important habitat for waterfowl, shorebirds, and wading birds.	X			X	X
Saline Marsh	Saline marshes act as a nursery area for many species of fish and crustaceans similar to other marsh types. Wildlife common in saline marsh include wading birds, shorebirds, small mammals, and polychaetes.					

Habitat Type		Sub-basin				
		St. Charles	Jefferson East Bank	Orleans East Bank	New Orleans East	Chalmette Loop
Open Water	Open water habitat within the study area consists of ponds, lakes, canals, bays, and bayous. Natural marsh ponds and lakes are typically shallow, ranging in depth from 6 inches to over 2 ft. Typically, the smaller ponds are shallow and the larger lakes and bays are deeper. In fresh and low salinity areas, ponds and lakes may support varying amounts of SAV and floating-leaved vegetation. Marine mammals and brown pelican (*Pelecanus occidentalis*) are known to occur in the inshore bays and estuaries. Sea turtles with the potential to occur in this habitat are protected species (See section 4.10 Threatened and Endangered Species). Brown pelicans feed in shallow estuarine waters and use sand spits and offshore sand bars as resting and roosting areas.	X	X	X	X	X
Upland Forest	Upland forest habitat is comprised of non-wetland hardwood and young, commercial pine forests. These young pine forests do not support the diversity of plant and animal species that were once supported by the historic longleaf pine (*Pinus palustris*) forests. This habitat provides vital breeding, wintering, and migratory habitat for many migratory non-game bird species. Both game and non-game mammals utilize managed upland forests. Predators of small mammals such as gray fox (*Urocyon cinereoargenteus*) also utilize upland forest habitat (Allen, Bernal, & Moulton, 1996). Small mammals may include harvest mouse (*Reithrodontomys* spp.), hispid cotton rat (*Sigmodon hispidus*), oldfield mouse (*Peromyscus polionotus*), and striped skunk (*Mephitis mephitis*). Similar species of woody vegetation can be found in upland hardwood forest scrub/shrub habitat as is found in BLH (described above).	X			X	X

Habitat Type		Sub-basin				
		St. Charles	Jefferson East Bank	Orleans East Bank	New Orleans East	Chalmette Loop
Urban Developed	Urban areas generally provide low-quality habitat for wildlife. Wildlife that is most adapted to development is found in these areas and can be found within green spaces and parks, as well as neighborhoods. Common amphibians and reptiles include eastern garter snake (*Thamnophis sirtalis sirtalis*), Fowler's toad (*Bufo woodhousii fowleri*) and Gulf coast toad (*Bufo valliceps*). Mammals common to developed or urban habitats include raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), nine-banded armadillo (*Dasypus novemcinctus*), rabbits, grey squirrels (*Sciurus carolinensis*), mice, rats, and feral dogs and cats. Birds in this habitat type include the American crow (*Corvus brachyrhynchos*), songbirds, pigeons, and raptors.	X	X	X	X	X

4.8.3 MAMMALS

Common mammals found within the study area include: nutria (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), swamp rabbit (*Sylvilagus aquaticus*), cotton mouse (*Peromyscus gossypinus*), fox squirrel (*Sciurus niger*), and raccoon (*Procyon lotor)*.

The study area supports a variety of game species including white-tailed deer (*Odocoileus virginianus*) and gray squirrel (*Sciurus carolinesis*).

4.8.4 AMPHIBIANS AND REPTILES

Common amphibians and reptiles use the study area including frogs, toads, salamanders, lizards, turtles, and snakes. Amphibians likely to occur include the southern dusky salamander (*Desmognathus auriculatus*), dwarf salamander (*Eurycea quadridigitata*), central newt (*Notophthalmus viridescens louisianensis*), three-toed amphiuma (*Amphiuma tridactylum*), western lesser siren (*Sirens intermedia nettingi*), gulf coast toad (*Bufo valliceps*), and northern cricket frog (*Acris crepitans crepitans*). Reptiles likely to occur within the study area include the common snapping turtle (*Chelydra serpentina*), green anole (*Anolis carolinensis*), broadhead skink (*Eumeces laticeps*), and western cottonmouth (*Agkistrodon piscivorous leucostoma*).

4.8.5 FORECASTING OF FUTURE CONDITIONS

The study team assumes relative sea level rise, human encroachment and development, and other factors would result in the continued loss of habitat. Relative sea level rise would increase saltwater intrusion and exacerbate ongoing conversion of marsh habitat to shallow open water. Figure 4-10 depicts the anticipated wildlife habitat landscape of the study area and vicinity in 2067 based on CPRA 2017 Master Plan data. As habitat loss continues, migratory avian species would have less suitable stopover habitat forcing them to fly further to suitable habitat. Most mammalian, amphibian, and reptilian species would migrate to habitats that are more suitable. Wildlife would benefit from restoration activities implemented by other programs; however, these activities are not likely to be enough to keep up with the current trends in habitat loss and relative sea level rise.

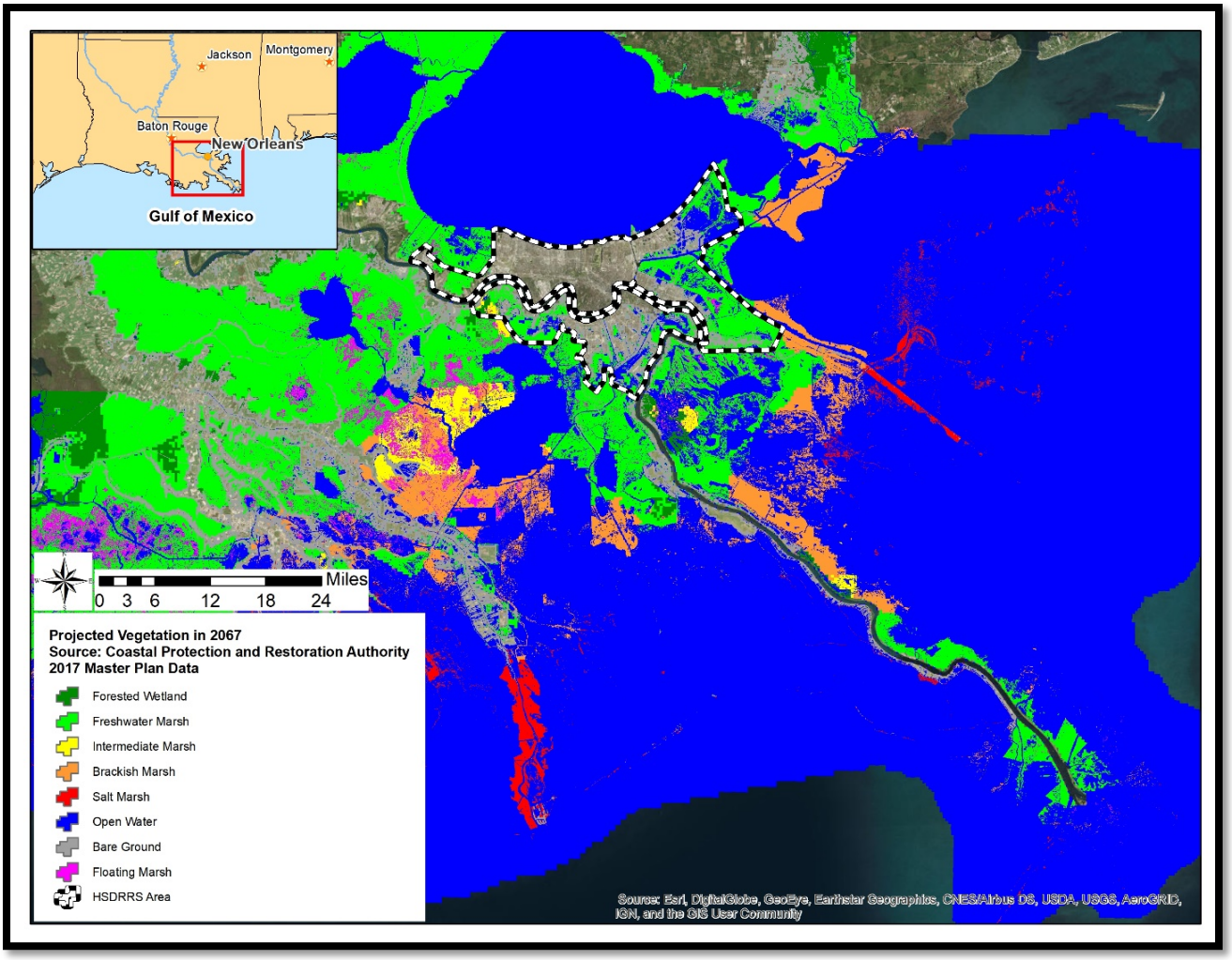

Figure 4-10. Projected Vegetation in 2067 based on CPRA 2017 Master Plan Data (medium scenario, with Master Plan implementation)

4.9 INVASIVE SPECIES (EXECUTIVE ORDER 13112)

4.9.1 EXISTING CONDITIONS

Presidential Executive Order 13112 addresses the prevention of the introduction of invasive species and provides for the control and minimization of the economic, ecological, and human health impacts caused by invasive species. Table 4-12 summarizes invasive species found in or near the study area.

Table 4-92. Invasive species found in or near the Study Area

Common Name	Scientific Name	Habitat
Coastal Plain toad	*Incilius nebulifer*	Freshwater
Greenhouse frog	*Eleutherodactylus planirostris*	Freshwater
Cuban treefrog	*Osteopilus septentrionalis*	Freshwater
Black Sea jellyfish	*Blackfordia virginica*	Freshwater-Marine

Common Name	Scientific Name	Habitat
Copepod	*Mesocyclops pehpeiensis*	Freshwater
Chinese mitten crab	*Eriocheir sinensis*	Marine-Freshwater
Riverine grass shrimp	*Palaemonetes paludosus*	Freshwater
Asian tiger shrimp	*Penaeus monodon*	Marine
White sucker	*Catostomus commersonii*	Freshwater
Pacu	*Colossoma or Piaractus sp.*	Freshwater
Black tetra	*Gymnocorymbus ternetzi*	Freshwater
Convict cichlid	*Archocentrus nigrofasciatus*	Freshwater
Rio grande cichlid	*Herichthys cyanoguttatus*	Freshwater
Jaguar guapote	*Parachromis managuensis*	Freshwater
Oriental weatherfish	*Misgurnus anguillicaudatus*	Freshwater
Goldfish	*Carassius auratus*	Freshwater
Grass carp	*Ctenopharyngodon idella*	Freshwater
Common carp	*Cyprinus carpio*	Freshwater
Silver carp	*Hypophthalmichthys molitrix*	Freshwater
Rosy barb	*Pethia conchonius*	Freshwater
Fathead minnow	*Pimephales promelas*	Freshwater
Paradise fish	*Macropodus opercularis*	Freshwater
Arapaima	*Arapaima sp.*	Freshwater
Green swordtail	*Xiphophorus hellerii*	Freshwater
Southern platyfish	*Xiphophorus maculatus*	Freshwater
Spotted green pufferfish	*Tetraodon nigroviridis*	Freshwater-Brackish
Nutria	*Myocastor coypus*	Freshwater
Asian clam	*Corbicula fluminea*	Freshwater
Giant applesnail	*Pomacea maculata*	Freshwater
Florida applesnail	*Pomacea paludosa*	Freshwater
Red-rim melania	*Melanoides tuberculatus*	Freshwater
Single-vein sweetflag	*Acorus calamus*	Freshwater
Alligatorweed	*Alternanthera philoxeroides*	Freshwater
Tidalmarsh amaranth	*Amaranthus cannabinus*	Brackish
Water lettuce	*Pistia stratiotes*	Freshwater
Smallflower umbrella sedge	*Cyperus difformis*	Freshwater
Giant water sensitive plant	*Aeschynomene fluitans*	Freshwater
Parrot feather	*Myriophyllum aquaticum*	Freshwater
Eurasian watermilfoil	*Myriophyllum spicatum*	Freshwater-Brackish
Brazilian waterweed	*Egeria densa*	Freshwater
Dioecious hydrilla	*Hydrilla verticillata [dioecious]*	Freshwater
Yellow iris	*Iris pseudacorus*	Freshwater
Big-foot water-clover	*Marsilea macropoda*	Freshwater
Large-flower primrose-willow	*Ludwigia grandiflora*	Freshwater
Rice	*Oryza sativa*	Freshwater
Floating waterhyacinth	*Eichhornia crassipes*	Freshwater
Curly-leaf pondweed	*Potamogeton crispus*	Freshwater
Triangle waterfern	*Ceratopteris richardii*	Freshwater
Watersprite	*Ceratopteris thalictroides*	Freshwater
Water spangles	*Salvinia minima*	Freshwater
Giant salvinia	*Salvinia molesta*	Freshwater
Peacock spikemoss	*Selaginella uncinata*	Freshwater
Zebra mussel	*Dreissena polymorpha*	Freshwater
Chinese tallow	*Triadica sebifera*	Forest; Swamp edges

Common Name	Scientific Name	Habitat
Cogongrass	*Imperata cylindrical*	Sandy soils with low nutrients; non-cultivated areas; areas with some disturbance
Kudzu	*Pueraria lobata*	Any
Asian tiger mosquito	*Aedes albopictus*	Artificial and natural containers with water
Formosan termite	*Coptotermes formosanus*	Wooden structures, trees, insulation
Red imported fire ant	*Solenopsis invicta*	Open, sunny areas
Roseau cane scale	*Nipponaclerda biwakoensis*	Freshwater-Marine
Air potato	*Dioscorea bulbifera*	Disturbed habitats

Sources: (USGS, 2019), (Tulane/Xavier Center for Bioenvironmental Research, 2019), (LSU AgCenter, 2019)

4.9.2 FORECASTING OF FUTURE CONDITIONS

The study team assumes invasive species would likely continue to pose a threat in and near the study area. The team assumes landscape disturbances and deteriorations would continue into the future allowing for continued and expanded invasions by non-native species. The team expects the existing native vegetative communities to degrade and become vulnerable to infestation. The study team assumes that invasive species would replace native vegetation, forming monoculture stands of dense vegetation. Habitats may realize some benefit from establishment of invasive species in some areas. For example, the robust above and belowground production of cogongrass (*Imperata cylindrical*) may provide substrate stabilization and biomass contributions; water hyacinth (*Eichhornia crassipes*) may provide potential water quality improvement through nutrient uptake and retention. However, the study team expects the overall adverse impacts of invasive species spread and abundance into the future to outweigh the potential benefits. Expected adverse impacts may include reduced vegetative biodiversity, alteration of soil properties and ecosystem processes, and reduction in wildlife food and habitats. The study team assumes the existing invasive species found in the study area would likely continue and new invasive species may become established in the future. The study team also assumes that Federal, state, and local laws, programs, and regulations aimed at invasive species management and control would continue.

4.10 THREATENED AND ENDANGERED SPECIES

4.10.1 EXISTING CONDITIONS

4.10.1.1 FEDERALLY-LISTED

The USFWS provided a list of Federally-listed species that could potentially be found in the study area (St. Charles, Jefferson, Orleans, and St. Bernard Parishes, Louisiana) via a letter dated April 29, 2019 (Appendix G, Environmental Compliance). Federally-listed species include any plant or animal listed as endangered or threatened under the Endangered Species Act of 1973, as amended. *Endangered* species include any species that are in danger of becoming extinct. *Threatened* species include any species that are likely to become endangered in the foreseeable future. *Proposed* species include any species that are being reviewed by the USFWS for possible addition to the list of endangered and threatened species (see Appendix G, Environmental Compliance, for more detail).

Table 4-13 lists the threatened and endangered species that may occur in St. Charles, Jefferson, Orleans, and St. Bernard Parishes within the study area. The study area contains Gulf sturgeon critical habitat as defined in the Endangered Species Act. Critical habitat is a specific geographic area containing features essential to the conservation of an endangered or threatened species and may require special management and protection. Gulf sturgeon critical habitat potentially affected by project features includes Lake Pontchartrain east of the Lake Pontchartrain Causeway.

Table 4-103. Federally-Listed Species Potentially Occurring in the Study Area

Species	Federal Status	Habitat	Parish of Occurrence	Potential to Occur in Study Area
West Indian manatee (*Trichechus manatus*)	T	Open water	All	Yes, in Lakes Pontchartrain and Borgne, Bayou Dupre, Bayou Bienvenue, GIWW, and IHNC
Leatherback sea turtle (*Dermochelys coriacea*)	E	No breeding habitat; feeding habitat in near shore, open water of Lake Pontchartrain and Lake Borgne	All	Yes, in Lakes Pontchartrain and Borgne, MRGO
Loggerhead sea turtle (*Caretta caretta*)	T	No breeding habitat; feeding habitat in near shore, open waters of Lake Pontchartrain and Lake Borgne	All	Yes, in Lakes Pontchartrain and Borgne, and MRGO
Kemp's ridley sea turtle (*Lepidochelys kempii*)	E	No breeding habitat; feeding habitat in near shore, open waters of Lake Pontchartrain and Lake Borgne	All	Yes, in Lakes Pontchartrain and Borgne, and MRGO
Green sea turtle (*Chelonia mydas*)	T	No breeding habitat; feeding habitat in near shore, open waters of Lake Pontchartrain and Lake Borgne	All	Yes, in Lakes Pontchartrain and Borgne, and MRGO
Hawksbill sea turtle (*Eretmochelys imbricata*)	E	No breeding habitat; feeding habitat in near shore, open waters of Lake Pontchartrain and Lake Borgne	All	Yes, in Lakes Pontchartrain and Borgne, and MRGO
Gulf sturgeon (Acipenser oxyrhynchus desotoi)	T	Inhabits coastal rivers from Louisiana to Florida during the warmer months and overwinters in estuaries, bays, and the Gulf of Mexico	All	Yes, in Lakes Pontchartrain and Borgne, IHNC, and GIWW
Pallid sturgeon (Scaphirhynchus albus)	E	Inhabits the Missouri and Mississippi Rivers from Montana to Louisiana.	All	Yes, in the Mississippi River

4.10.2 FORECASTING OF FUTURE CONDITIONS

The study team assumes that the degradation and loss of important essential fish and wildlife habitats would continue. Many different fish and wildlife species use these habitats for shelter, nesting, feeding, roosting, cover, nursery, and other life history requirements. The loss and deterioration of transitional wetland habitats would continue to adversely impact all listed species in and near the vicinity of the study area. The study team assumes the positive impacts

of Federal, state, local, and private restoration and recovery projects and programs would offset, to some degree, the adverse cumulative impacts on listed species.

4.11 CULTURAL AND HISTORICAL RESOURCES

4.11.1 EXISTING CONDITIONS

The National Historic Preservation Act of 1966 (Public Law 89 80 655), as amended; NEPA of 1969 (Public Law 91-90), as amended; and other applicable laws and regulations require Federal agencies to take into account the effects of their undertaking on the environment and any significant cultural resources, defined as historic properties, within the project area of the proposed undertaking, as well as its area of potential effects (APE). Typically, studies to inventory existing conditions require archival searches and field surveys to identify any cultural resources. When significant sites are recorded, efforts are made to minimize adverse effects and preserve the site(s) in place. If any significant sites cannot be avoided and would be adversely impacted, an appropriate mitigation plan would be implemented to recover data that would be otherwise lost due to the proposed undertaking.

For HSDRRS planning and construction, USACE completed studies of the potentially significant historic properties in the areas that would have been impacted by work associated with HSDRRS corridors. This required background historical research of the study area and identification of previous cultural surveys and known historic properties to assess the areas of probability for cultural resources. Phase I cultural resource surveys were conducted in the form of pedestrian surface surveys with systematic shovel test pit excavations and delineations of site boundaries, when necessary. Where applicable, Phase II site evaluations were conducted for assessing the NRHP eligibility. In all cases, the cultural resource survey areas exceeded the size of the preliminary APE, which allowed the USACE project archaeologists to adjust the APE, as needed, to avoid any damage to historic properties with potential eligibility for the NRHP.

Identified significant cultural resources within the project area range from the prehistoric to the historic periods of occupation. Within St. Charles Parish, two historic field drainage structures (16SC65 and 16SC67) were previously relocated. Site 16SC67 was found to be outside of the footprint of the LPV. Site 16SC65 was found to be not eligible for listing on the NRHP. No other sites were found within St. Charles Parish. Two prehistoric shell midden sites (16JE40 and 16JE04) located within Jefferson Parish were evaluated for National Register eligibility and found to be ineligible due to previously disturbance. Eight known cultural resource sites were identified to be within the Orleans Parish Section of the LPV area. These sites include prehistoric midden and occupation sites, such as sites 16OR70 and 16OR24, historic sites ranging from the 18th to the 20th century such as 16OR446 and 16OR19, and a historic structure the Port Pontchartrain Lighthouse. Within St. Bernard Parish, site 16SB84, the Battery Bienvenue a 19th century military fortification, is located adjacent to the LPV area and was avoided by all impacts. Two other historic sites, 16SB160 and 16SB161, a historic railway and artifact scatter respectively were documented in St. Bernard Parish. Both of these sites are located outside of the LPV footprint. One site 16PL150, a historic artifact scatter, was determined to be within the LPV area in Plaquemines Parish. The site was determined to be ineligible for the NRHP.

For the HSDRRS construction, in letters sent to the Louisiana SHPO and THPOs of the 12 Federally recognized tribes with an interest in the region, USACE provided project documentation, evaluated cultural resources potential in the project area, and found that the HSDRRS actions had no impact on historic properties with the implementation of the USACE avoidance measures. Section 106 consultation for the HSDRRS projects was then concluded. Compliance with NHPA Section 106 would also be achieved for the proposed LPV actions.

Through avoidance, minimization, monitoring and other mitigation, there were no known direct and long-term impacts to cultural resources as a result of the HSDRRS projects. Implementation of the HSDRRS projects had beneficial indirect impacts by providing an added level of flood risk reduction to known and unknown archaeological sites in the project vicinity on the protected side of the levees, thereby reducing the damage caused by flood events. Erosion of ground deposits during flood events can result in severe damage and destruction of archaeological sites.

A comprehensive summary of these studies, identified cultural resources, and previous Section 106 consultation for HSDRRS construction are presented in IERs #1, #2, #3, #4, #5, #6, #7, #8, #9, #10, #11, and #27 and complied and summarized in the Comprehensive Environmental Document Phase 1 and are incorporated herein by reference https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/.

4.11.2 FORECASTING OF FUTURE CONDITIONS

Routine maintenance of the existing levee would have no effect on cultural resources as none exists within current ROW. Cultural and historic resources that may exist within the study area would be at a higher risk for adverse impacts associated with hurricane storm surge, flood events, and land loss outside the LPV system.

4.12 AESTHETICS (VISUAL)

4.12.1 EXISTING CONDITIONS

Environmental assessments and impact statements for Corps planning studies are supposed to focus on significant environmental considerations as recognized by technical, institutional and public sources. The Visual Resources Assessment Procedure for U.S. Army Corps of Engineers (VRAP) (Smardon, et al., 1988) provides a method to evaluate visual resources affected by Corps water resources projects. The following VRAP criteria are used to identify significant visual resource considerations in the study area:

1. Important urban landscapes including visual corridors, monuments, sculptures, landscape plantings, and greenspace.
2. Area is easily accessible by a major population center.
3. Project is highly visible and/or requires major changes in the existing landscape.
4. Areas with low scenic quality and limited visibility.
5. Historic or archeological sites designated as such by the National Register or State Register of Historic places.

6. Parkways, highways, or scenic overlooks and vistas designated as such by a Federal, State, or municipal government agency.
7. Visual resources that are institutionally recognized by Federal, State or local policies.
8. Tourism is important in the area's economy.
9. Area contains parks, forest preserves, or municipal parks.
10. Wild, scenic, or recreational water bodies designated by government agencies.
11. Publically or privately operated recreation areas.

Much of the LPV corridor is currently comprised of levees, floodwalls, and floodgates that reduce the visual appeal and interrupt the line of sight between the urban environment on the protected side and the natural environment on the flood side. Significant visual resources in the study area include the New Orleans lakefront greenspace and the National Historical Landmark Vieux Carré Historic District, which is a major tourist destination. Lakes Pontchartrain, Borgne, and Catauatche and surrounding wetlands are visible from the levees, and the LPV corridor in Orleans and St. Bernard Parishes bisects wetlands and open water bodies of the Bayou Sauvage National Wildlife Refuge and the Central Wetlands Unit, respectively. Located in St Charles Parish are Bayou Trepagnier and Bayou LaBranche, which are part of the Louisiana Natural and Scenic River system. In Jefferson Parish, the visual resources of the area include open vistas of the lake and shoreline across the northern portion of the Jefferson East Bank sub-basin, and the LaBranche wetlands in the western portion. Inland areas of Jefferson Parish are mostly developed, and include several parks that are administered by the Jefferson Parish Parks and Recreation Department, including Lafreniere Park, Linear Park, and the Bonnabel Boat Launch.

Construction of the HSDRRS LPV and excavation of borrow sites had short-term adverse impacts to visual resources in the project area. After construction, the project corridor returned, to the maximum extent practicable, to pre-construction conditions. Direct long-term impacts on visual resources from the construction of the LPV were negligible.

These significant visual resource considerations in the study area are described in the aesthetics, cultural and recreational resources sections of the CED Phase I (USACE, 2013) and are incorporated herein by reference (https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/Comprehensive-Environmental-Document/).

4.12.2 FORECASTING OF FUTURE CONDITIONS

Physical and ecological changes, including vegetative succession occurring in the study area, determine the future of the study area's visual landscape in the absence of new projects. Additionally, recreation and land use trends contribute to determine the landscape's visual future. Future forecasts for the ecological, recreation, and land use resources can be found elsewhere in this document.

4.13 RECREATIONAL RESOURCES

4.13.1 EXISTING CONDITIONS

This resource is institutionally significant because of the Federal Water Project Recreation Act of 1965 (P L 89-72), as amended, and the Land and Water Conservation Fund Act of 1965 (P L 88-578), 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. Recreation resources are publicly significant because the public's utilization of parks, outdoor spaces, and other leisure activities improves quality of life and community interactions. The value the public places on recreational resources such as boating, fishing, and hunting can be directly measured by the large number of fishing and hunting licenses sold in Louisiana and the large number of recreational boat registrations per capita.

Many levee segments of the LPV project provide recreational opportunities for walking, running, and bicycling. Additionally, the MRL is used extensively by passive and active recreationalists, including walkers, joggers, wildlife viewers, and cyclists. The Bonnet Carré Spillway, a potential source of borrow material, is a recreational area offering biking, hiking, horseback riding, picnicking, ATV areas as well as hunting and fishing. Finally, segments along Lake Pontchartrain in Jefferson and Orleans parishes are especially important components of outdoor recreation in the region and offer many parks and open green spaces for picnicking.

Numerous water bodies in the region provide boating and fishing opportunities. Within the LPV study area, Bayou St. John, a designated Louisiana Natural and Scenic River, provides canoeing and kayaking activities, and Bayou Sauvage NWR provides areas for hunting, fishing, and bird watching. Lake Pontchartrain and Lake Borgne are used locally for recreational boating and fishing. Numerous boat launches in the region provide direct access to these estuarine water bodies.

The GIWW/MRGO/IHNC complex is used for fishing and recreational boat access to nearby bayous, canals, and estuaries. Bayou Bienvenue is a designated Louisiana Scenic River in St. Bernard Parish and extends from the Lower Ninth Ward in Orleans Parish to Lake Borgne. Bayou Bienvenue is an important urban recreational resource that provides local fishing and boating opportunities for residents of St. Bernard Parish and the Lower Ninth Ward and Holy Cross neighborhoods. Bayou Bienvenue is also a component of the approximately 29,000-acre Central Wetlands Unit, which is bounded by the LPV levees along the deauthorized MRGO and GIWW on the north and east sides and a local levee along the south side. Two hurricane and tropical storm surge gates, one located on Bayou Bienvenue and the other on Bayou Dupre, and another designated Louisiana Natural and Scenic River, allow for non-tropical storm exchanges of water to influence water levels in the Central Wetlands Unit.

Lake Pontchartrain is an important recreational resource and provides boating and fishing opportunities for the Greater New Orleans Metropolitan Area. In the vicinity of the Seabrook gate complex, the Frank Davis Fishing Pier extends from the shore underneath the Seabrook Bridge and is managed by the Orleans Levee Board. This pier is regionally known for catches of white trout, speckled trout, flounder, redfish, sheepshead, black drum, and Atlantic croaker, primarily due to its proximity to the existing scour holes (Davis, 2007). Fishing conditions in the

area are also thought to be positively influenced by certain tidal flow patterns, specifically when water moves from the IHNC into Lake Pontchartrain (St. Charles Herald Guide, 2008).

Although fishing occurs within all portions of the IHNC, and the Seabrook area is anecdotally reported to be the second best fishing site in the state, public access to the shores of the IHNC is officially restricted and fishing is not allowed. The Port of New Orleans Harbor Police Department has established a no-fishing zone for the entire IHNC, which includes restrictions on crabbing, fishing, and shrimping. Despite the posted warnings and the fact that Port of New Orleans Harbor Police Department officers have the authority to enforce these laws, fishing does occur along the IHNC.

4.13.2 FORECASTING OF FUTURE CONDITIONS

Recreational resources within the LPV study area will continue to be protected from storm surge inundation by the HSDRRS, but less so for the 1% AEP event in the without-project condition. The study area lies in a region of active subsidence and sea level rise (See Section 5.2.1). As levees subside, they provide a lower level of flood risk reduction. Land-based recreational resources, including camps, park structures, and recreation facilities would be susceptible to a higher risk of inundation in the future without-project condition. Water-based recreational resources, such as fishing and hunting, would also be affected by deposits of salt laden waters into interior estuaries thereby affecting fishing opportunities, especially in the short-term. Over time, water-based recreational resource opportunities would return to baseline conditions.

4.14 AIR QUALITY

4.14.1 EXISTING CONDITIONS

The U.S. Environmental Protection Agency (USEPA) sets national air quality standards for six common pollutants. These standards, known as National Ambient Air Quality Standards (NAAQS), include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM) 2.5, PM 10 and sulfur dioxide. Areas where air quality conditions violate these standards are classified as “non-attainment” and are subject to special air quality controls. St. Charles, Jefferson, and Orleans parishes are in attainment for all NAAQS. St. Bernard Parish is in attainment for all NAAQS except sulfur dioxide (SO_2) [4].

The General Conformity Rule (40 CFR Part 93) ensures that the actions taken by Federal agencies in nonattainment and maintenance areas do not interfere with a state’s plans to meet national standards for air quality. A conformity determination evaluates whether a Federal action meets the requirements of the general conformity rule and must be performed when a Federal action generates air pollutants that would exceed conformity threshold (“de minimis”) levels in a region designated as a non-attainment or maintenance area for one or more NAAQS. It requires the responsible Federal agency to evaluate the nature of the proposed action and associated air pollutant emissions, calculate emissions as a result of the proposed action, and if de minimis thresholds would be exceeded, the agency must prepare a general conformity determination demonstrating that project emissions would meet the requirements of the General

[4] Available online at: https://www3.epa.gov/airquality/greenbook/anayo_la.html. Accessed 28 January 2019

Conformity Rule and would conform to the relevant state implementation plan before the action will be allowed to proceed. If the agency's projected emissions would not exceed de minimus levels, a conformity determination is not required.

4.14.2 FORECASTING OF FUTURE CONDITIONS

The study team assumes air quality would continue to be subject to institutional recognition and regulation into the future. 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 coastal wetland vegetation that would no longer be available to remove gaseous pollutants. The study team assumes respiratory ailments, such as asthma, would increase in the human population due to the reduced air quality.

4.15 NOISE

4.15.1 EXISTING CONDITIONS

Noise is generally described as unwanted sound, which can be based either on objective effects (i.e., hearing loss, damage to structures, etc.) or subjective judgments (e.g., community annoyance). Sound is usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as sound level. The threshold of human hearing is approximately 3 dB, and the threshold of discomfort or pain is around 120 dB. Sound levels are typically expressed as A-weighted dB (dBA), which describes the relative loudness of sounds as perceived by the human ear.

Noise levels occurring at night generally produce a greater annoyance than do the same levels occurring during the day. People generally perceive intrusive noise at night as being 10 dBA louder than the same level of noise during the day. This perception is largely because background environmental sound levels at night in most areas are also about 10 dBA lower than those during the day. Noise levels are computed over a 24-hour period and adjusted for nighttime annoyances to produce the day-night average sound level (DNL). DNL is the community noise metric recommended by the USEPA and adopted by most Federal agencies (USEPA 1974). The U.S. Department of Housing and Urban Development (HUD) established acceptable DNL noise levels for construction activities in residential areas (HUD, 1984):

- **Acceptable (not exceeding 65 dBA) –** The noise exposure may be of some concern, but common building construction will make the indoor environment acceptable, and the outdoor environment will be reasonably pleasant for recreation and play.
- **Normally Unacceptable (above 65 dBA but not greater than 75 dBA) –** The noise exposure is significantly more severe; barriers may be necessary between the site and prominent noise sources to make the outdoor environment acceptable; special building construction may be necessary to ensure that people indoors are sufficiently protected from outdoor noise.

- **Unacceptable (greater than 75 dBA) –** The noise exposure at the site is so severe that the construction costs to make the indoor noise environment acceptable may be prohibitive, and the outdoor environment would still be unacceptable.

A DNL of 65 dBA is the impact threshold most commonly used for noise planning purposes and represents a compromise between community impact and the need for activities like construction. USEPA identified a DNL of 55 dBA as a level below which there is no adverse impact (USEPA, 1974).

There are no noise ordinances at the state level; however, there are noise ordinances at the local level.

Table 4-14 outlines the maximum permissible sound levels by land use category. Sounds generated from construction and demolition activities are exempt from the New Orleans ordinance between 7:00 am and 6:00 pm (11:00 pm for areas other than residential; Chapter 66 Article IV New Orleans Municipal Code). In Jefferson Parish, industrial sound level limits apply to construction activity for all land use categories. In addition, the Jefferson Parish ordinance specifically prohibits the operation of any construction equipment within 300 feet of any residential or noise-sensitive area between 9:00 pm and 7:00 am Monday through Saturday, and between 9:00 pm and 8:00 am on Sundays and holidays, except for emergency work (Section 20-102 Jefferson Parish Municipal Code). In St. Bernard Parish, construction activities directly connected with the abatement of an emergency are excluded from the noise provisions listed below. No exemptions exist for St. Charles Parish.

Table 4-114. Noise level limits by land use category in Study Area parishes

Receiving Land Use Category	Time	Maximum Permissible Sound Level Limit (dBA)				
		St. Charles	Jefferson	Orleans		St. Bernard
		L_{max}	L_{max}	L_{10}	L_{max}	L_{max}
Residential & Public Space	7:00 am – 10:00 pm	50	60	60	70	65
	10:00 pm – 7:00 am	45	55	55	60	60
Commercial	7:00 am – 10:00 pm	65	65	65	75	70
	10:00 pm – 7:00 am	60	60	60	65	65
Industrial	At all times	N/A	75	75	85	-
	7:00 am – 10:00 pm	-	-	-	-	85
	10:00 pm – 7:00 am	-	-	-	-	80

Sources: Chapter 66 Article IV New Orleans Municipal Code, Section 20-102 Jefferson Parish Municipal Code, Chapter 24 Section 24-4 St. Charles Municipal Code, Article VI Section 11-132 St. Bernard Municipal Code; www.municode.com. Accessed 28 January 2019
L_{10} = sound pressure level that is exceeded 10 percent of the time
L_{max} = maximum noise level of a particular event

4.15.2 FORECASTING OF FUTURE CONDITIONS

Local and temporary noise typically associated with human activities and habitations such as car and truck traffic; operation of commercial and recreational boats, water vessels, airboats, and other recreational vehicles; operation of machinery and motors; and human residential-related noise (air conditioners, lawn mowers, etc.) would likely continue to affect humans and animals in the study area in the future. Noise levels may increase slightly with increasing population and industrialization in the study area. Changes in local noise ordinances may also increase or decrease future noise levels.

4.16 TRANSPORTATION

4.16.1 EXISTING CONDITIONS

Regional transportation in and around the study area includes air traffic systems, railroads, public transit, navigation channels, and roadway networks. Figure 4-11 shows the regional transportation features in the study area.

4.16.1.1 AIRLINE SERVICES

The Louis Armstrong New Orleans International Airport is located west of most projects in the HSDRRS and is the primary commercial airport for the New Orleans area and most of the Greater New Orleans Metropolitan Area. The New Orleans Lakefront Airport is located on the southern bank of Lake Pontchartrain along Hayne Boulevard and serves general aviation, recreation flights, private charter flights, a small aircraft flight school, and some military flights. The New Orleans Lakefront Airport serves southeastern Louisiana and the Mississippi Gulf Coast (New Orleans Lakefront Airport, 2019).

4.16.1.2 PUBLIC TRANSIT

The Regional Transit Authority provides public transit within the New Orleans area. There are 34 bus routes, five streetcar lines, and two ferry routes that provide more than 19 million rides per year (New Orleans Regional Transit Authority, 2019). The streetcars have been an integral part of New Orleans public transportation network since 1923. Greyhound runs a bus service for regional transportation service from New Orleans. The New Orleans Greyhound station is located on Loyola Avenue. There are also several taxi cab companies that offer cab service, vehicles for hire, delivery service, and ground transportation.

4.16.1.3 ROADWAY NETWORK

Roads and bridges compose the majority of the transportation network serving the study area. Included with this network are several Louisiana Department of Transportation and Development roadway classifications, including interstates, principal roads, and local roads.

4.16.1.3.1 INTERSTATES

The I-10 corridor serves as an expressway for commuter traffic, as well as a regional interstate roadway serving east-west traffic from Florida to California. There is also a significant amount of commuting outbound from New Orleans to the petrochemical and oil refining industries along I-310 and the Mississippi River, as well as the shipbuilding industry. I-10 also connects New Orleans to Baton Rouge, the state capital. I-610 serves as a bypass from downtown New Orleans. I-510 connects I-10 to US 90 in New Orleans, as well as New Orleans East and Chalmette.

4.16.1.3.2 PRINCIPAL ROADS

There are several principal roads located throughout the study area. Some of these roads include US 61 (Airline Highway), US 90, US 11, LA 23, LA 47, LA 46, Causeway Boulevard, Veterans Boulevard, Metairie Road, Lakeshore Drive, Robert E. Lee Boulevard, Gentilly Boulevard, Lapalco Boulevard, Leon C. Simon Drive, Downman Road, and Hayne Boulevard.

4.16.1.3.3 LOCAL ROADS

Local roads are also used throughout the study area. Some important local roads include LA 39, LA 48, 17th Street, Orleans Avenue, London Avenue, Loyola Drive, Vintage Drive, Franklin Avenue, Marconi Drive, Bullard Avenue, and Read Boulevard.

4.16.1.4 NAVIGATION CHANNELS

The Port of New Orleans, which moves about 500 million tons of cargo each year, is located on the Mississippi River and connects with the IHNC and GIWW. The Port of New Orleans is one of the world's busiest ports, with many intersecting transportation modes (river and ocean vessels, rail, and highway).

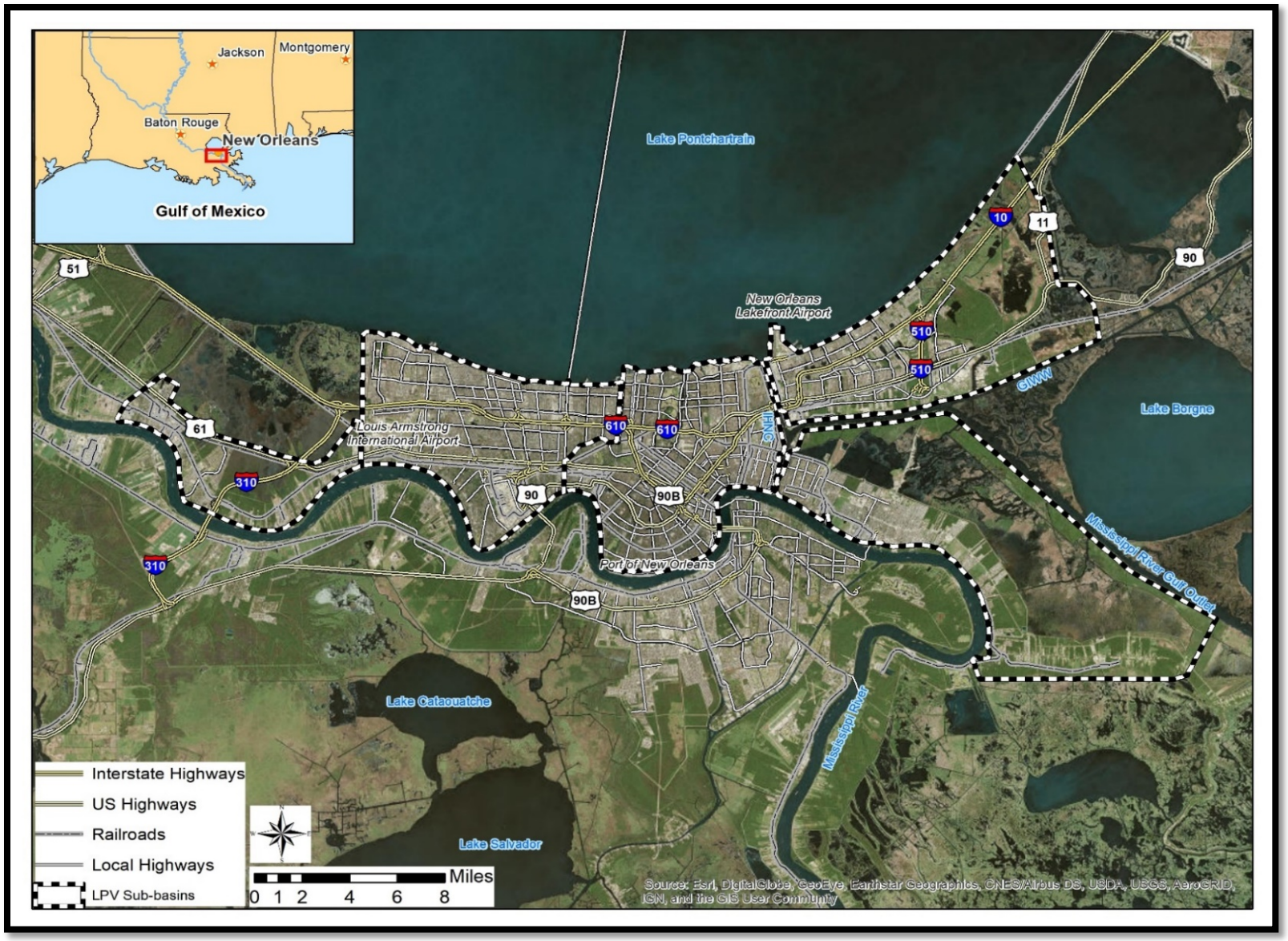

Figure 4-11. Locations of transportation systems in the Study Area

4.16.2 FORECASTING OF FUTURE CONDITIONS

The study team assumes that major transportation corridors within the study area would likely become more vulnerable to storm damage in the future without action due to subsidence and sea level rise as discussed elsewhere. Some transportation routes may also become more vulnerable due to future loss of coastal marshes, which act as natural buffers to tropical storms and hurricanes.

4.17 HUMAN ENVIRONMENT

4.17.1 EXISTING AND FUTURE CONDITIONS

The study area encompasses the entirety of four parishes: Jefferson, Orleans, St. Bernard, and St. Charles. The parish seats are Gretna, New Orleans, Chalmette, and Hahnville, respectively.

4.17.1.1 POPULATION & HOUSING

Table 4-15 and Figure 4-12 show the population trend in the four-parish area from 1970 to 2010 and projections through 2040. State-wide population is predicted to rise over this period.

Table 4-125. Population Trend in the Study Area*, Total Population in Thousands

		Total Population, (Ths.)						
	U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast							
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Jefferson Parish (LA)	338.75	456.62	448.57	454.94	432.75	447.04	466.71	478.88
Orleans Parish (LA)	594.38	558.43	495.74	485.61	347.90	399.23	416.80	427.67
St. Bernard Parish (LA)	51.26	64.51	66.72	67.28	36.81	46.53	48.58	49.84
St. Charles Parish (LA)	29.60	37.52	42.47	48.12	52.84	54.12	56.50	57.97
State of Louisiana	3,650.20	4,226.70	4,221.53	4,471.89	4,545.00	4,732.42	4,816.69	4,868.18

*Population data is presented by parish.

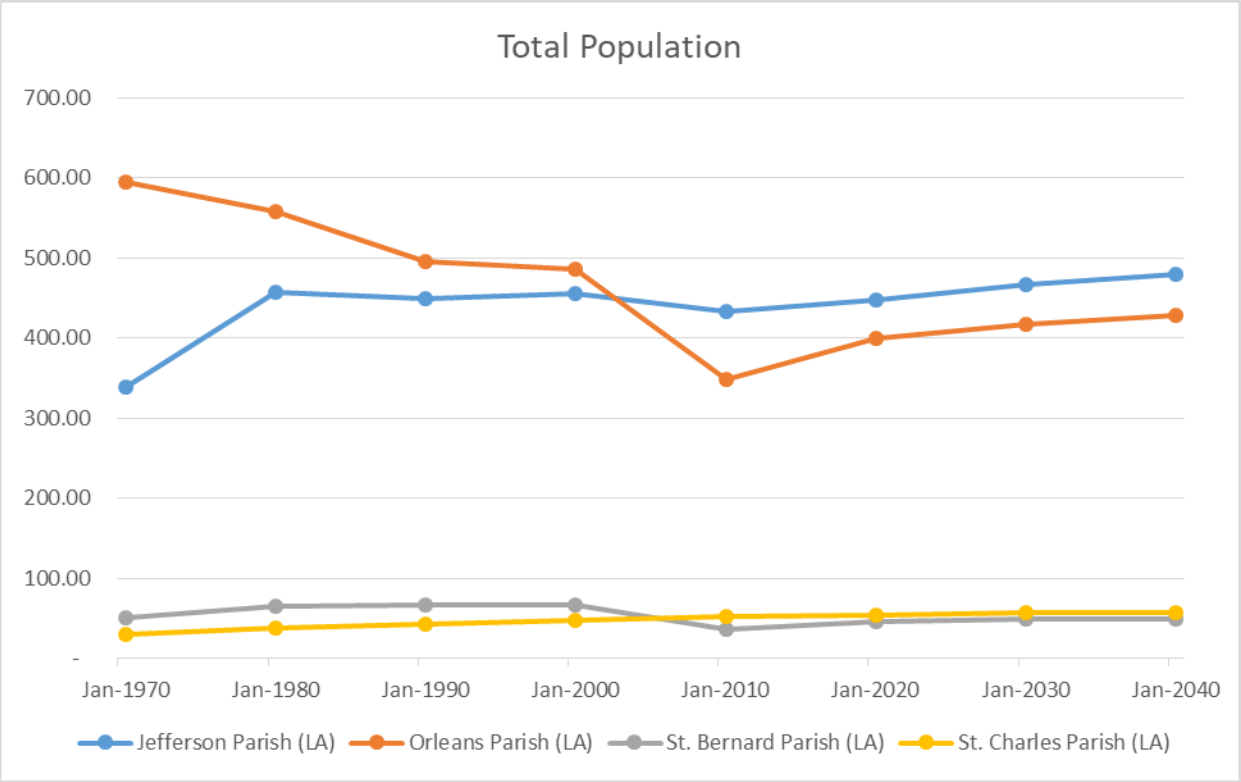

Figure 4-12. Total population trends for Study Area parishes

The trend in household formation, shown in Table 4-16 and Figure 4-13, is predicted to level off by 2020 and show little growth through the year 2040.

Table 4-16. Number of Households in the Study Area*, Total Number in Thousands

			Number of Households: Total, (Ths.)					
			U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast					
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Jefferson Parish (LA)	95.75	156.40	166.50	176.41	169.89	184.40	201.34	213.79
Orleans Parish (LA)	191.46	206.80	187.79	189.02	143.98	173.18	188.68	200.03
St. Bernard Parish (LA)	13.72	20.73	23.19	25.20	13.57	18.08	19.79	21.06
St. Charles Parish (LA)	7.59	11.57	14.35	16.47	18.60	20.12	22.08	23.52
State of Louisiana	1053.61	1418.77	1499.82	1660.62	1734.57	1887.22	2010.60	2104.10

*Household data is presented by parish.

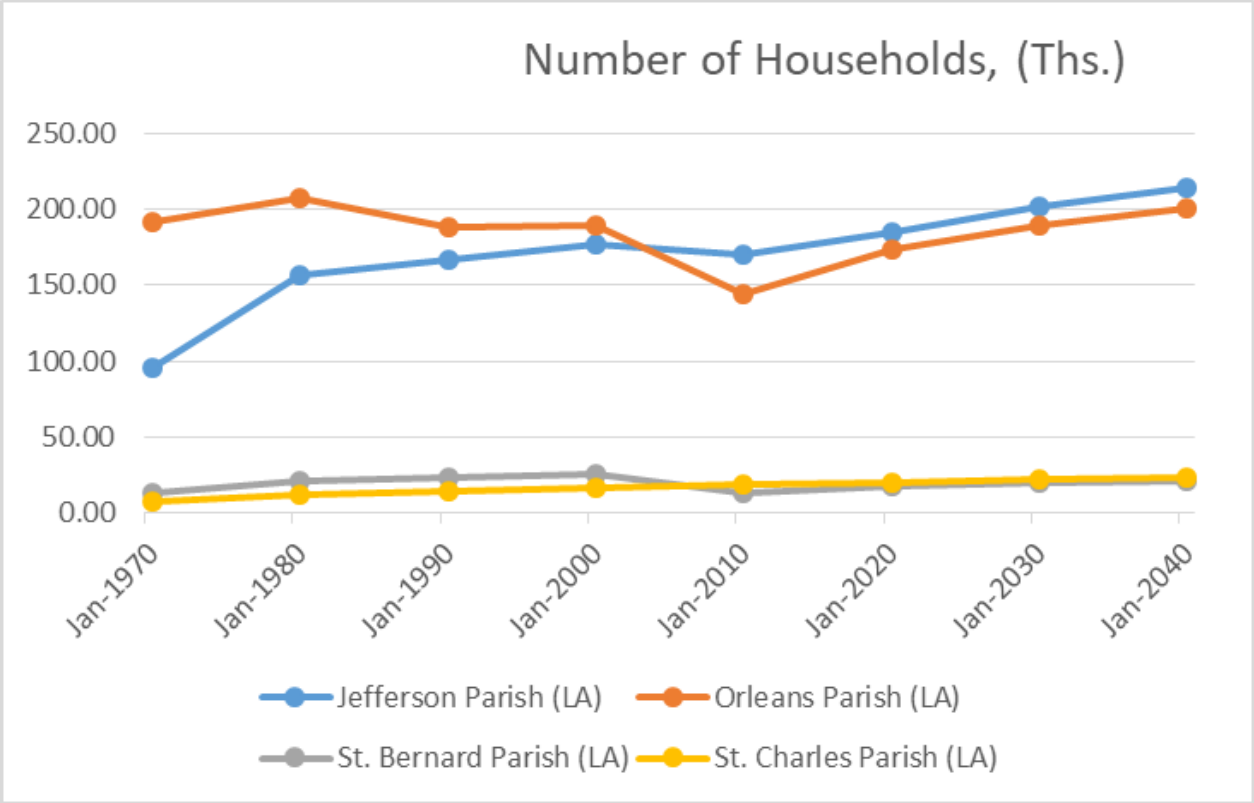

Figure 4-13. Trends in number of households for Study Area parishes

4.17.1.2 EMPLOYMENT, BUSINESS, AND INDUSTRIAL ACTIVITY

Table 4-17 shows the growth of non-farm employment over the last four decades which is predicted to decrease by the year 2040. The leading employment sectors are Trade, Transportation, and Utilities; Government, Local Government, and Office Using Industries. The Unemployment Rate in all three parishes is generally higher than the State of Louisiana Unemployment Rate (see Table 4-18).

Table 4-13. Employment Trends* for the Study Area

		Employment by Industry						
U.S. Bureau of Labor Statistics: Census of Employment & Wages (QCEW - ES202); Moody's Analytics (ECCA) Forecast								
	Dec-1970	**Dec-1980**	**Dec-1990**	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Total Nonfarm Payroll, (Ths.)	338.19	489.48	474.46	529.83	415.28	463.32	494.48	531.48
Natural Resources and Mining, (Ths.)	10.96	15.15	13.38	7.90	5.11	2.57	2.34	2.16
Construction, (Ths.)	20.70	36.06	22.94	24.96	23.66	23.32	22.66	21.26
Manufacturing, (Ths.)	42.04	49.77	38.19	35.55	24.20	18.29	16.21	14.52
Food; Beverage; and Tobacco Manufacturing, (Ths.)	9.95	8.67	5.43	4.35	3.52	4.33	3.86	3.37
Textile; Fiber; and Printing Manufacturing, (Ths.)	3.60	4.05	3.59	2.75	1.25	1.30	1.06	0.89
Chemical; Energy; Plastic; and Rubber Manufacturing, (Ths.)	9.17	10.76	7.77	8.97	7.03	7.52	6.79	6.15
Metals and Mining Based Manufacturing, (Ths.)	5.21	7.07	4.43	3.36	2.27	1.98	1.68	1.51
Machinery Manufacturing, (Ths.)	1.61	1.90	2.02	2.58	1.25	0.86	0.73	0.66
Electronic and Electrical Manufacturing, (Ths.)	0.60	0.76	0.79	0.98	0.89	0.75	0.64	0.55
Transportation Equipment Manufacturing, (Ths.)	10.98	15.56	13.38	11.69	7.42	1.00	0.92	0.91
Furniture and Misc. Manufacturing, (Ths.)	0.92	0.99	0.78	0.87	0.56	0.57	0.52	0.48
Trade; Transportation; and Utilities, (Ths.)	102.89	130.07	117.67	107.77	80.32	92.10	100.69	110.38
Wholesale Trade, (Ths.)	21.24	28.30	25.13	24.82	17.57	18.14	17.76	16.94
Retail Trade, (Ths.)	47.56	60.96	61.53	57.94	42.67	52.13	62.32	74.43
Transportation; Warehousing; and Utilities, (Ths.)	34.09	40.82	31.00	25.01	20.08	21.84	20.61	19.00
Transportation and Warehousing, (Ths.)	31.89	37.66	27.29	22.70	18.31	20.19	19.10	17.64
Utilities, (Ths.)	2.20	3.15	3.71	2.31	1.77	1.65	1.51	1.36
Information, (Ths.)	6.56	9.50	7.94	9.83	6.25	5.87	5.63	5.36
Financial Activities, (Ths.)	21.59	32.00	34.78	30.08	20.70	22.94	22.04	20.95
Professional and Business Services, (Ths.)	23.59	38.24	48.77	67.67	57.29	64.65	67.69	73.46
Education & Health Services, (Ths.)	23.00	42.64	54.37	68.40	61.38	86.26	91.05	95.48
Leisure and Hospitality, (Ths.)	28.17	48.36	51.31	71.16	56.90	74.33	85.93	100.79
Other Services (except Public Administration), (Ths.)	13.60	16.56	17.40	20.17	16.95	19.01	18.24	17.33
Government, (Ths.)	45.10	71.14	67.71	86.34	62.53	53.97	62.01	69.80
Federal Government, (Ths.)	9.96	16.06	14.94	14.90	11.60	11.41	11.57	11.72
Local Government, (Ths.)	22.65	35.04	33.58	49.06	33.00	31.98	38.35	44.61
State Government, (Ths.)	12.49	20.04	19.19	22.38	17.93	10.58	12.09	13.47
Office-using Industries, (Ths.)	55.75	86.29	99.48	111.45	93.16	103.53	103.63	105.42
High Technology Industries, (Ths.)	7.77	12.15	11.13	14.41	7.83	9.14	9.89	10.41

*Employment data is presented by parish.

Table 4-18. Study Area Unemployment Rates*

		Unemployment Rate, (%)				
		BLS; Moody's Analytics (ECCA) Forecast				
	Dec-1990	**Dec-2000**	**Dec-2010**	**Dec-2020**	**Dec-2030**	**Dec-2040**
Jefferson Parish (LA)	5.60	4.60	7.38	6.69	6.82	6.39
Orleans Parish (LA)	7.07	5.45	8.69	7.44	7.58	7.10
St. Bernard Parish (LA)	7.78	5.46	8.34	7.75	7.90	7.40
St. Charles Parish (LA)	6.07	5.58	7.41	6.69	6.83	6.39
State of Louisiana	6.20	5.30	7.97	6.88	7.06	6.71

*Employment data is presented by parish.

4.17.1.3 PUBLIC FACILITIES & SERVICES

Public facilities and services have historically grown to meet population demands. The area includes a mixture of community centers, schools, hospitals, airports, colleges, and fire protection.

4.17.1.4 COMMUNITY & REGIONAL GROWTH (INCOME)

Community and regional growth primarily track population and employment trends that were described in the preceding sections. Table 4-19 shows per capita growth in income since 1970 and predictions through the year 2040.

Table 4-19. Per Capita Income* ($) within the Study Area

	Income: Per Capita, ($)							
U.S. Bureau of Economic Analysis (BEA); U.S. Census Bureau (BOC); Moody's Analytics (ECCA) Forecast								
	1970	**1980**	**1990**	**2000**	**2010**	**2020**	**2030**	**2040**
Jefferson Parish (LA)	$ 3,962	$ 10,427	$ 18,086	$ 28,376	$ 42,033	$ 53,808	$ 75,451	$ 111,512
Orleans Parish (LA)	$ 3,774	$ 9,553	$ 17,500	$ 26,386	$ 41,769	$ 53,296	$ 76,039	$ 112,316
Plaquemines Parish (LA)	$ 3,189	$ 9,659	$ 15,589	$ 21,536	$ 42,074	$ 52,930	$ 74,587	$ 109,724
St. Charles Parish (LA)	$ 3,188	$ 10,462	$ 16,908	$ 24,634	$ 39,557	$ 53,117	$ 77,117	$ 117,900

*Income data is presented by parish.

4.17.1.5 TAX REVENUE & PROPERTY VALUES

Historically, damages from storm surge events have adversely impacted business and industrial activity, agricultural activity, and local employment and income, which then led to commensurate negative impacts to property values and the tax base upon which government revenues rely.

4.17.1.6 COMMUNITY COHESION

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations.

4.17.2 ENVIRONMENTAL JUSTICE

4.17.2.1 EXISTING CONDITIONS

An Environmental Justice (EJ) analysis focuses on the potential for disproportionately high and adverse impacts to minority and low-income populations during the construction and normal operation of the Federal action, in this case, the proposed levee lifts to segments of the HSDRRS. The EJ assessment identifies the minority and low-income communities in the LPV Study area, including eight Census Designated Places (CDP) or cities as shown in Table 4-20. An impacts assessment, provided in Section 7.17.2, identifies EJ communities near project alternative alignments and compares the minority and low-income population to the Parish reference community or metropolitan area and determines if any high, adverse impacts are disproportionate. Additionally, if the impact is appreciably more severe or greater in magnitude

on minority or low-income populations than the adverse effect suffered by the non-minority or non-low-income populations after taking offsetting benefits into account, then there may be a disproportionate finding. Avoidance and mitigation are then required.

Methodology

Environmental Justice is institutionally significant because of Executive Order 12898 of 1994 (E.O. 12898) and the DoD'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, Pacific Islander, some other race, or a combination of two or more races. 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 2017 are those whose income are below $25,094 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 or block group 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 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.

The methodology to accomplish an EJ analysis, consistent with E.O. 12898, includes identifying low-income and minority populations within the study area using up-to-date economic statistics, aerial photographs, U.S. Census Bureau decennial data, and the 2013-2017 American Community Survey (ACS) estimates, as well as conducting community outreach activities such as public meetings. At this time, outreach is not being conducted and may have to be performed during the study. The ACS estimates provide the latest socioeconomic community characteristics, including minority and poverty level data, released by the U.S. Census Bureau and are based on data collected between January 2013 and December 2017.

The U.S. Census Bureau identifies and provides demographic data on eight cities or Census Designated Places in the LPV study Area. The LPV study Area includes the cities of Kenner and New Orleans and six Census Designated Places including River Ridge, Metairie, Chalmette, Meraux, Violet and Poydras. The largest community in terms of population is the City of New Orleans followed by Metairie. Only two of the areas have a majority minority population identifying as Black/African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races and include the City of New Orleans and Violet CDP. Most of the minority population identifies as Black/African American. Hispanic ethnicity is between 5.5 percent and 24.7 percent of total population. Kenner, River Ridge and Metairie are located in Jefferson Parish while Chalmette, Meraux, Violet and Poydras are located in St. Bernard Parish. The City of New Orleans is synonymous with Orleans Parish.

Table 4-20. Total Population and Racial/Ethnic Composition of Communities* in LPV Study Area

Subject	City of Kenner	River Ridge CDP	Metairie	City of New Orleans	Chalmette CDP	Meraux CDP	Violet CDP	Poydras CDP	Jefferson Parish	St. Bernard Parish
Total population	67,253	13,809	144,822	388,182	22,907	7,073	5,705	2,695	437,038	45,067
RACE										
One race	98.5%	98.5%	98.4%	98.2%	96.8%	98.8%	98.8%	97.1%	98.1%	97.5%
White	65.1%	83.9%	81.4%	34.1%	70.3%	80.2%	33.0%	83.0%	63.2%	69.9%
Black or African American	24.2%	12.7%	10.2%	59.8%	19.4%	14.4%	62.3%	14.2%	26.6%	22.6%
American Indian and Alaska Native	0.2%	0.6%	0.3%	0.2%	1.0%	0.8%	0.0%	0.0%	0.4%	0.6%
Asian	3.8%	0.8%	3.8%	3.0%	3.9%	2.1%	0.3%	0.0%	4.3%	2.4%
Native Hawaiian and Other Pacific Islander	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Some other race	5.2%	0.5%	2.7%	1.2%	2.1%	1.4%	3.2%	0.0%	3.6%	1.9%
Two or more races	1.5%	1.5%	1.6%	1.8%	3.2%	1.2%	1.2%	2.9%	1.9%	2.5%
Minority	34.9%	16.1%	18.6%	66.0%	29.7%	19.9%	67.0%	17.1%	36.8%	30.1%
HISPANIC OR LATINO										
Total population	67,253	13,809	144,822	388,182	22,907	7,073	5,705	2,695	437,038	45,067
Hispanic or Latino (of any race)	24.7%	5.9%	15.5%	5.5%	12.1%	7.9%	8.2%	6.8%	14.3%	9.9%

Source: U.S. Census Bureau 2017 ACS.
*Data is presented by parish.

Four of eight of the Census areas in the LPV study area, including the City of New Orleans and the CDPs of Chalmette, Violet and Poydras, have 20 percent or more of individuals living below poverty. Less than 20 percent of the population lives below the poverty level in the Kenner, River Ridge, Metairie and Meraux CDPs (Table 4-21).

Table 4-141. Persons Living Below Poverty Level in Communities* in LPV Study Area

Place	Estimate*	Below Poverty Level	Percent Below Poverty Level
City of Kenner	66,686	10,651	16.00%
River Ridge CDP	13,795	1,130	8.20%
Metairie CDP	144,239	18,036	12.50%
City of New Orleans	375,961	95,346	25.40%
Chalmette CDP	22,556	4,589	20.30%
Meraux CDP	7,066	649	9.20%
Violet CDP	5,705	1,337	23.40%
Poydras CDP	2,695	993	36.80%

*Population for whom poverty status is determined

Source: U.S. Census Bureau 2017 ACS.
*Data is presented by parish.

4.17.2.2 FORECASTING OF FUTURE CONDITIONS

Minority and low-income residents would remain vulnerable to storm events and over time, may consider relocation. However, low-income populations may find it difficult to move to areas with lower flood risk because of the financial strain associated with moving. In those cases, residents would remain and continue to be impacted by storm events.

4.18 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

4.18.1 EXISTING CONDITIONS

USACE regulations (Engineering Regulation (ER) 1165-2-132 and ER 200-2-3) and USACE New Orleans policy require procedures be established to facilitate early identification and appropriate consideration of potential HTRW in feasibility, preconstruction engineering and design, land acquisition, construction, operations and maintenance, repairs, replacement, and rehabilitation phases of water resources studies or projects by conducting HTRW Phase I Environmental Site Assessments (ESAs). USACE specifies that these assessments follow the process/standard practices for conducting Phase I ESAs published by the American Society for Testing and Materials (ASTM). This assessment was prepared using the following ASTM Standards:

- E1527-13: Standard Practice for Environmental Site Assessments – Phase I Environmental Site Assessment process
- E1528-06: Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (interview questionnaires)
- E2247-08 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property

The purpose of a Phase I ESA is to identify, to the extent feasible in the absence of sampling and analysis, the range of contaminants within the scope of the USEPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and petroleum products.

After the devastation of the 2005 hurricane season, the U.S. embarked on one of the largest civil works projects ever undertaken, at an estimated cost of $14.5 billion, with restoration, accelerated construction, improvements, and enhancements of various risk reduction projects and ecosystem restoration projects within southeastern Louisiana. With the completion of the levees, floodwalls, gates, and pumps that together form the LPV and WBV, 1% AEP level of hurricane and storm damage risk reduction was brought to the areas within LPV and WBV. At this time, Phase I ESAs were performed for the selected project features and Recognized Environmental Conditions (RECs) were identified and remediated or avoided prior to construction. Some RECs were identified in the Phase I ESAs within the Rights-of-Way (ROW) for the LPV, on adjacent or adjoining properties and outside, but near, the project areas. All of these RECs were easily remediated or avoided and were unlikely to affect the HSDRRS, personnel working on the project, or the public.

During the feasibility phase, an abridged Phase I ESA was performed to determine the potential for HTRW problems which could impact or be impacted by potential project features. The abridged Phase I ESA included the following tasks: 1) the review of previous HTRW Phase I ESAs to identify previously recorded RECs that may have been found prior to the construction of the HSDRRS features, and 2) a field survey to determine if new RECs are within the HSDRRS levee and floodwall ROW. The results are outlined in Chapter 7, below. A full Phase I ESA will be performed on the TSP during feasibility level design and the results will be included in the final report.

4.18.2 FORECASTING OF FUTURE CONDITIONS

The probability of encountering RECs during future levee and floodwall improvements would remain low. The NFS would be responsible for testing and investigations to determine the existence and extent of any hazardous substances regulated under CERCLA and to develop and implement any response plan required by the regulating agency, at no cost to the Government.

5 FUTURE WITHOUT PROJECT CONDITION

The Future Without Project (FWOP) Condition is developed to describe the most likely future conditions in the project area if no Federal action is taken to address the identified problems. It is also sometimes referred to the Future Without Action Condition (FWAC) when a project already exists and the study is considering making modifications to the project. It forms the baseline for identifying the effects of the alternatives and is equivalent to the No Action alternative. The future is inherently uncertain and conditions change over time. For example, the levee risk may change if there are changes in the climate that affect storm frequency and intensity, storm surge elevations, and wave heights; and the condition of the levee system can degrade over time due to subsidence and settlement, even with adequate maintenance.

In order to identify the FWOP condition to be used for evaluation purposes, the study team began with the existing conditions information and considered where potential changes could occur in the future. Forecasted changes to the affected environment are fully described alongside the corresponding existing conditions in Chapter 4 and are summarized in Section 5.6. This chapter provides a detailed discussion on future conditions related to levee risk.

A forecast period of 50 years was selected as a reasonable time frame for analyzing potential changes in the project area. USACE policy requires a 50-year period of analysis except for major multipurpose reservoir projects (which can be evaluated for up to 100 years) or projects for which the beneficial or adverse effects will occur over less than 50 years. For this project, the effects are expected to extend beyond 50 years but it is not a reservoir project; therefore a 50-year period of analysis was chosen.

This section discusses six areas of potential changes during the forecast period which the team felt could result in a FWOP condition that differs from the existing conditions and, where needed, documents the differences. These six areas are levee system conditions, climate change, hydrology and hydraulics, economics, life safety, and relevant natural resources.

The following basic assumptions were made regarding future conditions related to system performance:

- The sponsor will continue to operate and maintain all levee system components as described in the operation and maintenance manual(s). This includes maintenance of the Section 408 levee lift alterations and the armoring by CPRAB and Southeast Louisiana Flood Protection Authority - East and/or PLD.
- The MR&T levees will continue to be maintained at the authorized levels.
- The levee will continue to settle into the future at rates that depend on the date of construction, until such time as equilibrium is reached. The amount of and timing of settlement is estimated.
- Subsidence will continue into the future at the rates identified in Section 5.2.1.
- Global Mean Sea Level will continue to rise due to climate change. Three relative sea level rise scenarios were calculated by the study team.

5.1 FUTURE LEVEE SYSTEM CONDITIONS

5.1.1 SETTLEMENT

2018 survey data was used to evaluate past settlement. Lift schedules previously developed to 2057 for the segments of each reach were compared and the control segment with the highest rate of settlement was selected. It should be noted that not all lift schedules were previously developed for all levee segments.

The 2018 average survey values of the control segment were then plotted on the lift schedules. Where armoring by articulated concrete blocks was completed, because the survey elevation was at the top of the blocks, the survey was lowered 6 inches to account for the concrete block. The settlement curve was then projected to 2073 following the general curvature of the curve to 2057, or following the trend of settlement from the actual lift to the survey elevation.

The MRL are older levees and so are expected to experience little settlement. Because the MRL levees are older, they are expected to experience little settlement. The study assumes the MRL levees above the existing cross-over points will settle 6 inches between 2023 and 2073, although if the levee settles below the MR&T authorized grade, then it is assumed to be lifted to the MR&T authorized grade under that program. In other words, the analysis assumes the MR&T levees remain at the authorized grade throughout the period of analysis.

Levee settlement values vary by location. Settlements ranged from 0.5 to 3.0 feet in LPV. Figure 5-1 shows projected levee settlement values by 2073. Levees are plotted as a green line. Floodwalls are grey lines. No settlement was assumed at floodwalls.

Figure 5-1 Projected Levee Settlement Values by 2073

5.1.2 SUBSIDENCE

Future subsidence was estimated as part of the relative sea level rise (RSLR) calculations. This is discussed in Section 5.2.1 as part of relative sea level change.

5.2 CLIMATE

USACE has an overarching climate preparedness and resilience policy and specific policies and guidance related to assessment of potential climate change impacts to inland hydrology and sea level change. This overarching policy requires consideration of climate change in all current and future studies to reduce vulnerabilities and enhance the resilience of communities. In support of its policies and guidance, USACE relies on climate change science performed and published by agencies and entities external to USACE. The conduct of science as to the causes, predicted scenarios, and consequences of climate change is not within the USACE mission as a water resources management agency.

ER 1100-2-8162 (Incorporating Sea Level Change in Civil Works Programs) applies to sea level change and calls for potential relative sea level change to be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. This ER requires a quantitative estimate of three sea level change scenarios (low, intermediate, and high) and also requires these scenarios to be utilized during the alternatives' formulation, evaluation, and comparison.

Engineer and Construction Bulletin (ECB) 2018-14 (Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects) applies to inland hydrology. Due to observations of more extreme seasonal conditions of rainfall and runoff (flooding or drought) and altered snow volume and melt in some regions, assumptions of past trends continuing into the future are no longer appropriate in some locations. This ECB helps support a qualitative assessment of potential climate change threats and impacts that may be relevant to the particular USACE hydrologic analysis being performed.

5.2.1 RELATIVE SEA LEVEL CHANGE

RSLC is the local change in sea level relative to the elevation of the land at a specific point on the coast. RSLC is a combination of both global and local sea level change, as well as local and/or regional vertical land motion (subsidence or uplift).

Three RSLC values were calculated: low, intermediate, and high. Per ER 1100-2-8162, the low sea level rise scenario is the historic rate of sea-level change into the future plus local subsidence. The intermediate sea level rise scenario uses the modified NRC Curve I plus local subsidence, and the high sea level rise scenario incorporates the modified NRC Curve III plus local subsidence. This high scenario exceeds the upper bounds of Intergovernmental Panel on Climate Change estimates from both 2001 and 2007 to accommodate potential rapid loss of ice from Antarctica and Greenland. Local subsidence rates at 7 gages were computed into the USACE climate change website to determine the RSLC scenarios. Figure 5-2 displays the location of the 7 gages relative to HSDRRS. Table 5-1 contains subsidence rates and the corresponding RSLC projections at the 7 gages.

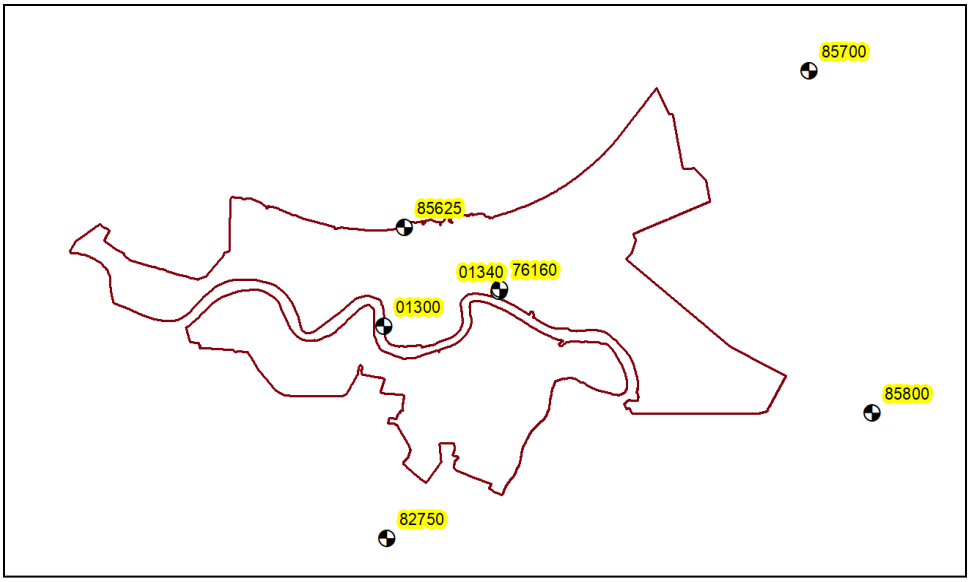

Figure 5-2 Location of Water Level Gages Used for RSLC Projections

Table 5-1 RSLC Projections

Location	Projected Subsidence (ft.) 2023-2073	Projected SLC 2023 to 2073			Projected RSLC 2023 to 2073		
		Low (ft.)	Int (ft.)	High (ft.)	Low (ft.)	Int (ft.)	High (ft.)
Lake Pontchartrain West End (85625)	1.2	0.2	0.7	2.3	1.4	1.9	3.5
Rigolets (85700)	0.5	0.2	0.7	2.4	0.7	1.2	2.9
IHNC (76160)	1.4	0.3	0.8	2.4	1.7	2.2	3.8
Bayou Barataria (82750)	0.9	0.3	0.7	2.3	1.2	1.6	3.2
IHNC Lock (01340)	0.8	0.3	0.8	2.4	1.1	1.6	3.2
MS River at Carrolton (01300)	0.9	0.3	0.8	2.3	1.2	1.7	3.2
MRGO Shell Beach (85800)	1.4	0.3	0.8	2.3	1.7	2.2	3.7
Average:	**1.0**	**0.3**	**0.8**	**2.3**	**1.3**	**1.8**	**3.4**

As seen in Table 5-1, this study will use the average relative sea level change of low (1.3ft), intermediate (1.8 ft.), and high (3.4 ft.) scenarios. Additionally Table 5-1shows the three RSLC scenarios are all projecting relative sea level rise. For the remainder of this report and to be clear about the direction of change, the RSLC scenarios will all use the term relative sea level rise (RSLR). For the FWOP condition and alternatives development, the intermediate RSLR scenario was selected. An intermediate RSLR scenario accounts for future acceleration of global mean sea level rise without the significant ice melt projected in the high RSLR scenario. This is consistent with other USACE studies that have been performed in this area.

5.2.2 INLAND HYDROLOGY

One key assumption in the inundation modeling is a 400,000 cubic feet per second (cfs) Mississippi River discharge during hurricane season, which is an assumption carried forward from the previous ADCIRC modeling. Observed hurricane-season daily flow records were checked for the entire period of record and the data shows how discharge in the river is, on average, lower than 400,000 cfs during the peak of hurricane season (August/Sept), but there are exceptions. The original HSDRRS analysis processed river discharges from 1976 to 2002. When the latest data through 2019 is added and statistics processed, there appears to be a small increase in the expected discharge during hurricane season. For example, the 50% or mean discharge during July was approximately 410,000 cfs with the data from 1976 to 2002. When the data is updated, the mean discharge during July becomes 450,000 cfs. Updating the assumed design discharge from 400,000 to 450,000 might change design water levels by 0.5 ft. to 1.0 ft. based on crude approximations. See Appendix C for additional information about river discharges.

Another assumption that can change stage-frequency information in the river is observed hurricane frequency by month. In the older HSDRRS analysis, a sample of 14 observed storms provided the hurricane probability by month. Since 2005, more storms have impacted New Orleans including Gustav, Ike, Isaac, Karen and Barry. These added storms may change some of the assumptions about hurricane frequency and ultimately impact the stage-frequency calculations in the river.

The latest hurricane frequency and river discharge data suggests that the assumptions made concerning hurricane frequency and discharge frequency are still valid for a feasibility level study. However, they have changed enough to warrant a revisit during later design assessments.

5.3 FUTURE HYDROLOGY AND HYDRAULICS

The overtopping calculations, River Analysis System (RAS) simulation and Joint Probability-Optimal Sampling (JPM-OS) statistics were repeated for the 2073 future no-action condition. ADCIRC simulations of the future condition for various RSLC conditions were used to develop future condition surge and wave time-series. A regression analysis was performed at 10 locations around LPV and WBV to determine impacts to surge levels resulting from RSLC. ADCIRC simulations were used in the assessment of future conditions. The peak surge of the base condition was plotted against the peak surge of the future RSLC condition. A regression analysis was performed at a location near the IHNC surge barrier for each RSLC scenario. The results of the regression provide future condition peak water levels for all 152 storms at all 415 design segments. The hydrographs from the existing condition are then normalized to the future condition peak levels. Future condition waves are also modified to account for increased depths.

Future condition overtopping calculations also factor in levee settlement over the 50 year period of evaluation. Levee settlement data was provided by the USACE New Orleans District Geotechnical Branch. Levee settlement and RSLC result in larger overtopping volumes and more inundation in the HEC-RAS simulations. Figure 5-3 displays the resulting 1% AEP flood depths for the future no-action scenario assuming intermediate 1.8 ft. RSLC. Figure 5-4 displays

the resulting 500YR flood depths for the future no-action scenario assuming intermediate 1.8 ft. RSLC. All statistical water surfaces and depths were utilized in the economic damages evaluations.

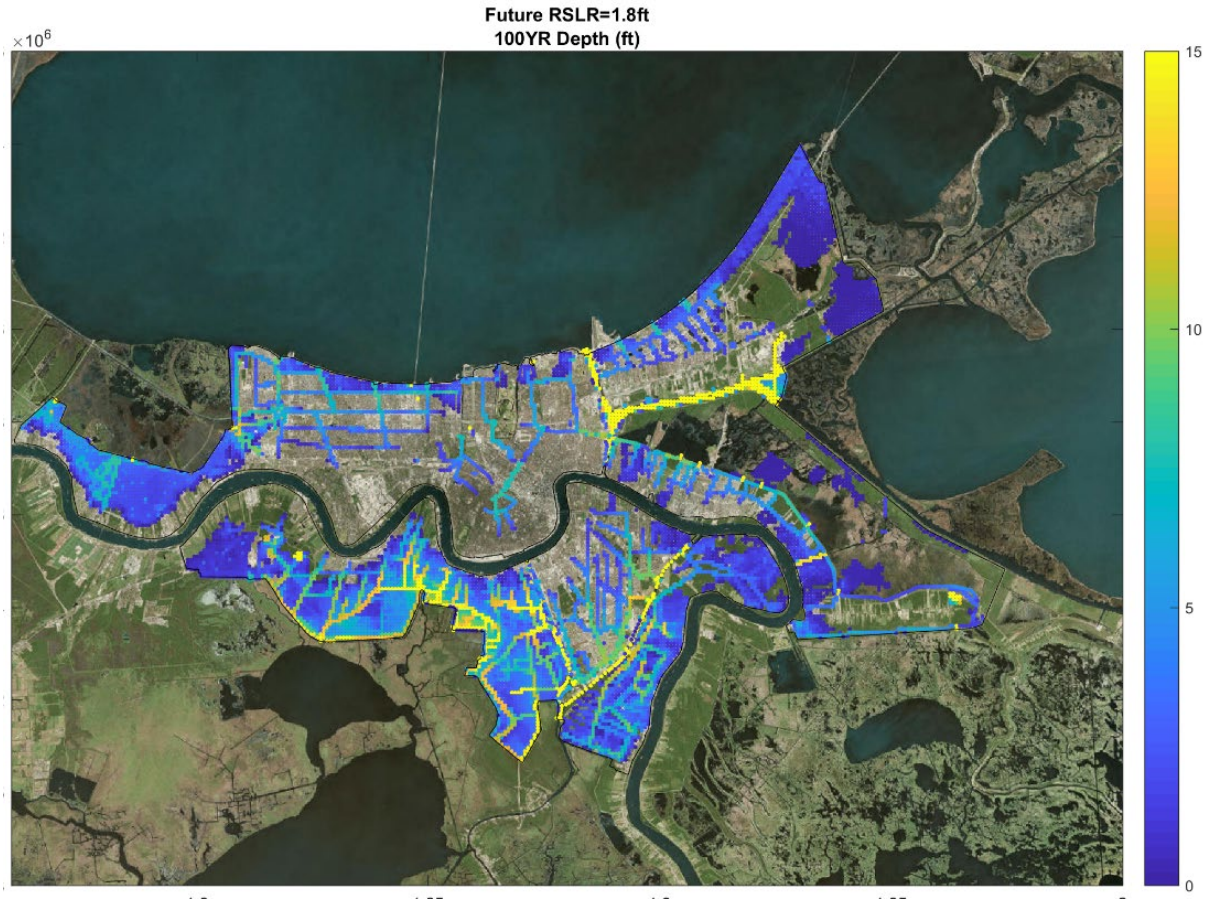

Figure 5-3. 1% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions

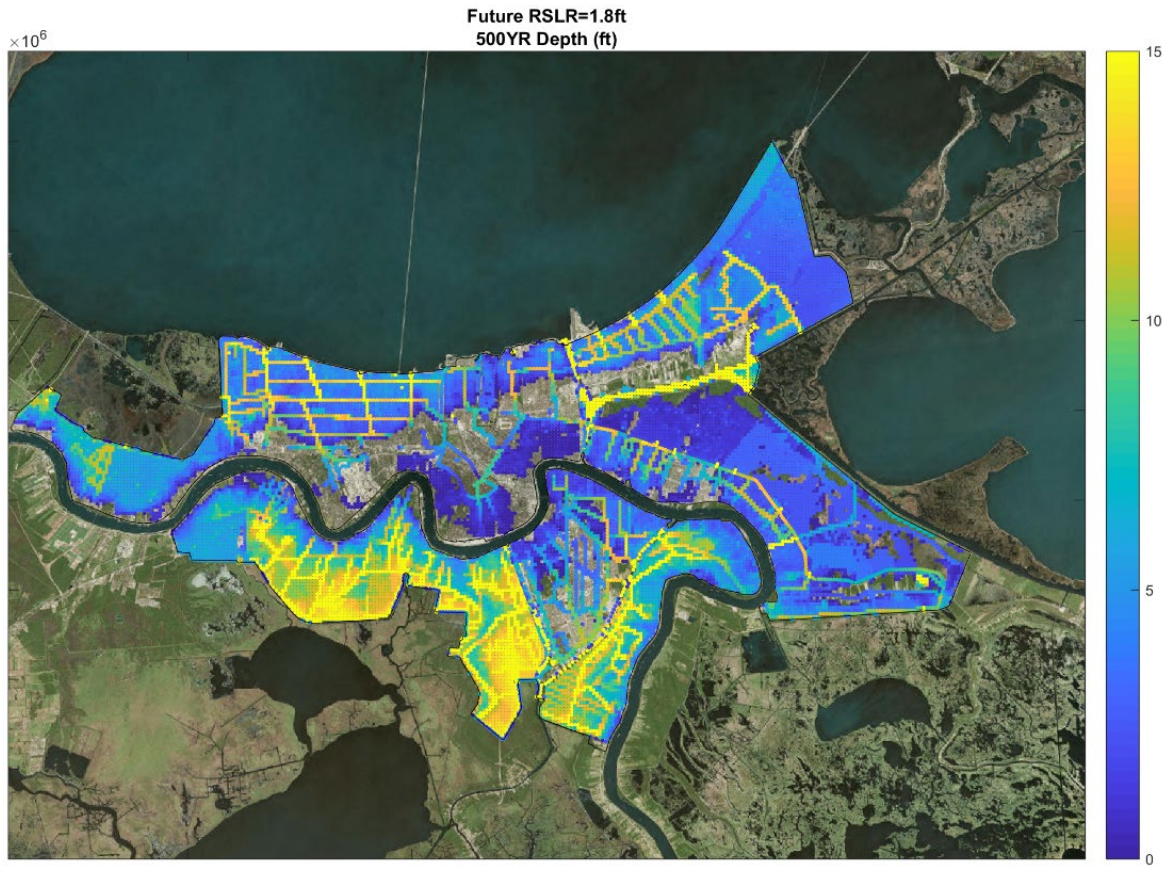

Figure 5-4. 0.2% AEP Peak Depths for Future 2073 Intermediate RSLC Conditions

Modeled future storm surge elevations for a range of events were plotted against the levee and floodwall elevation data to determine potential locations for surge overtopping. Additionally, in areas where surge or waves were estimated to overtop the levees or floodwalls, overtopping rates were calculated.

These plots demonstrate that in a future 2073 without project scenario where an intermediate RSLR is experienced, there are many reaches where surge elevations for the 0.2% AEP event overtops levees and the 1% AEP event overtops floodwalls. Additionally, the overtopping rates (including waves and surge) are above design requirements in most reaches for the 0.2% AEP event.

5.4 FUTURE ECONOMIC DAMAGES

The projected hydrologic conditions were entered into the HEC-FDA program to estimate potential future economic damages if no action is taken to address the combined effects of settlement, subsidence and sea level rise (intermediate scenario) on the LPV system. No other parameters were changed from the existing conditions modeling. Aside from the new airport terminal in Kenner, no new major construction is expected to occur in the near future. The current trend of repurposing existing retail and office buildings into residential units is expected to continue. Neither of these assumptions were included in the structure inventory at this time.

The future conditions damages by probability event are displayed in Table 5-2 and the expected annual damages and equivalent annual damages are displayed in Table 5-3 (by sub-basin).

Table 5-2. Future Conditions Damages by Probability Event

Lake Pontchartrain and Vicinity Damages by Probability Event 2073 $1000s	
100%	$0
10%	$0
5%	$0
2%	$0
1%	$1,335,000
0.5%	$35,886,000
0.2%	$81,902,000
0.1%	$99,531,000

Table 5-3. Future Conditions Economic Damages

Lake Pontchartrain and Vicinity Expected Annual and Equivalent Annual Damages $1,000s		
Sub-basin	**Expected Annual Damages 2073**	**Equivalent Annual Damages 2023-2073**
Chalmette Loop	$12,684	$8,665
Jefferson East Bank	$243,978	$134,333
Orleans East Bank	$38,964	$20,126
New Orleans East	$137,109	$58,046
St. Charles	$19,910	$11,812
Total	**$452,646**	**$232,982**

5.5 FUTURE CONDITIONS RISK

For future conditions risk estimates, the risk team utilized the updated hydrology and hydraulics information to evaluate the future breach and non-breach risks. The life safety risk assessment did not include any increase or decrease in risk to the population. As can be seen in Table 4-15 in Section 4.17.1.1, the population projections over the next 20 years show less than a 3% increase (the year 2040 is the last year for which we have projections). This small change would not materially affect the conclusions of the risk assessment and, therefore, the assessment utilized existing population and structure data.

5.5.1 LEVEE RISK

The FWOP condition assumes both settlement of the levees and 1.8 feet of relative sea level rise. Settlements ranged from 0.2 to 3.3 feet in LPV. MRL levees were assumed to be maintained at authorized heights through the MR&T program.

5.5.2 CONSEQUENCES

Life loss consequences for the future condition were estimated using the LifeSim model at the 1% AEP and the 0.2% AEP events, respectively. No changes to the variable inputs for the LifeSim model were made for the future condition. For LPV, the incremental life loss estimates ranged from low to extremely high.

Critical infrastructure is included in the structure inventory and economic damages to those structure are accounted for in the total economic damage estimates provided in Section 5.4. However, when these particular structures are inundated to the point where they are no longer able to provide services to the community, there is also a potential for life safety risk. Critical infrastructure data was obtained from the Homeland Security Infrastructure Program (HSIP) Gold 2015 database, which is a data inventory assembled by the National Geospatial-Intelligence Agency in partnership with the Department of Homeland Security. Table 5-4 summarizes the number of critical infrastructure structures, by category, which are inundated in the FWOP scenario.

Table 5-4. Critical Infrastructure Inundated in the FWOP Scenario

Intermediate SLR Without-Project LPV - Critical Infrastructure	
Category	**Number**
Agriculture	0
Chemicals	51
Communications	7
Education	60
Emergency Services	15
Energy	65
Law Enforcement	2
Manufacturing	35
National Symbols	0
Public Venues	89
Transportation-Air	2
Transportation-Ground	498
Transportation-Water	48
Water Supply	1
Total	**873**

5.5.3 FUTURE RISK CHARACTERIZATION

The estimated total annual probability of failure (APF) for LPV future condition is between 1E-04 and 1E-03 failures per year and the best estimate of the average annual incremental life loss is

3E-02 lives per year. Risks in the future condition are above tolerable risks and are driven by overtopping of the levees and tie-ins in St. Charles.

5.6 RELEVANT RESOURCES

The future without project condition of relevant resources is described in Chapter 4, *Affected Environment*.

6 PLAN FORMULATION

The guidance for conducting civil works planning studies, ER 1105-2-100, Planning Guidance Notebook, requires the systematic formulation of alternative plans that contribute to the Federal objective. This chapter presents the results of the plan formulation process. Alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability).

Reducing flood risk in conjunction with a levee system can be accomplished, in general, by four strategies:

1. reducing the flood hazard or load on the levee system (magnitude and likelihood of the hazard);
2. improving the performance or response of the levee system to the load (add to or modify features of the levee system to address failure modes or to promote system resilience and sustainability);
3. reducing the exposure of the people and item(s) (property, infrastructure, etc.) at risk (for example by altering or limiting future land development or relocating current populations away from the leveed area); and
4. reducing the vulnerability of the people and items at risk to harm (for example through actions such as strengthening emergency action and evacuation plans, improved warning systems, road improvements, enhanced building codes, and fostering effective response to such warnings by households and businesses, including vertical evacuation as appropriate).

When examining the four methods above, the study team concluded that while there may be no way to modify the source of the hazard (hurricanes), there may be ways to reduce the load on the system (#1) by considering actions to reduce surge elevations and wave heights. This could possibly be accomplished via structural measures (Section 6.2.1) or nature-based measures (Section 6.2.3)

Improving the performance or response of the levee system (#2) could be addressed via structural measures, which are discussed in Section 6.2.1.

While large-scale plans to limit development or relocate the population within the levee system would not likely be supported by the local population and governments, measures to reduce exposure (#3) are included in the plan formulation and are discussed in Section 6.2.2.

Finally, an assessment of existing emergency action and evacuation plans (#4) concluded that the existing plans are already at a very high level of effectiveness and the future condition is not expected to be significantly different even when using the “Best” present curves available in the LifeSim model. However, some minor improvements to risk communication may be possible. Measures to address this strategy were developed as non-structural measures, and are discussed in Section 6.2.2.

6.1 ASSUMPTIONS

In the formulation of measures and alternatives, the study team utilized the following overarching scope assumptions:

1. The period of analysis is 50 years from 2023. All future without project and future with project analyses will estimate conditions in 2073.
2. A full range of flood frequencies will be considered at 2073.
3. Semi-quantitative risk assessments will evaluate existing conditions (baseline), future without project/action, and future with project/action for each alternative in the final array.

6.2 MEASURE DEVELOPMENT

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. The study team developed and screened the following measures utilizing information on existing infrastructure, existing reports, and subject matter expertise. Coastal risk reduction can be achieved through a variety of approaches, including natural or nature-based features, structural features, and nonstructural interventions. The two dimensional representation (Figure 6-1) shows the variety of measures considered. Numerous risk reduction measures can be combined to form alternative plans. Risk reduction in any given coastal area is achieved through a combination of approaches described in more detail below. Application of the full array of features in any coastal system must consider interactions among the features (e.g., the effects of seawalls on down-drift beaches) and the multiple objectives being sought for the system (e.g., erosion control, navigation, risk reduction).

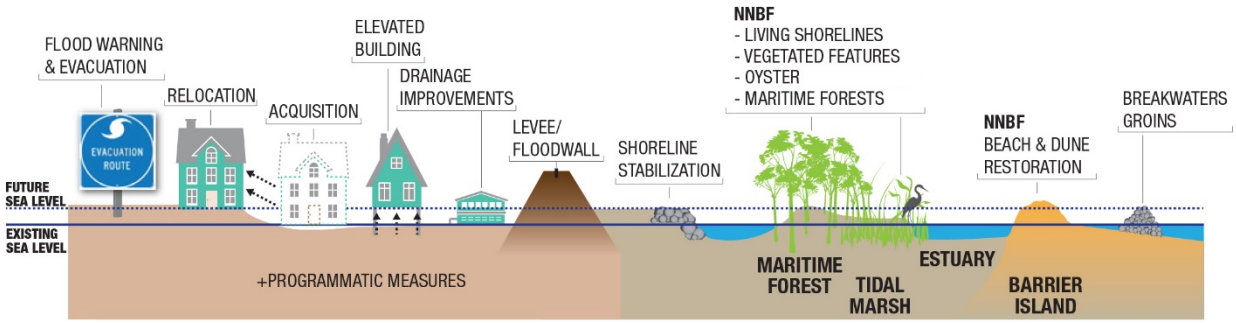

Figure 6-1 Two dimensional representation of measures considered

6.2.1 STRUCTURAL MEASURES

Structural measures can be designed to decrease shoreline erosion or reduce coastal risks associated with wave damage and flooding. Traditional structures include levees, floodwalls, storm surge barrier gates, seawalls, revetments, groins, and nearshore breakwaters. Structural measures were identified from the CPRA master plan, in addition to professional expertise.

LEVEE LIFT – Levees are typically onshore structures with the principal function of protecting low-lying areas against hurricane and tropical storm surge. Side slopes used by USACE for levee design vary by project. Front slopes range between 3H: 1V and 6H: 1V while back slopes

range between 3H: 1V and 4H: 1V. A top width of 10 feet was used for all levees as is typical of USACE earthen levee projects to provide reasonable access after levee construction.

For levees over soft foundations, engineers typically recommend construction in several lifts. This allows the foundation soils to consolidate and gain in shear strength. When future lifts are constructed to higher elevations, the footprint of the levee system does not need to increase. Levee lifts are typically constructed with a foot or more of added height in anticipation of long-term settlement. This added height assures that the levee crown elevation will be at or above the design elevation.

This measure is intended to include any secondary levee features that are related to the robustness of the levees, such as landside armoring and foreshore protection that is already being utilized. Foreshore protection typically consists of placement of rock or a rock dike on or immediately in front of a levee wave berm or shoreline, it is intended to prevent erosion of earthen material during daily wave action.

BARRIER ISLAND/SURGE BARRIER – In most cases a surge barrier consists of a series of movable gates that normally stay open under normal conditions to let the flow pass but are closed when storm surges are expected to exceed a certain level. Storm surge barriers are often chosen as a preferred alternative to close off estuaries and reduce the required length of storm risk reduction measures behind the barriers. Storm surge barriers are often required within a levee system to prevent surge from propagating up navigable waterways and distributaries. Storm surge barriers are typically opened during normal conditions to allow for navigation and saltwater exchange with the estuarine areas landward of the barrier. Examples of moveable storm surge barriers include floating sector gates, sluice gates, barge gates, lift gates, stop log gates, and tainter gates.

A barrier island is a permanent offshore structure that is intended to dissipate storm surge before it approaches the shoreline. Island barriers reduce risk to estuaries against storm surge flooding and waves.

NEW OR MODIFIED FLOODWALLS – Floodwalls are onshore structures built parallel to the shoreline with the principal function of reducing flood risk due to storm surge and its overtopping, as well as consequent flooding of land and infrastructure behind them. Floodwalls are a structural protection measure to reduce flood risk by acting as physical barriers against storm surge. Floodwalls can be permanent or temporary. However, because this is an existing system, there is little to no opportunity to consider implementation of temporary floodwalls and therefore all reference to floodwalls in this document refer to permanent floodwalls.

BREAKWATERS – Detached breakwaters are nearshore structures built parallel to the shore just seaward of the shoreline in shallow water depths, with the principal function of reducing beach erosion by reducing wave height and thus longshore and cross-shore sediment transport. They may or may not become inundated during a surge event and if inundated become less effective. They are more typically used for everyday waves. Submerged detached breakwaters are used in some cases because they do not spoil the view, but they represent a serious non-visible hazard to boats and swimmers.

INTERIOR DRAINAGE IMPROVEMENTS – A drainage system can carry water away via conveyance systems and, during times of high water, may store water until it can be carried away. Conveyance systems utilize measures such as pump stations, culverts, drains, and inlets to remove water from a site quickly and send it to larger streams. Storage facilities are used to store excess water until the storm or flood event has ended.

ADD ARMORING ON THE FLOOD SIDE – Adding armoring or revetments to onshore structures has the principal function of protecting the shoreline from erosion. Revetments typically consist of a cladding of stone, concrete, or asphalt to armor sloping natural shoreline profiles. Armoring is designed to add resiliency to the earthen levees. Armoring consists of High Performance Turf Reinforcement Mats and is designed to protect levees from surge and wave-related erosion caused by hurricanes. Floodside armoring is generally more effective against riverine flood events than tropical events and will only be utilized as appropriate

WAVE BERMS – Wave berms are generally earthen extensions on the floodside of a levee that are inundated during surge events and whose purpose is to reduce wave heights. By building up the land they cause these areas to be shallower and waves to become depth limited and break far enough from the levee crown that it reduces run-up and therefore design heights.

6.2.2 NON-STRUCTURAL MEASURES

Nonstructural measures essentially reduce the consequences of flooding, as compared to structural measures, which may also reduce the probability of flooding. They are often referred to as programmatic measures. Nonstructural measures addressed by the USACE National Nonstructural Floodproofing Committee include structure acquisitions or relocations, flood proofing of structures, implementing flood warning systems, flood preparedness planning, establishment of land use regulations, development restrictions within the greatest flood hazard areas, and elevated development.

Nonstructural measures are most often under the jurisdiction of state and local governments (and individuals) to develop, implement, and regulate. They can be encouraged or incentivized but are usually not imposed by the Federal government. As a result, the effective implementation of the full range of flood and coastal flood hazard mitigation actions relies on a collaborative, shared responsibility framework between Federal, state, and local agencies and the public (Comfort et al. 2010).

RISK COMMUNICATION WITH THE PUBLIC/FLOOD WARNING – Flood warning systems and evacuation planning are applicable to vulnerable areas. Despite improved tracking and forecasting techniques, the uncertainty associated with the size of a storm, the path, or its duration necessitate that warnings be issued as early as possible. Evacuation planning is imperative for areas with limited access, such as barrier islands, high density housing areas, elderly population centers, cultural resources, and areas with limited transportation options.

BUYOUTS – Property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures may be effective but if a structure is subject to repeated storm damage, this measure may represent the best alternative to eliminating risks to the property and residents. Acquisition or relocation would not be voluntary.

FLOOD-PROOFING – A non-elevated structure in the flood zone is prone to flooding. Dry floodproofing involves sealing the structure to make it watertight below the level that needs protection to prevent floodwaters from entering. Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete. Generally, dry floodproofing is used when the expected flood depths are low such as a few inches of water. Wet floodproofing is a design method that allows water to move in the enclosed parts of a structure (e.g., crawlspace or unoccupied area) and then out when water recedes.

ELEVATED BUILDINGS – An elevated building is a structure that has no basement and that has its lowest elevated floor raised above flood level by foundation walls, shear walls, posts, piers, pilings, or columns. Elevation of a structure is usually limited to smaller residential and commercial buildings. Whether a structure may be elevated depends on a number of factors including the foundation type, wall type, size of structure, condition, etc.

6.2.3 NATURE BASED / NATURAL MEASURES

The team also considered the full array of natural measures. Specific examples of coastal storm risk management nature based measures include marsh-building river diversions, mechanical beach or dune creation, and resilient living shorelines for stabilization and wave attenuation. These measures address the risk associated with storm surge and flooding such as wave attenuation, wave height, water level, and storm duration. Natural and nature-based features can enhance the resilience of coastal areas challenged by sea level rise (Borsje et al. 2011) and coastal storms (e.g., Gedan et al. 2011, Lopez 2009).

MARSH CREATION (REHABILITATION) – Marsh creation establishes new wetlands in open water areas such as bays, ponds, and canals. This can be achieved through sediment dredging and placement, diversion, or hydrologic restoration. Diversions use channels and/or structures to divert sediment and fresh water from the Mississippi and Atchafalaya Rivers into adjacent basins. Hydrologic Restoration conveys fresh water to areas that have been cut off by man-made features or prevents the intrusion of salt water into fresh areas through man-made channels and eroded wetlands.

Coastal wetlands may contribute to coastal storm surge reduction through wave attenuation and sediment stabilization. The dense vegetation and shallow water in wetlands can slow the advance of storm surge somewhat and slightly reduce the surge landward of the wetland or slow its arrival time (Wamsley et al. 2009 and 2010). Wetlands can also dissipate wave energy, potentially reducing the amount of destructive wave energy propagating on top of the surge, though evidence suggests that slow-moving storms and those with long periods of high winds that produce marsh flooding can reduce this benefit (Resio and Westerlink 2008). The magnitude of these effects depends on the specific characteristics of the wetlands, including the type of vegetation and the wetlands' rigidity, structure, extent, and position relative to the storm track.

BEACH/DUNES/RIDGE RESTORATION – Beaches are natural features that can provide coastal storm risk reduction and resilience. The sloping nearshore bottom causes waves to break, dissipating wave energy over the surf zone. The breaking waves typically form an offshore bar in front of the beach that helps to dissipate the following waves.

Dunes that may back a beach can act as a physical barrier that reduces inundation and wave attack on the coast landward of the dune. Although the dune may erode during a storm, in many cases it provides a sediment source for beach recovery after a storm passes.

Ridge restoration uses dredging, sediment placement, and vegetative plantings to restore natural ridge functions in basins. Ridge restoration projects are intended to reestablish historical ridges through sediment placement and vegetative plantings to provide additional storm surge attenuation and restore forested maritime habitat.

The functions of engineered beaches, dunes, and ridges are similar to natural features. These measures can contribute to coastal storm protection through breaking of offshore waves, attenuation of wave energy, and slow inland water transfer. Engineered beaches, dunes, and ridges are nature-based infrastructure specifically designed and maintained to provide coastal risk reduction services, although these features often require beach nourishment to mitigate ongoing erosion and other natural processes. Introducing additional sand into the system through beach nourishment reinforces the natural protection to the upland afforded by the beach.

LIVING SHORELINE - Living shorelines are essentially tidal wetlands constructed along a shoreline to reduce coastal erosion. Living shorelines can contribute to coastal storm surge reduction through breaking of offshore waves, attenuation of wave energy, and slow inland water transfer. Living shorelines maintain dynamic shoreline processes and provide habitat for organisms such as fish, crabs and turtles. An essential component of a living shoreline is constructing a nearshore rock structure (breakwater/sill) parallel to the shoreline to serve as protection from wave energy that would impact the wetland area and cause erosion and damage to or removal of the tidal plants. Oyster barrier reefs may be a component of a living shoreline, which are bioengineered to improve oyster propagation and serve as breakwaters to attenuate wave energies.

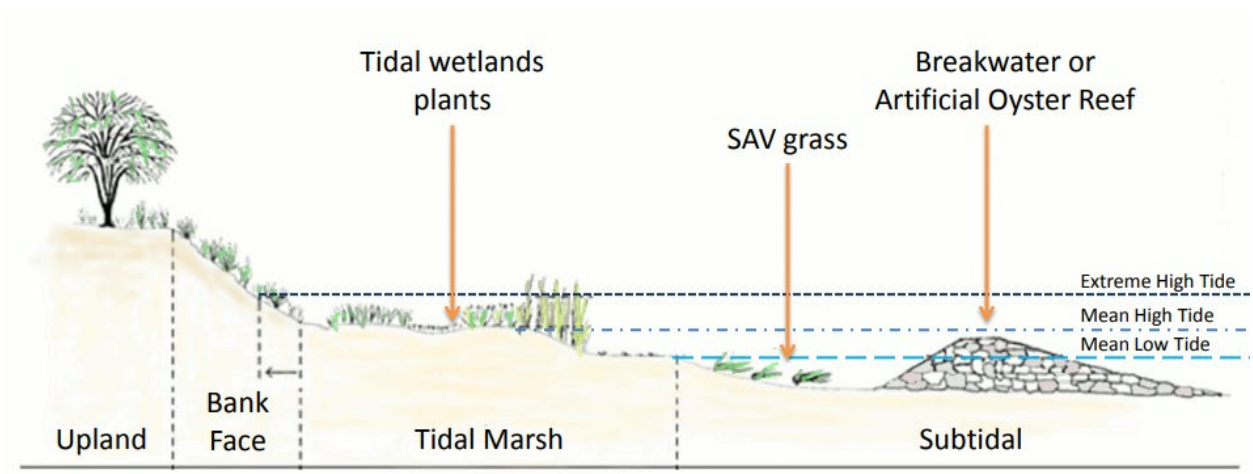

Figure 6-2. Nature-Based Measures (Image adapted from Burke Environmental Associates)

6.3 SCREENING OF MEASURES

Screening is the process of eliminating, based on planning criteria, those measures that will not be carried forward for consideration. Criteria are derived for the specific planning study based on the planning objectives, constraints, and the opportunities and problems of the study/project area.

6.3.1 SCREENING CRITERIA

The study team developed and screened the following measures seen in Table 6-1. Screening criteria included whether the measure meets planning objectives (described in Section 2.5) and avoid constraints (described in Section 2.6) as well as qualitative assessments of effectiveness, efficiency, and acceptability. More detail on rationale for elimination of specific measures is outlined in Section 6.3.2, below.

Table 6-1 Measures and Screening

Measure	Structural, Non-Structural, Nature/Natural	Meets Objective	Retained for further evaluation
Levee Lift	Structural	1, 2	Yes
Surge Barrier	Structural	1,2	No
New or Modified Floodwalls	Structural	1,2	Yes
Breakwaters	Structural	1,2	No
Interior Drainage Improvements	Structural	1,2	Yes
Add Armoring at the Flood Side	Structural	1,2	Yes
Wave Berms	Structural	1,2	Yes
Risk Communication with the public/Flood Warning System	Non-structural	1,2	Yes
Buyouts	Non-structural	1,2	Yes
Floodproofing	Non-structural	1,2	Yes
Elevation	Non-structural	1,2	Yes
Marshes	Nature-based/Natural	1,2	No
Dunes/Beaches	Nature-based/Natural	1,2	No
Living Shore Line	Nature-based/Natural	1,2	Yes

6.3.2 SCREENING RESULTS

The surge barrier measure was screened out primarily because it is cost prohibitive; it can meet objectives but at a higher cost compared to other measures. In addition, this measure was previously planned for implementation as part of the originally 1965 authorized LPV project but was abandoned after concerns were raised regarding significant negative environmental impacts.

Breakwaters were screened out due to information from prior investigations indicating this measure has both high costs and high environmental impacts.

The marsh creation alternative was screened out due to the high cost per acre of this measure for a low effect (minimal benefits for high cost).

Finally, the dunes/beaches measure was screened out because the measure would be located too far from the study area to be effective.

6.4 FORMULATION STRATEGIES

As described above, a management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. The management measures carried forward are all intended to be potentially implemented in combination with one another (i.e., not standalone). It is anticipated that a combination of measures can function as viable components of an integrated system to address flood risk in the study area.

In addition to these considerations about the combinability of measures, the following considerations also guided the development of the initial array of alternatives.

6.4.1 TOLERABLE RISK GUIDELINES (TRG)

USACE Planning Bulletin 2019-04 (Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies) requires that studies identify at least one alternative that addresses TRG 1 and TRG 4, defined below.

Per Planning Bulleting 2019-04 (Incorporating Life Safety into Flood and Coastal Storm Risk Management Studies), study teams will use the USACE TRGs for levee systems throughout the study including problem identification and study objectives, conceiving solutions to the identified problems in order to achieve study objectives, evaluating alternatives, and finally support decisions about risk management activities. The following paragraphs explain each TRG. TRG 1 was the primary focus during formulation of measures and alternatives because it establishes a threshold for life safety risk tolerability. This standard was applied only to the risks associated with overtopping risk.

TRG 1 – The first TRG involves determining that society is willing to live with the risk associated with the levee system to secure the benefits of living and working in the leveed area. USACE will consider the life safety, economic and environmental risk for TRG 1.

Life safety risk is considered in relation to TRGs: societal life risk and individual life risk. The societal life safety tolerable risk line shown in Figure 6-3 reflects that society becomes more averse to risk as the number of life loss increases. Risks that plot above the societal life risk line are considered unacceptable except in extreme circumstances. USACE has chosen to use 1 in 10,000 (i.e. 1.0 E-04) per year for the probability of life loss for an individual or group of individuals most at risk. This tolerable risk guideline is also shown on.

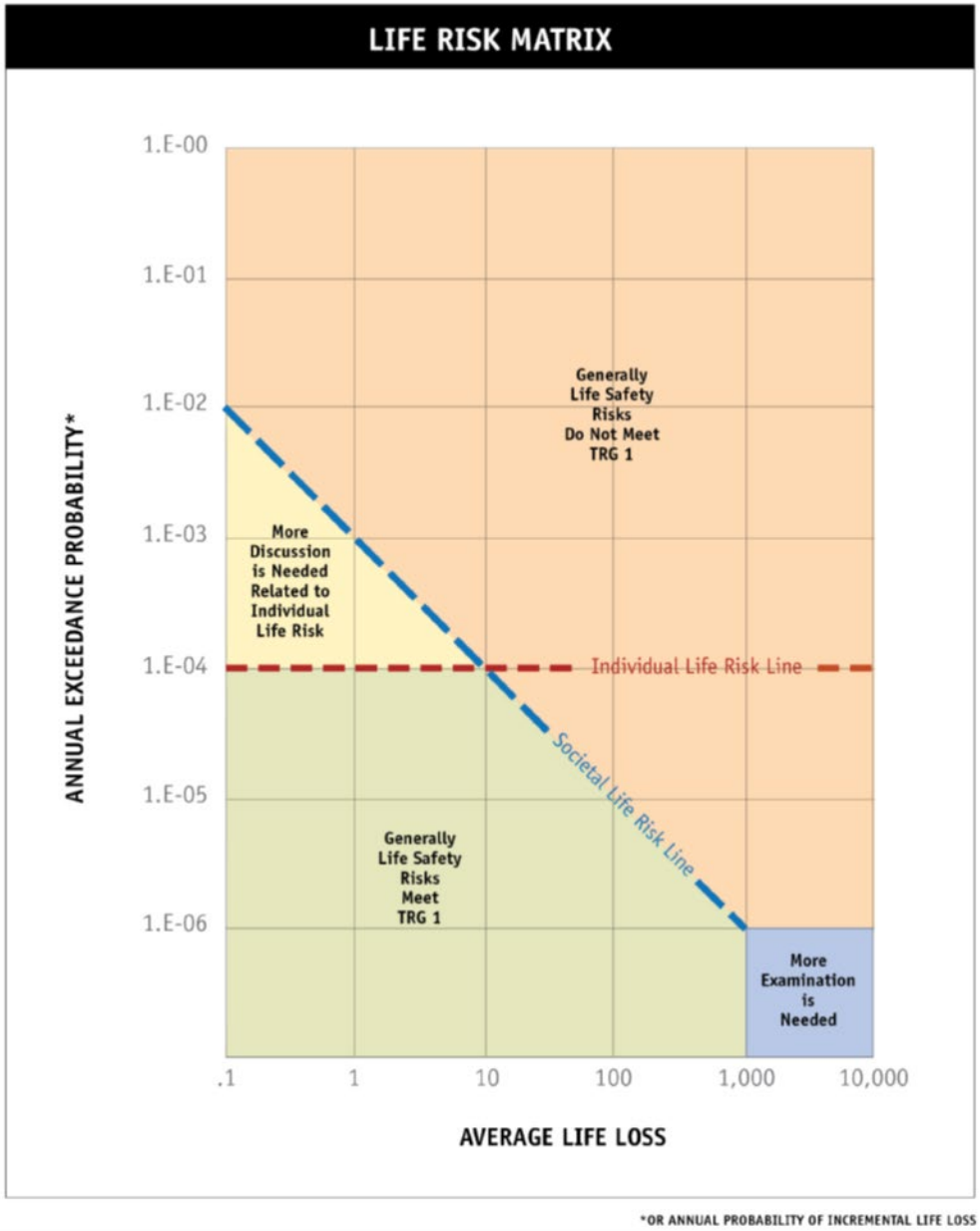

Figure 6-3. Life Risk Matrix

TRG 2 – The second TRG involves determining that there is a continuing recognition of the levee risk because the risk associated with levee systems are not broadly acceptable and cannot be ignored. The rationale for meeting TRG 2 will be determined qualitatively and may consider if the levee sponsor has access to and is aware of the best available levee risk information, if the community in the leveed area been provided the best available risk information associated with the levee system, and if flood risk (residual risk) and potential changes to flood risk over time have been communicated to the community.

TRG 3 – The third TRG involves determining that the risks associated with the levee system are being properly monitored and managed by those responsible for managing the risk. The rationale for meeting TRG 3 will be determined qualitatively and may be met through

demonstrated monitoring and risk management activities. This would include an active operation and maintenance program, visual monitoring (documented regular inspections), updated and tested emergency plans, an instrumentation program, and a best available risk characterization.

TRG 4 – The fourth TRG involves determining that those responsible for managing the risk associated with a levee system continue to reduce the risk still further as practicable. The rationale for meeting TRG 4 will be determined qualitatively and USACE will take into account the level of life safety risk in relation to the societal and individual tolerable risk lines; the disproportion between implementing the risk reduction measures and the subsequent risk reduction achieved; the cost-effectiveness of the risk reduction measures; and societal concerns as revealed by consultation with the community and other stakeholders. The plan formulation and evaluation during the study focuses on achieving risks that society is willing to live with to secure certain benefits (TRG 1). At a minimum, there will be at least one alternative that meets TRG 1 identified during the study. TRGs 2-4 primarily will be met through life-cycle OMRR&R requirements and the required floodplain management plan. Activities of the levee safety program may be identified and used to determine if and how TRGs 2-4 will be met. All requirements must be identified and accounted for in the benefits and costs in order for the alternative plans to be considered effective and complete. Actions necessary to make the project complete, including achieving TRGs 2-4, will be included in the report.

Contributions to meeting TRGs will be identified as being fully, partially, or not met. The TRGs will be considered in the context of the four Principles and Guidelines criteria (completeness, acceptability, efficiency, and effectiveness) and the four evaluation accounts (NED, Regional Economic Development (RED), Other Social Effects (OSE), and Environmental Quality (EQ)), as appropriate.

6.4.2 2057 DESIGN

As previously discussed, the existing project design elevations for floodwalls and hardened structures are intended to provide 1% AEP risk reduction in the year 2057 (the “2057 design”). Alternatives will consider increasing, maintaining, or decreasing these elevations and this level of risk reduction.

Additionally, because the perimeter hard structures were constructed to the estimated 2057 required elevation for 1% AEP risk reduction based on projections for subsidence, sea level rise and other variables at the time of design and construction, they may not achieve the same level of risk reduction in the updated analysis. Cost concerns related to re-building of hard structures may limit the achievable level of risk reduction.

6.5 INITIAL ARRAY OF ALTERNATIVES

This section and Table 6-2 summarize the strategies utilized to identify the initial array of structural and non-structural alternative plans based on initial data collection and professional judgment. At this stage of the planning process, the potential alternatives do not consist of any particular structures, structural modifications, or non-structural alternatives. Particular features are developed later in the planning process.

The initial array of alternatives includes:

- No Action Alternative
- Alternative 1: System Levee Lifts to the Projected 1% AEP Event at 2057
- Alternative 2: System Levee Lifts to the Projected 1% AEP Event at 2073
- Alternative 3: System Levee Lifts at 2073 that Maximize Benefits
- Alternative 4: Selective Levee Lifts
- Alternative 5: Non-Structural
- Alternative 6: Sponsor Plan

The term “levee lifts” in this initial array of alternatives is used to indicate that levee lifts are anticipated to be the primary measure in those alternatives but is not meant to imply the exclusion of other measures.

6.5.1 NO ACTION

The No Action Alternative assumes the FWOP conditions in the absence of any additional Federal action beyond the non-Federal sponsor’s operation and maintenance (O&M) of existing authorized features. Levee lifts are not currently specified as O&M requirements under the Project Partnership Agreements (PPAs) for the LPV and WBV projects. Any specified O&M and any reasonable activities to be pursued by state and local interests in the future are assumed to be undertaken. The No Action Alternative forms the basis against which all other alternatives plans are measured.

6.5.2 ALTERNATIVE 1. SYSTEM LEVEE LIFTS TO THE PROJECTED 1% AEP EVENT AT 2057

The first alternative would incrementally raise the elevation of levees and floodwalls (if needed) over time to maintain 1% AEP event risk reduction at the 2057 time period. LPV authorization is for FEMA levee certification for participation in the NFIP (1% AEP level of risk reduction) under the base flood elevation at the time of construction. The hard structures were designed for the 1% AEP event at the year 2057 and may create a limiting factor on the achievable level of risk reduction.

6.5.3 ALTERNATIVE 2. SYSTEM LEVEE LIFTS TO THE PROJECTED 1% EVENT AT 2073

The second alternative would incrementally raise the elevation of levees and floodwalls (if needed) over time to restore the system’s ability to provide risk reduction from the projected future (2073) 1% AEP coastal storm event, as determined during the design phase prior to the time of initial construction. Existing LPV authorization is to construct the level of risk reduction required for participation in the National Flood Insurance Program at the time of construction, which requires a levee be accredited to the 1% AEP level of risk reduction. However, absent additional construction, that 1% AEP LORR would be lost sometime during the study’s period of analysis due to subsidence and sea level rise. Alternative 2 would extend that 1% AEP level of risk reduction to 2073, which is the end of this GRR study’s 50-year period of analysis.

6.5.4 ALTERNATIVE 3. SYSTEM LEVEE LIFTS AT 2073 THAT MAXIMIZES BENEFITS

The third alternative would seek to identify the maximum benefits achievable in the 50 year period of analysis (which may be more or less than the 1% AEP event). This alternative considers whether higher net benefits could be achieved by either 1) adding measures to Alternative 1 or Alternative 2 that would improve project performance or reduce costs or 2) considering different levels of risk reduction. The actual measures included in this alternative are left undefined until more information about Alternatives 1 and 2 become available.

6.5.5 ALTERNATIVE 4. SELECTIVE LEVEE LIFTS UP TO THE 1% AEP EVENT

The fourth alternative considers the possibility that there may be no need or possibly insufficient benefits to raise the entire system. For this “selective lifts” alternative, consideration would be given to the feasibility of constructing features to maintain a consistent level of risk reduction across the system or reducing risk in areas where life safety risk is highest and/or where economic damages are greatest.

6.5.6 ALTERNATIVE 5. NON-STRUCTURAL

Alternative 5 is a non-structural plan that avoids levee modifications as much as possible. While non-structural measures may be included as part of any of the structural plans, Alternative 5 is the only standalone non-structural alternative formulated for the study.

6.5.7 ALTERNATIVE 6. SPONSOR PLAN

Alternative 6 is a placeholder alternative for any other plan that the sponsor may propose.

6.5.8 SUMMARY: INITIAL ARRAY OF ALTERNATIVES

Table 6-2 provides a high level indication of how the alternatives were initially conceptualized. Once the marsh creation and surge barrier measures were screened out, the levee lifts (and floodwall measures if needed) became the most effective structural measure to address the identified objectives and therefore became integral to all structural alternatives. Other measures were added to each structural alternative to demonstrate how each is conceptually different from the others. Alternative 3 included all of the structural measures at this stage because it was not fully defined until later in the study process. The non-structural alternative consists of purely nonstructural measures. Measures assigned to Alternative 6 are purely speculative in the table and would remain so until the other alternatives could be better defined and the sponsor could potentially identify a different plan.

Table 6-2. Initial Array of Alternatives

Type[1]	Measures	Alternatives					
		1 1% to 2057	2 1% to 2073	3 2073 Max Benefits	4 Selective Raise 1%	5 Non-Structural	6 Tentative Sponsor
S	Levee Lift	X	X	X	X		X
S	New or Modified Floodwalls		X	X	X		
S	Interior Drainage Improvements		X	X	X		
S	Add Floodside Armoring			X			
S	Wave Berms			X			
N	Risk Communication w/ Public					X	X
N	Buyouts					X	X
N	Floodproofing					X	X
N	Elevations					X	X
NB	Living Shore Line			X			

[1]S = structural, NS = nonstructural, NB = nature-based

6.6 SCREENING OF INITIAL ARRAY OF ALTERNATIVES

6.6.1 SCREENING CRITERIA

The initial array of alternatives was qualitatively evaluated and screened based on preliminary H&H, life safety risk, and economic damages information (effectiveness and efficiency). First, existing and FWOP H&H conditions were modeled and preliminary economic damages were assessed using HEC-FDA. In addition, a semi-quantitative risk assessment of existing conditions was completed to identify relevant potential failure modes and evaluate performance of the systems as well as assess potential life loss and economic consequences for different conceptual breach locations across the system.

For all of these analyses, an intermediate RSLR scenario was utilized. The low RSLR scenario was not selected because the low 2073 projection is very similar (within 6 inches) of the intermediate RSLR projection. While the high RSLR scenario was not selected at this stage, it will be used as a comparison tool when the TSP is optimized.

At this stage of the study, economic benefits (estimated damages and associated flood risk management benefits) were the primary factor used to screen smaller-scale alternatives from further consideration. Table 6-3 below presents the results of the screening process.

Table 6-3. Evaluation of Initial Array

#	Alternative Details	Status
No Action	No Action	Final Array
1	System levee lifts to the projected 1% AEP event at 2057	Screened from further analysis: Preliminary analysis shows level of protection is not constrained by floodwall heights.
2	System levee lifts to the projected 1% AEP event at 2073	Final Array
3	System levee lifts at 2073 that maximizes benefits	Final Array
4	Selective levee lifts up to the 1% AEP event	Screened from further analysis: Preliminary benefits show no justification to consider selective areas.
5	Non-Structural	Final Array
6	Sponsor Plan	Screened from further analysis: Sponsor indicated no additional alternative needed.

6.6.2 SCREENING RESULTS

The No Action Alternative was carried forward as the basis against which all other alternatives plans are measured.

Alternative 1 was formulated as a smaller-scale plan that would be constrained by current floodwall heights (i.e., in case the potential economic benefits would not support the cost of modifying the floodwalls). This would maintain the 1% AEP level of risk reduction until sometime in the future when sea level rise would cause the floodwall design to be exceeded. While the exact time that the floodwall design elevations would be exceeded was not estimated, initial modeling indicated it would be within the 50-year period of analysis. Preliminary economic analysis indicates that there are sufficient potential benefits to include floodwall modifications in an alternative. Thus, Alternative 1 was screened out; other alternatives that include floodwall modifications were carried forward.

Similar to Alternative 1, Alternative 4 envisioned a scenario where the cost of raising the whole system to a single uniform level of risk reduction would not be justified and selective levee lifts in targeted areas would need to be pursued. This would create an uneven level of risk reduction around the systems and would constrain the level of risk reduction to something less than 1% AEP in the future as un-raised reaches continued to be impacted by the combined effects of subsidence, settlement, and potential sea level rise. However, based on the magnitude of potential economic benefits across the entire system, alternatives that implement system-wide levee lifts will likely be justified. As such, Alternative 4 was screened out; other alternatives that include system-wide levee lifts were carried forward.

Finally, Alternative 6 was formulated as a placeholder in case the sponsor wished to identify another alternative that was not already being considered as part of the traditional plan formulation process. The sponsor did not identify an additional alternative and Alternative 6 was screened out.

6.7 FINAL ARRAY OF ALTERNATIVES

Features recommended in USACE decision documents are generally presented at a 35% design level, utilizing existing data (such as topography and subsurface conditions) as much as possible. Design is completed during the Preconstruction Engineering and Design (PED) phase, when detailed data is acquired and final design calculations are performed. The non-Federal sponsor and others have completed some Section 408 levee lift alterations independently from the Federal project, which may require the recommended project features to be adjusted in those reaches.

Based on the evaluation of the initial array as described above, the following alternatives were carried forward into the final array for further development and evaluation:

- No Action Alternative
- Alternative 2: System Levee Lifts to the Projected 1% AEP Event at 2073
- Alternative 3: System Levee Lifts at 2073 that Maximizes Benefits
- Alternative 5: Non-Structural

All alternatives were developed and evaluated utilizing the intermediate RSLR projection at 2073.

6.7.1 INITIAL EVALUATION OF FINAL ARRAY OF ALTERNATIVES

6.7.1.1 ALTERNATIVE 2: SYSTEM LEVEE LIFTS TO THE PROJECTED 1% AEP EVENT AT 2073

When 1% AEP design heights were calculated for this alternative, it became apparent that levee lifts alone would not be sufficient and many floodwalls would also have to be modified or replaced to achieve the elevations required by current HSDRRS design criteria. This resulted in much higher than anticipated project costs for both systems, but there continued to be sufficient economic benefits to support those costs. Additionally, by maintaining the current level of risk reduction, this alternative was anticipated to return the future life safety risk to tolerable levels, thus satisfying the policy requirement to have at least one alternative which addresses TRG 1 and TRG 4.

6.7.1.2 ALTERNATIVE 3: SYSTEM LEVEE LIFTS AT 2073 THAT MAXIMIZES BENEFITS

As described above, Alternative 3 was originally formulated to potentially capture greater benefits than Alternative 2 by either 1) identifying measures in addition to levee lifts that could provide additional economic benefits (reduce overall cost and/or improve project performance), or 2) considering other levels of risk reduction. During preliminary analyses it became clear that levee lifts (and, later, floodwall modifications or replacements) would be integral to any structural alternative. The other remaining measures would be insufficiently effective (alone or in combination with each other) if there were no levee or floodwall modifications or replacements. To further assess this alternative, the study team evaluated potential locations for wave berms in the project area. Wave berms would have the effect of causing waves to break far enough from the levee crown that it reduces runup and therefore decreases design heights. However,

there were few technically feasible locations to place wave berms in the project area and thus no significant improvements in overall project performance were determined to be likely.

The team then considered if a higher (greater than 1% AEP) level of risk reduction may yield greater net benefits. To determine this, a 0.5% AEP design was developed and net economic benefits were estimated. While both systems still produced significant positive net benefits, the 0.5% AEP yielded fewer net benefits than the 1% AEP design. Given that net benefits declined between the 1% AEP and 0.5% AEP designs, no additional levels of risk reduction were considered.

6.7.1.3 ALTERNATIVE 5: NON-STRUCTURAL ALTERNATIVE EVALUATION

The study team completed a targeted evaluation of Alternative 5 (Non-Structural). To evaluate the viability of the non-structural alternative, an equivalent annual damage (EAD) value for each structure was compared to an annualized cost for a generic non-structural action. This assessment helped the study team determine the number of structures economically justified for a non-structural action. A non-structural action would be economically justified if the expected storm damages to a structure (Expected Annual Damages – EAD) are greater than the cost of a non-structural improvement to the structure.

First, the EAD was calculated for each structure in the inventory using output files from the HEC-FDA model. Next, the EAD per structure was compared against the average annualized cost of applying a non-structural measure (e.g., house raising and dry floodproofing). Average costs for non-structural measures were identified using the Southwest Coastal study as a proxy reference. In this instance, similar per-structure costs (approximately $150,000) were used as a commensurate estimate for this screening-level assessment.

Using this methodology, approximately 1,600 structures would be economically justified for the non-structural alternative for LPV, meaning the EAD for each of the 1,600 structures was greater than the approximate $150,000 cost to implement a non-structural solution at each structure. This total is 0.7% of the total structure inventory in the study area and 1% of the subset of structures damaged from inundation. Eight smaller economically justified aggregations of structures were identified, roughly corresponding to a city block; no large economically justified aggregations of structures were identified.

Based on this assessment, the non-structural alternative is not considered complete, effective, or efficient. Implementation of a stand-alone non-structural alternative would not provide comprehensive flood risk management solutions in the study area and would result in a large residual flood risk in the system, as less than 1% of structures would receive flood risk reduction benefits from the alternative. A more likely application of non-structural and flood proofing techniques to reduce flood risks could be implemented for individual buildings that still exhibit substantial residual flood damages after the TSP is constructed.

6.7.2 SUMMARY: FINAL ARRAY OF ALTERNATIVES

Based on the evaluations summarized above, Alternatives 2 and 3 were the only action alternatives that were found to be complete, effective, efficient, and acceptable while meeting study objectives.

Figure 6-4 depicts the general footprint for both Alternatives 2 and 3. It should be noted that both alternatives are located in generally the same footprint as the existing LPV project area and existing MRL levees. Project features for both alternatives include levee lifts along the existing levee alignment as well as floodwall modifications and replacements along the existing alignment. Existing landside armoring and foreshore protection along Lake Pontchartrain would be restored following levee and floodwall modifications. The primary difference between Alternatives 2 and 3 is the height of the levees and floodwalls to be lifted and the amount of co-located levee to be added to the project. These alternatives are compared to each other in Chapter 8.

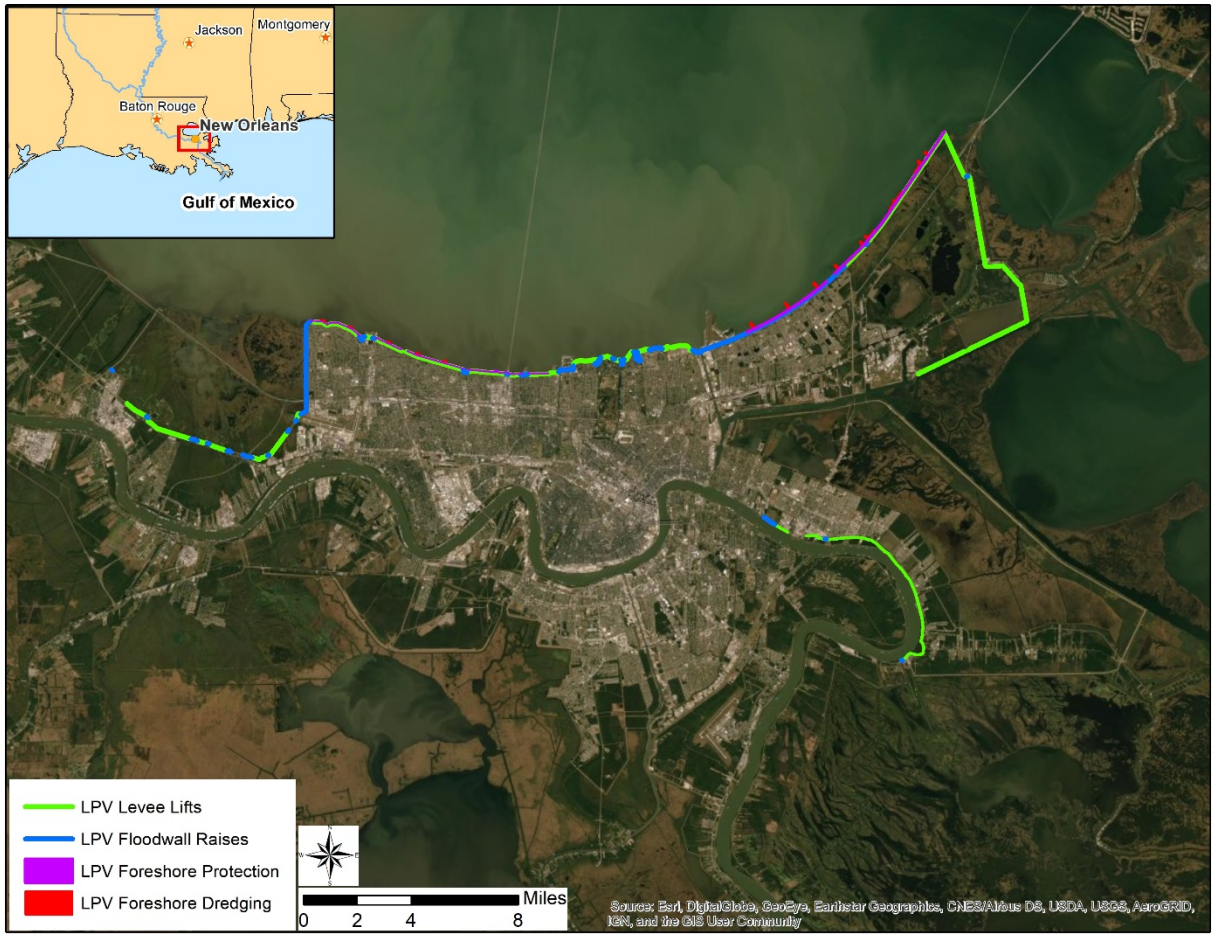

Figure 6-4. LPV Alternative 2 and 3 – General Footprint

7 ENVIRONMENTAL EFFECTS*

7.1 INFORMATIONAL BACKGROUND

In accordance with NEPA, this chapter includes the scientific and analytic basis for comparison of the considered alternatives identified in Chapter 6 – Plan Formulation. This chapter discusses the important environmental resources located in the study area and describes those resources impacted, directly or indirectly, by the proposed actions (Table 7-1). *Direct impacts* are those actions that are a result of the implementation of an action alternative and occur at the same location and time. *Indirect impacts* are those impacts that occur later in time and/or farther removed from the study area but are still reasonably foreseeable. *Cumulative impacts* are defined as the "impact on the environment, which results 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 action" (40 Code of Federal Regulations [CFR]. § 1508.7). Cumulative impacts are discussed in Section 7.1.3 and at the end of each resource section within this chapter of this EIS.

The resources described in this chapter are those recognized as significant by laws, EOs, regulations, and other standards of national, state, or regional agencies and organizations; technical and scientific agencies, groups, or individuals; and the general public. The environmental impacts discussed are summarized and incorporate by reference the previous IERs, CED Phase I (USACE, 2013), and draft Phase II associated with the HSDRRS Emergency Alternative Arrangements[5].

The relevant resources discussed in detail include: soils, water quality resources, wetlands, uplands, fisheries, essential fish habitat, wildlife, threatened and endangered species, noise, transportation, recreation, aesthetics, and the human environment (*i.e.,* socioeconomics). Although invasive species, cultural and historical resources, air quality, EJ, and HTRW have negligible impacts from proposed actions, they are nonetheless discussed in the following sections to demonstrate compliance with applicable laws.

7.1.1 DETERMINATION OF SIGNIFICANCE

Pursuant to NEPA, this chapter addresses the impacts in proportion to their significance (40 CFR § 1502[b]). *Significance* requires consideration of context and intensity[6]. To determine whether an action has the potential to result in significant impacts, the context and intensity of the action must be considered. *Context* refers to impact timing and duration. Context is estimated as either short-term or long-term. *Short-term* effects include those impacts that would occur during implementation of the project, as well as transient ecological effects that can be expected to occur during the first one to three years. *Long-term* effects might be expected to persist for up to ten years and beyond. *Intensity* refers to the area and severity of the impact. For purposes of this analysis, intensity definitions (*i.e.,* negligible, minor, moderate, and major)

[5] These documents are available online at: https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/ Accessed 9 July 2019

[6] Context means the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Intensity refers to the severity of impact (40 CFR § 1508.27).

have been developed to assess the magnitude of effects for all of the affected resource categories resulting from implementing of either Proposed Action Alternative.

From the purpose of this analysis, the intensity of impacts are classified as negligible, minor, moderate, or major and defined as the following:

- ***Negligible*:** A resource was not affected or the effects were not appreciable; changes were not of any measurable or perceptible consequence.
- ***Minor*:** Effects on a resource were detectable, although the effects were localized, small, and of little consequence to the sustainability of the resource and determined to be less than significant.
- ***Moderate*:** Effects on a resource were readily detectable, long-term, localized, and measurable and determined to be significant.
- ***Major*:** Effects on a resource were obvious, long-term, and had substantial consequences on a regional scale and were determined to be significant.

7.1.2 PROPOSED ALTERNATIVES

This chapter compares the effects of use of generalized borrow areas (explained in Section 7.1.4) *and* the following Proposed Alternatives:

- **Alternative 1:** No Action Alternative
- **Alternative 2:** Raising floodwalls and system levee lifts to the projected 1% AEP event at year 2073 with intermediate relative sea level rise (1.8 feet)
- **Alternative 3:** Raising floodwalls and system levee lifts to the projected 0.5% AEP event at year 2073 with intermediate relative sea level rise (1.8 feet)

Table 7-1. Magnitude of Impacts for the Lake Pontchartrain and Vicinity Proposed Alternatives and Generalized Borrow Areas

Resource	Proposed Alternative	Less than Significant		Significant	
		Negligible Impacts	Minor Impacts	Moderate Impacts	Major Impacts
Soils	No Action	☑			
	Alt 2				☑
	Alt 3				☑
	Borrow Areas				☑
Water Quality Resources	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Wetlands & Forest Resources	No Action		☑		
	Alt 2			☑	
	Alt 3			☑	
	Borrow Areas		☑		
Uplands	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas		☑		
Fisheries	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Essential Fish Habitat	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Wildlife	No Action	☑			
	Alt 2			☑	
	Alt 3			☑	
	Borrow Areas		☑		
Threatened & Endangered Species	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Invasive Species	No Action		☑		
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Cultural & Historical Resources	No Action	☑			
	Alt 2	☑			
	Alt 3	☑			
	Borrow Areas	☑			
Aesthetics	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas	☑			
Recreational	No Action	☑			
	Alt 2	☑			
	Alt 3	☑			

Resource	Proposed Alternative	Less than Significant		Significant	
		Negligible Impacts	Minor Impacts	Moderate Impacts	Major Impacts
	Borrow Areas	☑			
Air Quality	No Action	☑			
	Alt 2	☑			
	Alt 3	☑			
	Borrow Areas	☑			
Noise	No Action	☑			
	Alt 2		☑		
	Alt 3		☑		
	Borrow Areas		☑		
Transportation	No Action	☑			
	Alt 2			☑	
	Alt 3			☑	
	Borrow Areas			☑	
Human Environment (including Environmental Justice)	No Action	☑			
	Alt 2	☑			
	Alt 3	☑			
	Borrow Areas	☑			
HTRW	No Action	☑			
	Alt 2	☑			
	Alt 3	☑			
	Borrow Areas	☑			

7.1.3 CUMULATIVE IMPACTS ANALYSIS

NEPA requires a Federal agency to consider not only the direct and indirect impacts of a proposed action but also the cumulative impacts of the action. Cumulative impacts are defined as those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes the actions. Representative past, present, and future regional projects were utilized in the cumulative impacts analysis.

Cumulative impacts result from the proposed action when added to other past, present and reasonably foreseeable projects or actions. Cumulative impacts are not caused by a single project but include the effects of a particular project in conjunction with other projects (past, present and future) on the particular resource. Cumulative effects are studied to enable the public, decision-makers and project proponents to consider the “big picture” effects of a given project on the community and the environment. In a broad sense, all impacts on affected resources are probably cumulative; however, the role of the analyst is to narrow the focus of the cumulative impacts analysis to important issues of national, regional and local significance (CEQ, 1997).

The CEQ issued a manual entitled *Cumulative Effects Under the National Environmental Policy Act* (CEQ, 1997). This manual presents an 11-step procedure for addressing cumulative impact analysis. The cumulative impacts analysis for the LPV GRR followed these 11 steps, shown in Box 7-1. The cumulative impacts analysis concentrated on whether the actions proposed for this study, combined with the impacts of other projects, would result in a significant cumulative

impact and if so whether this study's contribution to this impact would be *cumulatively considerable*.[7]

Future levee lifts conducted by USACE have been discussed in CED Phase I as part of HSDRRS 2057. In summary, the impacts discussion for each resource incorporates by reference the impacts previously described in the CED Phase I Volumes I, II, and III[8].

7.1.3.1 BOUNDING CUMULATIVE IMPACTS ANALYSIS

Cumulative impacts analysis requires expanding the geographic boundaries and extending the time frame to include additional effects on the resources, ecosystems, and human communities of concern.

The cumulative impacts geographic boundary is not restricted to the project impact area. Rather it is based on cumulative cause-and-effect relationships wherein the action's direct and indirect effects on resources no longer measurably contribute to cumulative impacts (Shipley, 2016).

GEOGRAPHIC SCOPE OF THE HUMAN ENVIRONMENT – The geographic scope of the human environment for the LPV study lies within the Greater New Orleans Metropolitan Area and includes portions of St. Charles, Jefferson, Orleans, and St. Bernard parishes. The future borrow sites would be located within 11 parishes in Louisiana; these include, in addition to the aforementioned parishes (excluding St. Bernard), Ascension, East Baton Rouge, Lafourche, St. James, St. John the Baptist, Iberville, and St. Tammany parishes.

GEOGRAPHIC SCOPE OF THE NATURAL ENVIRONMENT – Figure 7-1 displays the ecoregions impacted by the various components of the LPV study and potential future borrow areas. Ecoregions denote ecosystems similar in type, quality, and quantity of environmental resources that are critical for structuring and implementing ecosystem management strategies across Federal and state agencies and nongovernment organizations. Ecoregions stratify the environment recognizing the

Box 7-1. Approach to Cumulative Impacts

Scoping

1. Identify resources
2. Define the study area for each resource
3. Define time frame for analysis

Describing the Affected Environment

4. Identify other actions affecting the resources
5. Characterize resources in terms of its response to change and capacity to withstand stress
6. Characterize stresses in relation to thresholds
7. Define baseline conditions

Determining the Environmental Consequences

8. Identify cause-and-effect relationships
9. Determine magnitude and significance of cumulative effects
10. Assess the need for mitigation of significant cumulative effects
11. Monitor and adaptive management, accordingly

[7] Cumulatively considerable means that the incremental effects of an individual action are significant when viewed in connection with the effects of past, present, and probable future actions.
[8] Available online at: https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/Comprehensive-Environmental-Document/ accessed 29 Aug 2019.

capacities and potentials of ecosystems by their probable response to disturbance. Ecoregions are characterized by their geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. For example, the proposed actions along the Mississippi River affect the Level III ecoregion Mississippi Alluvial Plain that extends north into Arkansas. More specifically, this area is characterized as Level IV ecoregion 73k (Southern Holocene Meander Belts), a subcomponent of the larger Level III ecoregion. This Level IV ecoregion is dominated by flat plains and river meander belts with levees, with prominent land cover and land use of forested wetlands, croplands, and urban and industrial areas (Daigle, et al., 2006).

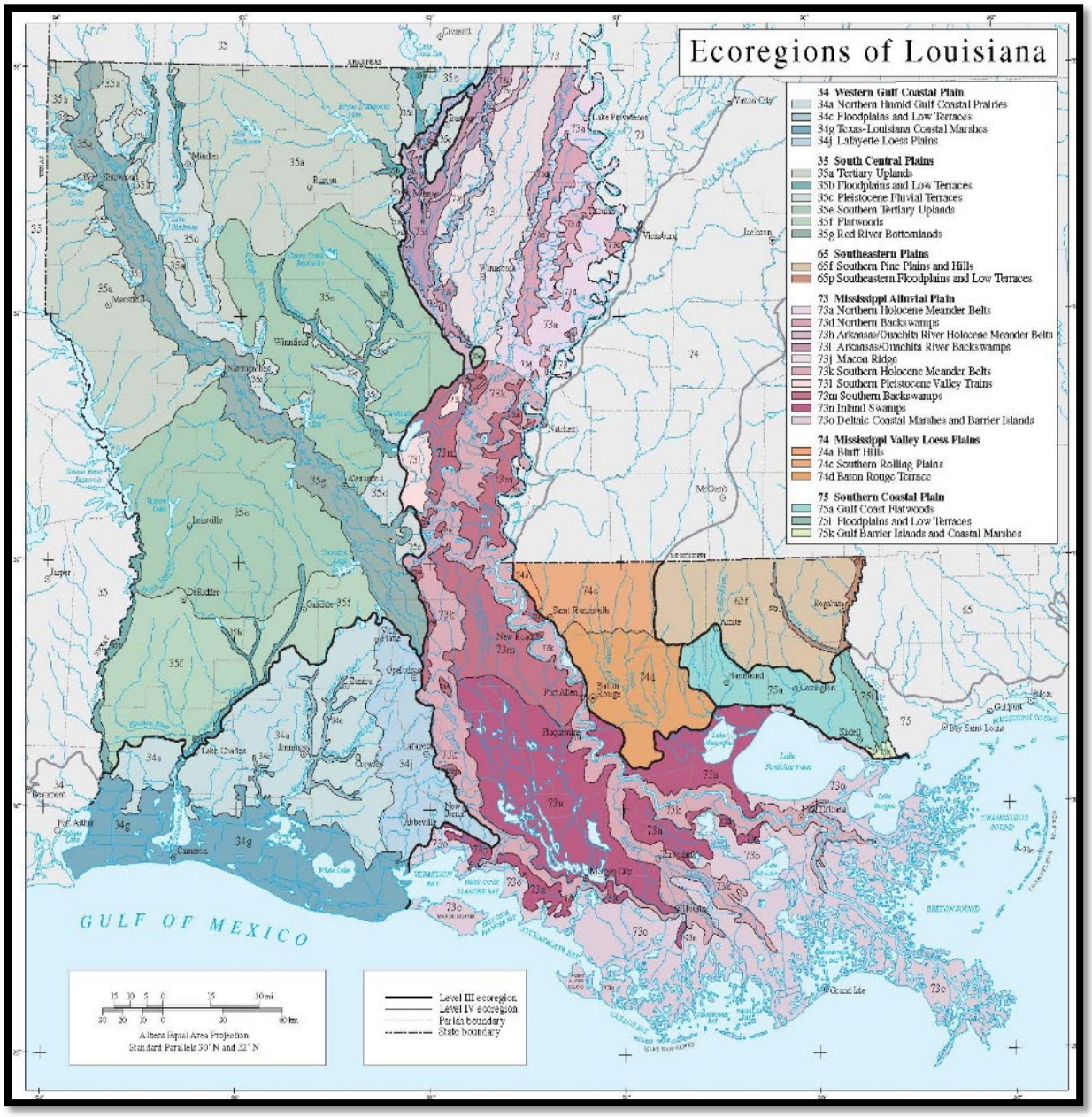

Figure 7-1. Ecoregions of Louisiana impacted by Lake Pontchartrain and Vicinity.
Courtesy of www.epa.gov/wed/pages/ecoregions.htm

TIMEFRAME FOR THE ANALYSIS – The timeframe for the cumulative impacts analysis for each considered resource begins when past actions began to change the status of the resource from its original condition, setting the long-term trend currently evident and likely to continue into the reasonably foreseeable future. Historic or past actions are those occurring before October 2018 (the start of this GRR study). The present includes actions from October 2018 to the present date of GRR study report. The reasonably foreseeable future includes the 50-year period of analysis which extends from the present through 2073.

7.1.3.2 IDENTIFYING PAST, PRESENT, AND REASONABLY FORESEEABLE FUTURE ACTIONS

Chapter 4 discusses the existing condition of each resource by describing the present condition and providing historical context (*i.e.,* the past condition) for how the resource was altered to the current conditions. The study team used information from field surveys, discussions with the project sponsor and subject matter experts, scoping comments, and literature searches to assess the past and existing conditions of the resource and to identify present and reasonably foreseeable future actions.

"Reasonably foreseeable actions" are defined as actions or projects with a reasonable expectation of actually happening, as opposed to potential developments expected only on the basis of speculation. Other present and future regional projects and programs that are applicable for the LPV study human environment and natural resources have been previously described in the IERs, supplemental IERs, and CED Phase I[9] and are not repeated here. Only those past, present, and reasonably foreseeable future actions that overlap in space and time with the direct and indirect effects are considered, with the boundary for cumulative effects expanded to the point at which the action's direct and indirect effects no longer measurably contribute to cumulative effects.

7.1.3.3 CUMULATIVE EFFECTS BY RESOURCE

The cumulative effects for each resource considered are discussed within each relevant resource below. Table 7-2 is a checklist identifying potential incremental cumulative effects on the resources affected by the LPV DEIS-GRR. Table 7-3 summarizes the cumulative impact analysis which includes the past, present, and reasonably foreseeable actions that might impact each resource category identified to have an incremental cumulative effect.

[9] Previous NEPA documents available online at https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/ . Accessed on 23 September 2019

Table 7-2. Checklist for Identifying Potential Cumulative Effects

Resource	Without Project	With Project		Past Actions	Other Present Action	Other Future Actions	Project's Incremental Cumulative Impact
		Construction	Operation				
Soils	●	●	⊙	●	●	●	●
Water Quality Resources	⊙	●	⊙	●	●	●	❍
Wetland & Forest Resources	⊙	⊙	⊙	●	●	●	⊙
Uplands	●	⊙	❍	●	●	●	⊙
Fisheries	⊙	❍	❍	●	⊙	⊙	❍
Essential Fish Habitat	❍	❍	❍	●	⊙	⊙	❍
Wildlife	❍	⊙	❍	●	⊙	⊙	⊙
Threatened & Endangered Species	❍	❍	❍	●	⊙	⊙	❍
Invasive Species	❍	❍	❍	●	⊙	⊙	❍
Cultural & Historical Resources	❍	❍	❍	●	⊙	⊙	❍
Aesthetics	❍	❍	❍	●	⊙	⊙	❍
Recreational Resources	❍	❍	❍	●	⊙	⊙	❍
Air Quality	❍	❍	❍	●	⊙	⊙	❍
Noise	❍	❍	❍	●	⊙	⊙	❍
Transportation	❍	⊙	⊙	●	⊙	⊙	⊙
Human Environment & Environmental Justice	❍	❍	❍	●	⊙	⊙	❍
HTRW	❍	❍	❍	●	⊙	⊙	❍

KEY: ❍= Less than Significant Effect ⊙ = Moderate, Significant Effect ●= Major, Significant Effect

Table 7-3. Cumulative Effects Summary for Identified Resources

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Soils	Previous levee construction for hurricane and coastal storm risk reduction and flood risk reduction projects have had significant impacts on soils, including prime farmland, throughout SE Louisiana due to the need for borrow. The HSDRRS projects resulted in significant impacts on prime farmland soils.	Ongoing levee modifications for hurricane and coastal storm risk reduction and flood risk reductions projects within the study area are continuing to impact soils, including prime farmland, due to the need for borrow.	Future actions in SE Louisiana will continue to need borrow to construct/maintain levees for hurricane and coastal storm risk reduction and flood risk reduction projects. These future actions would likely require borrow and likely come from prime farmland.	Continued impacts from past and ongoing development, constructed levees, and other risk reduction structures. The area within the HSDRRS would have increased flood risk resulting in prime farmlands and soils being more prone to flooding into the future. Existing borrow areas would continue to be used by private individuals, non-Federal, and Federal agencies for other construction activities.	Alternative 2 would require 8.3 million cubic yards of fill material. Alternative 3 would require 9.3 million cubic yards of fill, likely impacting prime farmland. Significant impacts on soils are expected from the proposed actions due to the need for borrow likely coming from prime farmland soils. See Sections 7.2.2 and 7.2.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Water Quality Resources	Clean Water Act of 1977, NEPA of 1966, Coastal Zone Management Act, and institutional recognition to restore and protect waters. Past industrial use and channelization of water bodies for oil and gas exploration	Continued impacts to water resources due to population growth, oil & gas exploration, and industrialization. Continued regulation enforcement, and societal recognition help reduce water degradation. Programs by state and non-profit agencies as well as private citizens to improve water quality; continued localized dumping	Continued impacts to water resources due to population growth, oil & gas exploration, and industrialization. Continued regulation enforcement, and societal recognition help reduce water degradation. Programs by state and non-profit agencies as well as private citizens to improve water quality; continued localized dumping	Continued impacts to water resources due to population growth and industrialization. The existing levees and flood walls would continue to be operated and maintained into future. Existing borrow areas would continue to be operated.	Construction-related impacts to water resources likely to occur due to increased turbidity and sedimentation, decreased DO, and increased water body temperature. The foreshore protection would impact 75.1 acres of shoreline in Lake Pontchartrain. The levee expansions along the MRL and filling in of BLH-Wet habitat permanently eliminating the affected wetlands' ability to perform water quality functions. Less than significant impacts to water quality resources are expected from the proposed actions. See Sections 7.3.2 and 7.3.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Wetland & Forest Resources	Wetland loss and conversion to other land use	Wetland loss and conversions to other land use. Mitigation projects and bank credits offset adverse impacts to wetlands due to constructed projects.	Wetland loss and conversion to other land use. Mitigation will continue to be used to offset wetland damages due to future actions	Wetland loss in coastal Louisiana is expected to continue related to subsidence, sea level rise, and human development. Existing borrow areas would continue to be operated. Maintenance along existing LPV levee reaches would continue to occur. No impacts to wetlands are expected due to routine maintenance.	No permanent impacts to marsh or Cypress-Tupelo swamp habitats are anticipated with the proposed actions. Wetland impacts would occur due to MRL flood side levee shifts, impacting BLH-Wet. These impacts would be offset through mitigation (Appendix K). The flood side shift would impact approximately 27 acres for Alternative 2 and 28 acres for Alternative 3. The proposed actions are anticipated to have significant impacts to wetland resources. See Sections 7.4.2 and 7.4.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Uplands	Past construction of levees and risk reduction structures have resulted in highly disturbed areas along the levee reaches. Upland habitats have been adversely impacted due to uplands being used for borrow areas for construction activities.	Continued use of upland habitats for borrow areas for construction activities. Existing levees would continue to be maintained as grass turf with routine maintenance of mowing along the levee as necessary.	Continued use of upland habitats for borrow areas for construction activities. Existing levees would continue to be maintained as grass turf with routine maintenance of mowing along the levee as necessary.	Actions by others on uplands would continue. Maintenance of existing LPV levee system would continue, but no new borrow impacting uplands would occur.	Existing levees would be cleared of turf during construction and then re-vegetated with turf. Uplands associated with the levee footprints would stabilize following construction. Upland habitat associated with borrow areas would likely come from upland areas. Impacts to uplands within the proposed footprint of the levee lifts and floodwall raises would be less than significant, but uplands associated with required borrow would likely be significantly impacted. Exact impacts would be analyzed upon selection of borrow sites in the future. See Sections 7.5.2 and 7.5.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Fisheries and Essential Fish Habitat	Institutional recognition of decline in EFH quality; passage of Magnuson-Stevens Fishery Conservation and Management Act, as amended; formation of NMFS, and Louisiana Department of Wildlife and Fisheries (LDWF); Fish and Wildlife Coordination Act; Marine Mammal Protection Act; decline in fish and EFH due to overharvesting and loss of habitat from natural conditions and human induced changes.	Institutional recognition of natural resources and fish resources and its habitats. Continued loss of habitat due to conversion and subsidence. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Continued loss of fish and EFH resources due to habitat loss. Sea level rise and subsidence expected to continue. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Actions by others would continue to affect fisheries and EFH. Sea level rise will likely increase saltwater intrusion and exacerbate ongoing conversion of wetlands to shallow open water resulting in loss of existing fish habitats. The existing levee maintenance would not impact existing fisheries or EFH.	Less than significant construction-related impacts on fisheries and aquatic habitat are anticipated to occur at discrete levee lift and floodwall raise construction sites. The placement of foreshore protection would lead to direct burial of immobile species. Despite some adverse impacts to fisheries and EFH, the proposed action is expected to result in only minor, less than significant short-term effects. See Section 7.6.2, 7.6.3, 7.7.2, and 7.7.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Wildlife	Institutional recognition through formation of LDWF; Endangered Species Act, Fish and Wildlife Coordination Act; Bald and Golden Eagle Protection Act; Marine Mammal Protection Act; Migratory Bird Treaty Act; decline in wildlife due to overharvest and loss of habitat from natural conditions and human induced changes.	Institutional recognition of natural resources and wildlife resources and its habitats. Continued loss of habitat due to conversion and subsidence. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Continued loss of wildlife resources due to habitat loss. Authorized ecosystem restoration construction projects offset some of the impacts to habitat loss.	Existing maintenance of the LPV levees would continue. Wildlife that currently use the levees would continue to do so with negligible, temporary, less than significant impacts. Continued loss of wildlife resources due to habitat loss and sea level rise. Actions by others would continue.	Wildlife would be directly impacted during construction and due to loss of BLH-Wet habitat adjacent to the MRL. During construction, mobile wildlife likely to avoid the area. Significant impacts to wildlife are expected due to loss of BLH-Wet habitat along the MRL. See Sections 7.8.2 and 7.8.3 for further details.
Threatened & Endangered Species	Institutional recognition through Endangered Species Act; decline in listed and protected species due to overharvest and loss of habitat from natural conditions and human-induced changes.	Continued impacts to listed and protected species habitat by natural conditions such as hurricane storm surge, saltwater intrusion and subsidence, and man-made conditions such as agriculture, human development, and industrialization.	Continued impacts to listed and protected species habitat by natural conditions such as hurricane storm surge, saltwater intrusion and subsidence, and man-made conditions such as agriculture, human development, and industrialization.	Degradation and loss of habitat would continue and adversely impact the listed species in and near the vicinity of the study area. Recovery plans for the listed species would offset, to some degree, the adverse cumulative impacts on listed species. Continued maintenance of the LPV levees is not likely to adversely affect listed species.	The listed species may be affected, but not likely adversely affected, during construction and future operation of the proposed actions. These effects are considered to be temporary and less than significant. See Sections 7.9.2 and 7.9.3, and Appendix G for more details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Invasive Species	Introduction and spread of invasive species degraded native habitats. Institutional recognition through EO 13112 and EO 13751	Continued threat of invasive species. Invasive species management and eradication programs conducted by other entities offset some damage to native habitats.	Continued threat of invasive species. Invasive species management and eradication programs conducted by other entities would offset some damage to native habitats. New invasive species likely to expand into study area.	Threats of invasive species would continue. Existing invasive species would persist.	Existing invasive species would persist in the study area. Implementation of best management practices (BMPs) to reduce the spread of invasive species would be followed during construction. Less than significant impacts on invasive species are expected. See Section 7.10.2 and 7.10.3 for further details.
Cultural & Historical Resources	Institutional recognition through National Historic Preservation Act, EO 13007, EO 11593, Native American Graves Protection and Repatriation Act, National Register of Historic Places.	Construction of levee and risk reduction structures would continue to disturb ground and unknown archaeological sites may be uncovered. Erosion and ground deposits during hurricane and coastal storm events would continue to damage known sites.	Continued construction activities would occur and unknown sites may be uncovered. Erosion and ground deposits during hurricane and coastal storm events would continue and could damage/destroy known sites.	Existing levees and floodwalls would continue to be maintained and would have no effect on cultural resources. With LORR reduced, known and unknown sites within the protected side of the LPV system may have higher risk of damage/destruction during hurricane and coastal storm events.	The proposed action of levee lifts and floodwall raises are not expected to impact cultural resources due to previous surveys already being performed. If any unrecorded cultural resources are determined to exist, then no work will proceed in the area until final coordination with SHPO and THPO has been completed. Added level of flood risk reduction to known and unknown archaeological sites within the protected side of the LPV system, reducing damage caused by flood events. Less than significant impacts are anticipated. See Sections 7.11.2 and 7.11.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Aesthetics & Recreational Resources	Technical recognition via 1988 Visual Resources Assessment Procedure. Institutional recognition via Wild and Scenic Rivers Act, Louisiana Scenic River Act, Scenic Byways and others. Aesthetic and recreational resources negatively impacted by past hurricanes.	Continued institutional recognition. Visual resources destroyed, enhanced, or preserved by human activities and natural processes. Continued wetland loss and damages from hurricanes may have an adverse effect on the visual complexity and recreational resources within SE Louisiana.	Continued institutional recognition. Continued human population growth and development and other human activities have the potential to destroy, enhance, or preserve aesthetic and recreational resources.	Continued institutional recognition. Aesthetic and recreational resources would not change from existing conditions.	Aesthetics and recreational resources would be temporarily impacted by construction activities. However, the proposed action impacts on aesthetics and recreational resources would be less than significant. See Section 7.12.2., 7.12.3, 7.13.2, and 7.13.3 for further details.
Air Quality	Institutional recognition through the Clean Air Act; General Conformity Rule; industrialization, urbanization, and human development.	Continued human development, industrialization, and urbanization have the potential to adversely impact air quality; Continued regulation enforcement and societal recognition help reduce air quality degradation.	Continued human development, industrialization, and urbanization have the potential to adversely impact air quality; Continued regulation enforcement and societal recognition help reduce air quality degradation.	Continued maintenance of the existing LPV system would continue. No changes to the attainment area status for the study area are anticipated. Continued human development, industrialization, and urbanization have the potential to adversely impact air quality. Continued regulation enforcement and societal recognition help reduce air quality degradation.	During construction probable direct impacts to air quality would include temporary diesel and gasoline emissions. Air emissions from the proposed action would be temporary and less than significant. No violation of Federal or state ambient air quality standards are expected. Less than significant impacts to air quality are expected. See Section 7.14.2 and 7.14.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Noise	Institutional recognition through the Noise Control Act and local noise ordinances. Human development, urbanization, and industrialization.	Continued human development, industrialization, and urbanization have the potential to adversely impact noise quality; Continued regulation enforcement and societal recognition help reduce noise.	Continued human development, industrialization, and urbanization have the potential to adversely impact noise quality; Continued regulation enforcement and societal recognition help reduce noise.	Noise impacts would be similar to existing conditions. Continued maintenance of the LPV system would have minor noise related to mowing of existing levees. Local and temporary noise related to human activities would continue.	Noise levels associated with construction activities would have the potential to temporarily impact noise. Future maintenance activities could result in slight increase in noise levels from equipment and associated activities; however, these increases are expected to be temporary. The noise impacts associated with the proposed action alternatives would be less than significant. See Sections 7.15.2 and 7.15.3 for further details.
Transportation	The transportation infrastructure includes major roads, highways, railroads, and navigable water ways that have developed historically to meet the needs of the public. Interstate 10 (I-10), an east-west bicoastal thoroughfare that connects Houston to Baton Rouge, is a primary route for hurricane evacuation and post-storm emergency response.	The transportation infrastructure continues to meet the needs of the public. I-10 is the primary route for hurricane evacuation and post-storm emergency response.	Portions of I-10 and other highways and roads would continue to be periodically damaged by hurricane storm surge.	The routine maintenance of public roads around the study area would continue. Major transportation corridors within the study area likely would become more vulnerable to storm damage in the future. Transportation associated with existing borrow areas would continue.	Use of the area's roads would increase during construction. Truck hauling of borrow would temporarily impede vehicle traffic, increase local congestion, and adversely impact roads. These impacts would be significant. See Sections 7.16.2 and 7.16.3 for further details.

Resource	Past Actions	Present Actions	Future Actions	No Action Alternative	Proposed Action Alternatives
Human Environment & Environmental Justice	Institutional recognition of Environmental Justice (EO 12898) and the DoD's Strategy on EJ of 1995.	High poverty rates negatively impact the social welfare of residents and undermine the community's ability to provide assistance to residents in times of need.	Institutional recognition of EJ would continue.	Institutional recognition of EJ would continue. LPV system would not provide hurricane and coastal storm risk reduction for a 1% AEP storm; the perceived and actual risks to minority and/or low-income population groups would increase. Potential for residents to re-locate to areas with higher levels of flood risk reduction.	The proposed actions would not adversely impact socioeconomic or EJ resources within the study area. Flood side shifts of the MRL would spare impacts to the human environment. No permanent disproportionate impacts are expected to occur on any minority or low-income community. Less than significant impacts to the human environment and EJ are expected. See Sections 7.17.2 and 7.17.3 for further details.
HTRW	Institutional recognition thru Resource Conservation and Recovery Act; CERCLA; Solid Waste Disposal Act; Industrialization and urbanization	Continued human population growth and industrialization with the potential of new HTRW impacts. Continued cleanup efforts to offset past HTRW impacts.	Continued human population growth and industrialization with the potential of new HTRW impacts	Continued maintenance of the LPV system would have low risk of encountering RECs. Should HTRW concerns or RECs arise at any time during future maintenance, USACE would coordinate with the appropriate Federal and state authorities to implement an approved response action.	Phase 1 Environmental Site Assessment completed during feasibility. New Phase 1 would be required within a 6-month period prior to start of construction to ensure that no RECs are present. Less than significant impacts to HTRW are expected. See Section 7.18.2 and 7.18.3 for further details.

7.1.4 GENERALIZED BORROW AREA IMPACT ANALYSIS

Extended construction windows throughout the 50-year period of analysis would be required for implementation of the multiple levee lifts associated with the project. Borrow areas available for use now may not be available when future levee lifts are needed. Accordingly, an analysis of borrow area impacts has been conducted on a “typical” borrow pit that could be chosen for use. Anticipated impacts of excavation and use of such “typical” borrow areas for the action alternatives were evaluated using the below assumptions. The assumptions are based on extensive borrow area impact assessments performed for HSDRRS implementation. The quantities of borrow that would be needed for each lift are estimates. Specific borrow areas would be identified during pre-construction engineering and design for each segment of project construction. Borrow area acquisition requirements will continue to be evaluated during feasibility design to determine whether temporary or permanent easements are most advantageous to the Government. Additional NEPA documentation and associated public review would be conducted, as necessary, to address impacts associated with those borrow areas. Additionally, if a proposed borrow area contains upland bottomland hardwood forests or another significant resource that requires mitigation, a mitigation plan would be prepared in compliance with WRDA 1986, Section 906 (33 U.S.C. §2283). See Appendix A for construction schedule and estimated borrow quantity for each levee lift.

Table 7-4. Borrow Area Assumptions and Requirements Incorporated into Borrow Area Analysis

Resource	Assumptions and Requirements
Locations	Borrow sites would be located within one or more of the following parishes: • Orleans Parish • Plaquemines Parish • Jefferson Parish • St. Charles Parish • Lafourche Parish • St. John the Baptist Parish
Socioeconomics	Borrow sites with potential EJ impacts or potential impacts to sensitive receptors would be avoided.

Resource	Assumptions and Requirements
Soils	Based on the estimated 8.3 million cubic yards of material needed for construction and based on an assumed 20-ft depth of borrow areas, Alternative 2 would require approximately 320.9 acres of borrow area. Based on the estimated 9.3 million cubic yards of material needed for construction, Alternative 3 would require approximately 361.5 acres of borrow area. Suitable clay material would meet the following requirements: • Soils classified as fat or lean clays are allowed • Soils with organic content greater than 9% are NOT allowed • Soils with plasticity indices less than 10 are NOT allowed • Soils classified as silts are NOT allowed • Clays will NOT have more than 35% sand content Significant impacts to prime farmland soils would be anticipated given the strong correlation between suitable borrow soils and prime farmland soils.
Transportation	The same transportation corridors used during HSDRRS would be used, as described in *Transportation Report for the Construction of the 100-year Hurricane and Storm Damage Risk Reduction System* prepared in 2009 and incorporated by reference (USACE, 2009)[10].
Jurisdictional Wetlands	Suitable borrow areas that avoid jurisdictional wetland impacts would be used.
Non-Jurisdictional (i.e. upland) Bottomland Hardwoods	Suitable borrow areas that avoid non-jurisdictional bottomland hardwood (BLH-dry) impacts would be used.
Water Quality	Water quality impacts would be minimized through the use of Best Management Practices (BMPs).
Fisheries/Essential Fish Habitat	No impacts to fisheries or EFH would be anticipated due to the use of inland sites
Wildlife	Some permanent impacts to wildlife would be anticipated due to permanent removal of habitat.
Threatened and Endangered Species	No impacts to T&E species would be anticipated as no T&E species are present in upland areas in the target parishes.
Cultural Resources	Cultural resource surveys would be conducted on potential borrow sites; sites with cultural resources would be avoided; no impacts to cultural resources would be anticipated.

[10] Available online in Appendix F at https://www.mvn.usace.army.mil/Portals/56/Users/194/42/2242/CED%20Volume%20II%20Compiled.pdf; accessed 4 December 2019

Resource	Assumptions and Requirements
Recreational Resources	No impacts to recreational resources would be anticipated as borrow sites would likely be located on private property away from recreational areas
Aesthetics	Minor impacts to aesthetics would be anticipated due to conversion of habitat.
Air Quality	Minor impacts during construction would be anticipated, dissipating upon completion; borrow areas would avoid non-attainment areas
Noise	Minor impacts during construction would be anticipated and minimized through compliance with local noise ordinances; temporary impacts to wildlife in adjacent habitat would be anticipated during construction; avoidance of construction areas may cause carrying capacity of adjacent habitats to be temporarily exceeded.
HTRW	HTRW surveys would be conducted on potential borrow sites; sites with HTRW would be avoided; no impacts would be anticipated.

During scoping, the USFWS provided a recommended protocol for identifying borrow sources. The recommendations in descending order of priority are:

1. *Permitted commercial sources, authorized borrow sources for which environmental clearance and mitigation have been completed, or non-functional levees after newly constructed adjacent levees are providing equal protection.*
2. *Areas under forced drainage that are protected from flooding by levees, and that are:*
    a. *non-forested (e.g., pastures, fallow fields, abandoned orchards, former urban areas) and non-wetlands;*
    b. *wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands(e.g., wet pastures), excluding marshes;*
    c. *disturbed wetlands (e.g., hydrologically altered, artificially impounded).*
3. *Sites that are outside a forced drainage system and levees, and that are:*
    a. *non-forested (e.g., pastures fallow fields, abandoned orchards, former urban areas) and non-wetlands;*
    b. *wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands(e.g., wet pastures), excluding marshes;*
    c. *disturbed wetlands (e.g., hydrologically altered, artificially impounded).*

Notwithstanding this protocol, the location, size, and configuration of borrow sites within the landscape is also critically important. Coastal ridges, natural levee flanks, and other geographic features that provide forested/wetland habitats and/or potential barriers to hurricane surges should not be utilized as borrow sources, especially where such uses would diminish the natural functions and values of those landscape features.

USACE would follow this recommended protocol to the extent practicable during borrow area selection. In addition, USACE will select borrow areas in the parishes listed in Table 7-4 that fall within the areas provided by USFWS that contain suitable soils and avoid potential mitigation (see Figure 7-2). Once borrow areas are identified, additional NEPA and environmental

coordination for those sites would occur and, if necessary, a mitigation plan would be prepared to compensate for any significant resources existing on those borrow sites.

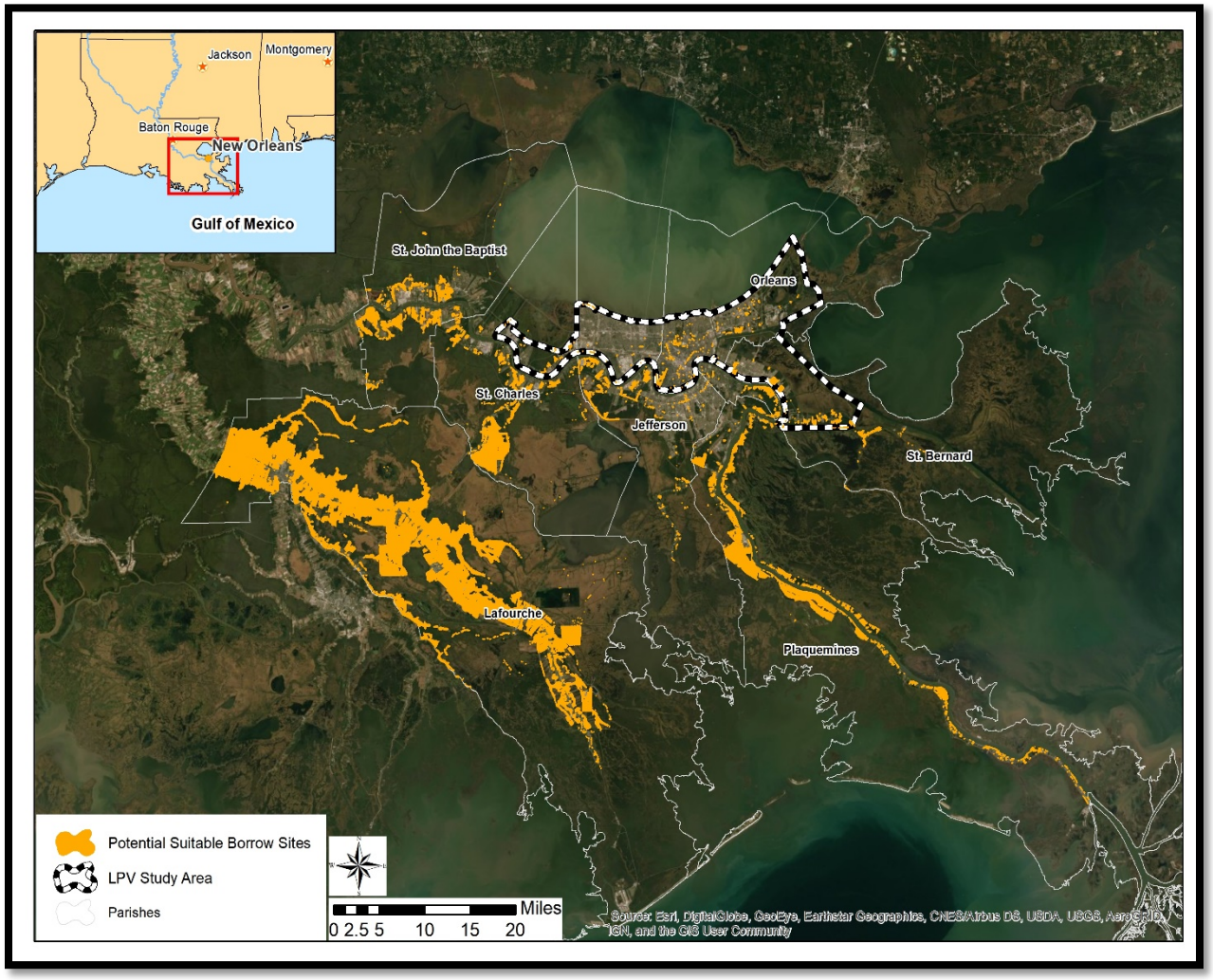

Figure 7-2. Potential Suitable Borrow Sites Based on Soil Types and Avoidance of Potential Mitigation

(data provided by USFWS, 2019; based on 2016 National Land Cover Database and National Resources Conservation Service (NRCS) soil surveys)

7.2 SOILS

7.2.1 REGULATORY FRAMEWORK

This soils resources section addresses compliance for the following applicable environmental laws and regulations:

- Farmland Protection Policy Act of 1981 (7 USC 4201 *et seq.*) 7 CFR 657-658
- 7 USC 4201, Prime and Unique Farmland
- Soil Conservation Act (16 USC 590(a) *et seq.*)
- Section 402 Clean Water Act

Impacts to soils would be considered significant if an alternative resulted in substantial conversion or loss of prime farmland soils.

7.2.2 IMPACTS OF PROPOSED ALTERNATIVES

Soil impacts are generally defined as the change in land use of an area such that the soils in the area are no longer suitable for their best use or the construction of facilities or structures on soils that cannot support the facilities or structures due to soil instability. The urban areas affected by the proposed actions contain soils that have previously been impacted by development, constructed levees, and other risk reduction structures.

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Soils in the study area are expected to continue to be impacted from previous development, constructed levees, and other risk reduction structures. The 2011 HSDRRS projects resulted in significant impacts on prime farmland soils, which were relatively undisturbed. Impacts were both adverse due to a permanent loss of the soils and beneficial due to a reduction in risk of future flooding. Under the no action alternative, the area within HSDRRS would have increased flood risk resulting in prime farmlands and soils within the HSDRRS being more prone to flooding into the future, leading to continued significant impacts to soils. Under the no action alternative, any existing borrow areas would continue to be used by private individuals, non-Federal, and Federal agencies for other construction activities. Prime farmland soils within these borrow areas would continue to be adversely impacted under the No Action Alternative.

PROPOSED ACTION ALTERNATIVES – For soil resources, the proposed action alternatives have similar impacts; they only differ in the amount of fill material needed for construction:

- **ALTERNATIVE 2** would require approximately 8.3 million cubic yards of fill material for construction activities. Assuming a 20-foot average depth of borrow areas this would require approximately 321 acres of borrow.
- **ALTERNATIVE 3** would require approximately 9.3 million cubic yards of fill material for construction activities. Assuming a 20-foot average depth of borrow areas this would require approximately 362 acres of borrow.

Direct Effects – Short-term construction-related impacts due to future levee lifts, armoring, and soil stabilization would include soil loss through water and wind erosion, compaction, and loss of biological productivity. Exposed soil during construction would be unstable and susceptible to wind and water erosion. After construction, the disturbed soils would stabilize and re-vegetate.

Soils would also be impacted by compaction at the construction sites and loss of biological productivity. Structurally, levee soils must be compacted to provide adequate support against the pressure produced by high floodwaters. Compacted soils are less productive than aerated, loamy soils, and woody vegetation is not allowed on the levees or within a 15-foot vegetation-free zone past the levee toe. No significant impacts to prime farmland soils in the levee footprints are anticipated with implementation of the proposed alternatives since these soils have already been impacted by previous HSDRRS construction projects. Beneficial effects would be realized due to reduction in risk of future flooding.

Indirect Effects – Eroded soils from construction sites are likely to damage adjacent vegetation by coating leaf surfaces and limiting transpiration and photosynthesis and disturbing adjacent wetland communities through increased suspended solids in the water column, which reduces light penetration and decreases overall water quality.

GENERALIZED BORROW AREAS – Specific borrow areas to be used for construction of levee lifts have not been identified. USACE compared suitable borrow areas (*i.e.,* suitable soil types in areas with no sensitive ecological resources) provided by USFWS to areas designated as prime farmland (USDA, 2019) and determined that the majority of suitable fill material occurs in areas of prime farmland. Accordingly, there is a high likelihood that borrow areas would be located in areas with prime farmland soils. Therefore, it is anticipated that proposed alternatives requiring borrow would result in adverse, major impacts to prime farmland soils in the region. The use of the excavated prime farmland soils from borrow sites for LPV construction provides a benefit to the Greater New Orleans Metropolitan Area and provides a reduction in risk of flooding undisturbed farmland within the HSDRRS. The potential loss of 321 acres (Alternative 2) or 362 acres (Alternative 3) of prime farmland is a major impact for southeast Louisiana and the region. Although this is a worst-case scenario that assumes all borrow sites would be excavated, and all soils would be designated as prime farmland, the estimated impact constitutes a loss of approximately 0.1% of all prime farmlands within the seven parishes analyzed. Because the loss of these prime farmland soils is permanent and would result in a substantial reduction in the available productive farmland regionally, the loss of prime farmland soils is anticipated to have a significant impact. No mitigation measures can be implemented that would reduce the level of impact.

Therefore, Alternatives 2, 3, and associated borrow areas would have significant impacts on soils.

7.2.3 CUMULATIVE IMPACTS

Other regional past, present, and future actions would also continue to change the land use patterns and would contribute to the cumulative loss of prime farmland soils in southeastern Louisiana. The CED Phase 1, Volume I (USACE, 2013) provides additional detail and is incorporated by reference and only briefly summarized here.

Beneficial cumulative impacts on soils would occur from coastal and wetlands restoration projects as healthier marsh and forested wetlands are created and protected and are to some degree better able to trap sediments, sustain vegetation, and build rich organic soils. Additionally, healthier marshes would act as a buffer for storm surge and could provide beneficial impacts on prime farmland soils further inland. Flood risk reduction projects would

also provide beneficial impacts due to the reduction of storm surge inundation through increased hurricane surge protection.

Long-term cumulative beneficial impacts on soils would result from the implementation of levee lifts and maintenance of the LPV levees in addition to the HSDRRS construction. All soils within the LPV would have a lower risk of inundation from storm events, including prime farmland soils, which could continue to be used for agricultural production during storm events. Further, with reduced risk of storm surge, it would be less likely for crop destruction to occur from flooding or brackish water inundation.

There would be adverse permanent, major cumulative impacts on soils from the construction of risk reduction efforts since Hurricane Katrina and removal of borrow materials associated with the proposed action alternatives, primarily due to the permanent loss of acres of prime farmland soils used for borrow. The magnitude of cumulative impacts on soils would be greater for the borrow sites than for construction of LPV levee lift components. Soil removed from borrow sites for LPV construction and future maintenance would occur primarily in rural areas and result in 321 acres for Alternative 2 or 362 acres for Alternative 3 that would no longer be suitable for pasture or farmland uses.

The LPV could also have a minor adverse cumulative impact on soils due to the potential for induced development in the study area as flooding risk of properties is reduced. Development pressures often result in encroachment into rural agricultural lands and with more development comes an increase in the use of impervious surfaces such as roads, homes, and parking areas. Impervious surfaces increase the flow of rainwater and erosion of exposed soils. Increased development in the study area would remove soils from biological productivity, and permanently remove prime farmland soils from agricultural production.

Collectively, the cumulative impacts due to construction of risk reduction structures and levee raises in urban areas within LPV would have little adverse effect on previously disturbed soils. Areas within the HSDRRS that are designated prime farmland soils are beneficially impacted by the risk reduction system, as the land used as farmland, forestland, and wildlife habitat has a reduced risk of flooding.

Borrow material has been used by USACE for the construction of the HSDRRS and other projects in southeastern Louisiana. Over 17 million cubic yards of borrow material is estimated to have been obtained for the HSDRRS construction effort. Cumulatively, past, ongoing, and future projects in the region would result in the cumulative loss of biological productivity of soils and the potential for cumulative indirect impacts on soils through erosion and stormwater runoff as the area of impermeable surfaces increases. Due to the volume of prime farmland soils already removed for HSDRRS construction, the anticipated removal of prime farmland soils from borrow areas regionally for LPV construction would be a major impact and would be a significant loss of prime farmland soils.

Therefore, Alternatives 2, 3, and associated borrow would have significant cumulative impacts on soils.

7.2.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to soil resources, the following environmental commitments shall be implemented:

1) BMPs as described by Stormwater Pollution Prevention Plans (SWPPP) would be used at levee lift construction sites to reduce erosion.
2) Environmentally acceptable construction practices would be used to avoid excessive disturbance of soils present in the project area.
3) Silt fencing and hay bales would be installed around the perimeter of the borrow areas to control runoff.
4) Post-construction earthen levees would be re-vegetated to reduce erosion and scour.
5) All fill material used for levee lift construction would be free from contamination and certified by physical testing, chemical analysis, and/or manufacturer's certification.
6) To make optimal use of available borrow material, excavation would begin at one end of the borrow area and be made continuous across the width of the areas to the required borrow depths, to provide surface drainage to the low side of the borrow pit as excavation proceeds.
7) Excavation for semi-compacted fill would not be permitted in water, nor should excavated material be scraped, dragged, or otherwise moved through water. In some cases, the borrow areas may need to be drained with the use of a sump pump.
8) Upon abandonment of a borrow area, site restoration would include placing the stockpiled overburden back into the pit and grading the slopes to the specified cross-section figures.
9) At borrow sites, all proper local, state, and Federal permits would be required for potential impacts to water quality.

7.3 WATER QUALITY

7.3.1 REGULATORY FRAMEWORK

This water quality section addresses compliance for the following applicable environmental laws and regulations:

- Clean Water Act Section 401: Water quality certification pursuant to Section 401 of the Clean Water Act would be achieved prior to construction.
- Clean Water Act Section 402: Prior to construction, the National Pollutant Discharge Elimination System permit process would be completed and a General Stormwater Permit would be required. Contractors would need a site-specific Spill Prevention, Control and Countermeasure Plan in place prior to the start of construction.
- Clean Water Act Section 404: Specific impacts to water quality due to displacement of water bodies by fill materials, stockpiling, and hydro-modifications will be described in the 404(b)1 evaluation and included prior to final report approval.
- EO 11988, Floodplains
- Coastal Zone Management Act Compliance (see Appendix G for full compliance details)

Impacts to water resources would be considered significant if an alternative:

- Caused long-term or permanent violation of state water quality standards or otherwise substantially degraded water quality.
- Caused the study area to no longer meet state of Louisiana water quality attainment status.

7.3.2 IMPACTS OF CONSIDERED ALTERNATIVES

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – There would be no direct, indirect or cumulative impacts to water quality or other water resources as a result of not constructing the proposed project. The existing levees and floodwalls would continue to be operated and maintained into the future.

Without the proposed action, the USACE expects the water quality in and near the study area to continue in a fashion similar to current conditions. Natural and human-influenced activities affecting water quality would have both potentially beneficial and detrimental effects into the future. Some water bodies in and adjacent to the study area would likely continue to violate LDEQ pollution criteria for their designated uses due to natural and human-influenced causes. Those with known or suspected sources of impairment may show improvement through time as controls are put in place to address the impairment.

PROPOSED ACTION ALTERNATIVE – For water resources, Alternatives 2 and 3 have similar impacts unless called out otherwise.

Direct Effects – Construction-related impacts would have direct effects to canals, drainage waterways, and open water due to increased sedimentation and nutrient loading of waterways from stormwater runoff during rain events notwithstanding use of BMPs during construction and prior to establishment of vegetated cover in newly raised levees. Direct, minor, short-term, construction-related impacts on water quality from the levee lift construction would include decreased DO levels in the waters immediately surrounding the construction site, excessive turbidity due to construction runoff and sedimentation, and increased water body temperature due to the increased suspended solids produced during construction that could absorb incident solar radiation (USACE, 2013). Where the base of the earthen levee was expanded into open water of a bayou or lake, these actions would directly impact water quality through increased sedimentation during construction activities, but impacts on water quality are expected to cease once levee material stabilized and was armored. The foreshore protection in Lake Pontchartrain would impact approximately 75.1 acres of shoreline, which would have direct short-term less than significant impacts on water quality from increased turbidity.

Indirect Effects – Minor, short-term, construction-related impacts on water quality from construction activities may include decreased DO levels in the waters immediately surrounding the construction site, decreased clarity due to construction runofff and sedimentation due to dredging activities, and increased water temperature due to increased suspended solids produced during construction that could absorb incident solar radiation. Temporary, minor less than significant water quality impacts could occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. After construction, conditions would be expected to stabilize and return to conditions similar to pre-construction.

Mississippi River – In the MRL locations requiring levee expansion to the flood side, filling of BLH-wet habitat would permanently eliminate the affected wetlands' ability to perform water quality functions, causing a major, permanent significant impact to water quality. These impacts would be offset by BLH –wet compensatory mitigation (See Appendix K, *Mitigation Plan).*

Therefore, impacts to water resources from proposed action alternatives would be less than significant.

GENERALIZED BORROW AREAS – Dewatering activities during borrow site excavation is expected to increase suspended sediment concentration in waterways and wetlands near discharge points. No permanent impacts on water quality from borrow site construction and use are expected. Borrow sites are expected to be constructed in upland environments, and the beds and banks of open water bodies created from borrow site construction are expected to quickly stabilize and not contribute to sedimentation and turbidity of nearby waterways during storm events. The new water bodies in abandoned borrow pits would remain isolated and would not contribute to any degradation of existing water bodies in the region. Disturbance of water quality would be temporary and confined to the borrow pit. **Therefore, impacts to water quality associated with borrow areas would be less than significant.**

7.3.3 CUMULATIVE IMPACTS

Past HSDRRS construction activities modified the surface hydrology, increased turbidity, decreased DO, increased suspended sediments, and potentially caused a slight increase in water temperature. Specific impacts of the HSDRRS are documented in the CED Phase I, Chapter 4, and are only summarized here (USACE, 2013). The HSDRRS construction activities did result in short-term moderate impacts to water quality for some of the sub-basins related to construction and maintenance activities. However, following the completion of construction activities and stabilization of material, there would be no further impacts on water quality.

Collectively, other present and future levee construction projects, storm damage reconstruction, redevelopment, and transportation projects would have cumulative short-term moderate adverse impacts on water quality in the region due to stormwater runoff from construction sites, dredging, and hydro-modification. As noted in Table 4-7, water quality in some water bodies in the region is impaired because of existing commercial and industrial uses and point source discharges of stormwater and wastewater.

The direct cumulative LPV impacts on water quality would be associated with the actual construction and maintenance activities. This would likely cause sedimentation and nutrient loading of waterways from stormwater runoff during rain events. These minor, short-term less than significant impacts would include localized changes in turbidity, water temperature, dissolved oxygen, hydrology, and water velocity.

In general, there would be less than significant cumulative impacts on water quality from the proposed action.

7.3.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to water quality, the following environmental commitments shall be implemented:

1) All appropriate and practicable steps would be taken, through application of the recommendations of 40 CFR Part 230, subpart H, 230.70-230.77, to minimize adverse effects of the discharge for all proposed construction activities.
2) Prior to construction a SWPPP would be prepared to address potential impacts to water quality from construction equipment, construction crews, and construction practices. The SWPPP would include required BMPs to reduce run-off, prevent accidental spills, and otherwise minimize the potential for impacts to water quality.
3) Construction BMPs (*e.g.*, sediment curtain) would be in place during construction.
4) Dust suppression methods such as watering of construction sites would be in place during construction.
5) Containment of fuel and construction-required chemicals would be in place during construction.
6) For foreshore protection construction, use of turbidity control measures is required.

7.4 WETLAND AND FOREST RESOURCES

7.4.1 REGULATORY FRAMEWORK

This section addresses compliance for the following applicable environmental laws and regulations:

- Section 906(d) of WRDA 1986
- Fish and Wildlife Coordination Act
- Clean Water Act Section 401
- Clean Water Act Section 402
- Clean Water Act Section 404
- EO 11990, Protection of Wetlands
- EO 11988, Floodplain Management

Impacts to wetlands and forest resources would be considered significant if substantial conversion or loss of wetlands would occur due to proposed actions.

7.4.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Wetland loss in coastal Louisiana is expected to continue due to subsidence and development of human infrastructure (USACE, 2013; Boesch, 1994). Future major hurricane events are expected to convert marsh into open water similar to the conversion that occurred from Hurricanes Rita and Katrina (Barras, Bernier, & Morton, 2008). The historic balance between wetland loss and formation along the deltaic plan would continue to be interrupted due to changes to the Mississippi River. The maintenance of the Mississippi River in its current course and subsequent changes to the deltaic cycle would continue as today, resulting in the majority of the sediment deposition and fresh water to be discharged off the continental shelf. The problem of saltwater intrusion into historically less

saline marshes is expected to continue. Continued loss of cypress-tupelo swamps and BLH forests due to wind, storm surge damage, and saltwater intrusion would continue to impact the regional habitat and biological resources in the study area. CPRA 2017 Master Plan data indicate that large expanses of coastal marsh may be lost over the next 50 years, even with implementation of the Master Plan (Figure 4-8, above).

Without implementation of the proposed action, there would be no actions taken to lift the LPV levee reaches or raise existing floodwalls. However, maintenance activities would continue to occur. As no vegetated wetlands exist in the project footprints, no wetlands would be impacted by such continued maintenance.

PROPOSED ACTION ALTERNATIVES – For wetland and forest resources, Alternatives 2 and 3 have identical impacts unless called out otherwise.

Direct Effects – No permanent impacts to marsh or cypress-tupelo swamp habitats are anticipated with implementation of the Proposed Action Alternatives. However, potential wetland impacts would occur with lifts associated with Mississippi River levees due to the necessity to expand the levees to the flood side, thereby impacting BLH-wet habitat. These impacts would be avoided to the maximum extent practicable but would be unavoidable in some locations due to avoidance of infrastructure on the protected side of the levees. Initial design estimates indicate an additional 25 feet would be required on the flood side of the levees for construction. These flood side levee shifts would impact approximately 26.9 acres of bottomland hardwood-wet habitat with Alternative 2 and 28.4 acres with Alternative 3, requiring compensatory mitigation. See Appendix K for detailed mitigation information.

Existing rights of way would be used in almost all other cases. Minor increases in rights of way (0.7 acres total) would be required at 4 locations along the existing levee footprint on the Lake Pontchartrain shoreline, but the increases are in existing disturbed habitat and no wetland or forest habitat would be impacted.

Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.

Indirect Effects – Temporary increases in suspended sediment and turbidity in habitats adjacent to construction sites and staging areas could occur from stormwater runoff and from water-based construction activities, but these impacts are anticipated to be minor and short-term in nature.

GENERALIZED BORROW AREAS – Borrow areas would be selected so as to avoid any impacts to wetland or bottomland hardwood resources. The potential for indirect impacts on jurisdictional wetlands from borrow site excavation exists; however, measures implemented to protect jurisdictional wetlands from borrow site excavation during HSDRRS construction (upland buffers) were successful in preventing indirect impacts.

The proposed Action Alternatives are anticipated to have significant impacts on wetland and forest resources, requiring compensatory mitigation (see Appendix K). Approximately 17.2 AAHUs of BLH-Wet habitat would be required for Alternative 2 and 17.7 AAHUs for

Alternative 3 to offset BLH-Wet impacts. These estimates will be refined during feasibility level design.

7.4.3 CUMULATIVE IMPACTS

Cumulative impacts to jurisdictional wetlands throughout the Greater New Orleans Metro area would continue with or without the proposed action. Impacts to wetlands, including mitigation projects from HSDRRS would continue. Past, ongoing, and future 404 permitted actions are expected to continue which would impact wetland resources. Historical and present wetland loss and gain in southeastern Louisiana has been caused by a multitude of natural and anthropogenic actions (Barras, Bernier, & Morton, 2008). Coastal wetland loss has occurred for thousands of years in Louisiana and has until the 20th century been balanced by various natural wetland building processes (LACOAST, 1997). Multiple factors have been associated with coastal land loss, including the inhibition of sediment movement into coastal systems due to levee systems along the Mississippi River; man-made canals and their associated hydrologic changes (i.e., saltwater intrusion); a decline of suspended sediments coming from the Mississippi River due to upriver dams and other projects; erosion caused by wave action and boating activity; geologic compaction and faulting; storm events, including hurricanes; and relative sea level rise (Boesch et al., 1994). Public and private wetland creation and restoration projects have contributed to wetland gain in southeastern Louisiana. Major programs and initiatives include the Coastal Wetlands Planning, Protection and Restoration Act program; the Beneficial Use of Dredged Material program; WRDA restoration projects (e.g., Davis Pond Freshwater Diversion, Caernarvon Freshwater Diversion); vegetation restoration projects (e.g., National Resources Conservation Service Plant Materials Center); Louisiana state restoration projects; the Louisiana Parish Coastal Wetland Restoration Program; FEMA restoration projects; public and private parties' initiatives, including those of nongovernmental organizations and corporations; and private mitigation banks. It is expected that the trend of wetland loss would continue, the rate of which would be slowed by the previously mentioned wetland creation and restoration initiatives.

Indirect cumulative impacts include alterations to habitats and hydrology, which could result in changes to salinity and nutrient loads in local wetlands, leading to additional wetlands loss. Flood risk reduction projects and other regional projects occurring near wetlands would cause damage to adjacent wetlands vegetation (including SAV) and increase turbidity and sedimentation in the adjacent wetlands habitat and drainage canals.

The proposed Action Alternatives are anticipated to have significant cumulative impacts on wetland and forest resources, requiring compensatory mitigation.

7.4.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to wetland and forest resources, the following environmental commitments shall be implemented:

1) Compensatory mitigation required to offset impacts to Bottomland Hardwood – Wet (See Appendix K, *Mitigation Plan* for details)
2) Avoidance methods and the use of buffer and "no-work" zones for the minimization of impacts on wetlands and non-jurisdictional BLH would be used.

3) Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.
4) No borrow excavation or work areas would be permitted in the area designated as wetlands. Wetlands would be protected through implementation of BMPs. These practices include installation of a silt fence around areas of excavation and maintaining a 100-foot buffer between the fence and wetlands areas in order to prevent surface runoff discharge into the wetlands.
5) A SWPPP and daily inspections by borrow personnel and other BMPs designed to protect wetlands as necessary would be used.
6) BMPs would be implemented to ensure adjacent wetlands and waters of the United States are not impacted by runoff during construction. Construction-related run-off into the wetlands would be managed through BMPs, which would minimize the potential indirect adverse impacts from considered action alternatives on wetlands. BMPs are effective, practical, structural or nonstructural methods which prevent or reduce movement of sediment, nutrients, pesticides, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of construction activities. BMPs would be used to minimize construction related impacts along the entire study area.
7) Borrow areas would be selected to avoid impacts to wetlands and non-jurisdictional BLH.
8) All fill material used for levee lift construction would be free from contaminants.
9) All fill material would be placed by qualified contractors using the appropriate equipment to minimize impacts on wetland areas and equipment would be properly maintained.

7.5 UPLANDS

7.5.1 REGULATORY FRAMEWORK

This uplands resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Section 906(d) of WRDA 1986

Impacts to uplands would be considered significant if an alternative resulted in substantial loss and conversion of upland habitats.

7.5.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – The habitat within all of the levee footprints is grass turf. The project areas of all reaches have been highly disturbed as a result of HSDRRS construction. The levee reaches were replanted with grass turf following completion of HSDRRS levee construction and are maintained by periodic mowing. Herbaceous woody vegetation is not allowed to take root within the levee footprint or the “vegetation-free zone” which extends 15 feet past the toe of each levee reach.

There would be no direct or indirect impacts to uplands within the project area if the levee lifts were not constructed. The existing levee would be maintained to keep turf grass growing and woody species from establishing. The existing levee would be mowed routinely as necessary.

ALTERNATIVES 2 AND 3 – Alternatives 2 and 3 would have similar impacts unless otherwise noted below.

***Direct Effects* –** Direct impacts would result from the clearing of approximately 1,760 acres of the existing turf grass and associated organic material for both proposed action alternatives. The waste material would be disposed of in compliance with all applicable Federal, state and local laws. Following the completion of construction, the levee slopes would be re-vegetated and turf grasses maintained similar to pre-construction conditions.

***Indirect Effects* –** Indirect effects of construction (e.g., increased turbidity, noise, vibrations, fugitive dust, etc.) would have temporary effects to the upland habitats. Overall, the uplands would stabilize following construction, allowing sediment to settle and vegetation to stabilize the area.

Impacts to uplands within the proposed footprint of the levee lifts and floodwall raises are anticipated to be less than significant.

GENERALIZED BORROW AREAS – Excavation of borrow areas would affect upland habitat. In general, borrow areas would likely consist primarily of agricultural lands (*e.g.*, sugarcane fields, pasture), fallow agricultural lands, pine plantations, existing borrow sites, or formerly developed land. Any new upland borrow areas used for the proposed action would be cleared of existing vegetation, excavated, and would most likely convert to open water habitat, reducing forage and breeding habitat for upland wildlife. Alternative 2 would require approximately 321 acres of borrow area to supply fill for construction. Alternative 3 would require approximately 362 acres of borrow area to supply fill for construction. Borrow areas would be located in uplands. Borrow areas would meet the assumptions outlined in Section 7.1.4, including avoiding impacts to BLH-Dry habitat.

Until borrow areas are selected, exact impacts on upland resources cannot be analyzed.

7.5.3 CUMULATIVE IMPACTS

Even though minimal in size when compared to the regional extent of forested and grassland habitats directly and indirectly affected by previous development activities, the excavation and use of borrow material in the study area, in combination with the past, present, and future large-scale construction projects, would cumulatively lead to the loss of upland habitats within southeast Louisiana. Based on historical human activities and land use trends in the area, it is reasonable to anticipate that the future activities would further contribute to cumulative degradation of the land resources and ultimately upland habitats. In southeast Louisiana, most development occurs in the upland areas, which compose a relatively small portion of the surface area of the region. Most of southeast Louisiana is composed of wetlands, open water, and estuarine habitats, and undeveloped and undisturbed upland areas are relatively rare. **Therefore, the cumulative loss of upland area that functions as habitat for wildlife provides forested resources is a long-term, moderate cumulative impact.**

7.5.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to upland resources, the following environmental commitments shall be implemented:

- USFWS recommendations for identification of borrow areas would be followed to the greatest extent practicable.
- Applicable mitigation measures, as described in Section 5.3.1.8 in the Comprehensive Environmental Document, Phase 1 (USACE, 2013) would be followed, including:
    - Tree protection measures
    - Pre-construction surveys for nesting birds
    - Limit removal of trees in forested wetlands to the fall or winter

7.6 FISHERIES

7.6.1 REGULATORY FRAMEWORK

This fisheries resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Coastal Zone Management Act
- Marine Mammal Protection Act

Impacts to fisheries would be considered significant if an alternative resulted in substantial loss of desired aquatic habitat for native species or the direct loss of fishes within the study area as a result of implementing the proposed actions.

7.6.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – RLSR would likely increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water resulting in loss of existing estuarine fish habitats. RLSR could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there would likely be a corresponding reduction in overall species diversity and abundance as well as a loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats.

Although fisheries productivity has remained high (Caffey & Schexnayder, 2002) as Louisiana has experienced tremendous marsh loss, this level of productivity may be unsustainable. As marsh loss occurs, a maximum marsh to water interface (i.e., edge) is reached (Browder, Bartley, & Davis, 1985). A decline in this interface would follow if marsh loss continues and the overall value of the area as fisheries habitat would decrease (Minello, Able, Weinstein, & Hays, 2003). Because fishery productivity is related to the extent of the marsh to water interface (Faller, 1979; Dow, Herke, Knudsen, Marotz, & Swenson, 1985; Zimmerman, Minello, & Zamora, 1984), it is reasonable to expect fishery productivity to decline as the amount of this interface decreases.

PROPOSED ACTION ALTERNATIVES – For Alternatives 2 and 3, impacts on fisheries are identical.

Direct Effects – The placement of stone foreshore protection along the shoreline of Lake Pontchartrain to bring existing foreshore protection back up to the proper elevation for levee protection would permanently re-cover approximately 75.1 acres of lake bottom habitat. The removal of this habitat represents proportionately a very small area of similar aquatic habitat within the expanse of Lake Pontchartrain, which has an area of over 400,000 acres.

The dredging and material stockpiling to provide access to deliver and place the stone for foreshore protection could temporarily displace and possibly destroy the benthic organisms within a total area of approximately 212.5 acres of Lake Pontchartrain. All stockpiled material would be returned to its original location upon project completion. Increased turbidity from access dredging could affect fish and other organisms by clogging gills, reducing growth rates, and adversely affecting egg and larval development. However, most mobile species would avoid the areas temporarily impacted by dredging as well as shoreline areas that would be permanently lost due to filling. Stockpile areas would be brought to pre-construction lake bottom elevations upon project completion, which would minimize impacts to the lake bottom and re-establish fish habitat in the area. Impacts to less mobile benthic species from these activities likely would occur, but would be temporary, approximately 1.5 years to 2.5 years in duration, with effects lasting until the areas stabilize. Once the proposed action is complete, sediment would settle, benthos would repopulate, and fish and other mobile aquatic species would return.

Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.

Indirect Effects – Less than significant, Indirect, minor, short-term, construction-related impacts on fisheries may include decreased DO levels in the waters immediately surrounding the construction site, increased turbidity due to construction runoff and sedimentation, and increased water body temperature due to increased suspended solids produced during construction that could absorb incident solar radiation. Temporary, minor water quality impacts could occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. Any of these localized changes in water quality could cause fish to temporarily avoid impacted areas and seek refuge in nearby suitable habitat. Water quality impacts in the project area would be temporary during project construction and would be minimized by the movement of the tides and the use of silt curtains and other best management practices. After construction, conditions would be expected to stabilize and return to conditions similar to pre-construction.

Overall, impacts on fisheries and fish habitat as result of the proposed action are anticipated to be less than significant.

GENERALIZED BORROW AREAS – Borrow areas are anticipated to be located in uplands so no direct or indirect impacts to fisheries habitat are anticipated. If borrow areas are identified near aquatic habitat, then potential impacts would be evaluated, as necessary, in a site-specific NEPA document. If borrow areas no longer in production are converted to open water habitat and fish are introduced, then abandoned borrow pits may provide fish habitat in the future.

7.6.3 CUMULATIVE IMPACTS

Direct cumulative adverse impacts on fisheries and fish habitat are associated with the actual construction activities, the associated dredge, fill, and material stockpiling activities, and water body displacement. These impacts would be primarily during the construction period. The total area within the study area potentially affected would be small and most areas would be affected only temporarily. The study area would be modified very slightly relative to the magnitude of historical changes within the study area.

Rain events during past and on-going risk reduction construction activities have caused sedimentation and contamination of waterways from storm water runoff (USACE, 2013). Alterations in water quality from sediment loading adversely impacted fisheries by lowering DO and increasing water temperatures. Additional adverse impacts on fish and other aquatic organisms from sediment suspension and siltation in water adjacent to risk reduction construction activities included clogged gills, reduced growth rates, and disruption of egg and larval development (USACE, 2013).

Indirect cumulative adverse impacts on fisheries and their habitats occur from alterations to fish migratory movements, active/passive transport of fish eggs and larvae, nursery habitat, recruitment of fish larvae and juveniles, water characteristics and organism access to abiotic water quality habitats (e.g., temperature, salinity, turbidity, and DO), organism access to biotic water quality habitats (e.g., protection from predators and food availability), and hydrology and water velocity.

Storm damage reconstruction and transportation projects in the region are anticipated to result in less than significant cumulative impacts on fisheries or fish habitat, since most of the projects proposed are either limited to upland construction or occur in previously disturbed areas. Hurricane and coastal storm risk reduction projects and flood risk reduction projects often alter existing nearshore habitats and impact interior marshes by impacting the natural processes of hydrology, erosion, subsidence, and saltwater intrusion. Water flow and important fish habitats between the protected side and the flood side of levees often become further fragmented.

Hurricane and coastal storm risk reduction projects and flood risk reduction projects, combined with other regional coastal and marsh restoration projects, would result in fish habitat with greater heterogeneity and interspersion and lower salinity levels. Hurricane and coastal storm risk reduction projects and flood risk reduction projects would also provide beneficial impacts on fish habitat through the reduction of storm surge inundation via increased hurricane and coastal storm damage reduction. Future regional projects also provide opportunities for dredged material from access channels to be used for marsh rebuilding and thus fish habitat creation or nourishment.

The cumulative direct and indirect impacts from regional projects that result in the temporary degradation of water quality or the permanent loss of wetlands that serve as quality fish habitat, combined with the current trend of water quality and habitat degradation in southeastern Louisiana, would result in cumulative minor impacts on fisheries and fish habitat regionally.

As water quality and structural habitat improve as a result of habitat restoration and a reduction in discharge of urban flood waters from better operational procedures, fisheries production

would increase. Restoration of wetlands would also lead to improved nursery habitat for important finfish. In addition, the rock utilized for shoreline protection and stabilization would, over time, cumulatively benefit fisheries by providing protection for juvenile and larval species and enhancing foraging potential of aquatic prey species. Providing rocky shoreline habitat to otherwise sand and mud benthic communities would expand the surface area for motile and sessile aquatic organisms to inhabit and thrive.

Therefore, less than significant cumulative impacts to fisheries and fish habitat are anticipated.

7.6.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to fisheries resources, the following environmental commitments shall be implemented:

1) Direct and indirect impacts associated with foreshore protection would be minimized by the use of BMPs to control sediment transport.
2) Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.
3) Continued coordination with natural resources agencies to ensure final design of features would enhance fish habitat to the fullest extent practicable.

7.7 ESSENTIAL FISH HABITAT

7.7.1 REGULATORY FRAMEWORK

Mandatory Contents of EFH Assessment

Per 50 CFR 600.920(e)(3), all EFH assessments must include the following information:

- Description of the action
- Analysis of the potential adverse effects of the action on EFH and the managed species
- Federal agency's conclusions regarding the effects of the action on EFH
- Proposed mitigation, if applicable

Mandatory contents of the EFH assessment for the LPV GRR can be found at the following locations within this document:

1. **Description of the action.** A description of each of the proposed Alternatives, a description of each considered alternative is provided in Section 6.5, above.
2. **Analysis of the potential adverse effects of the action on EFH and the managed species.** An analysis of the direct, indirect, and cumulative impacts of the Alternatives on EFH and managed species can be found below in this section. A description of historic and existing conditions of EFH in the project area can be found in Chapter 4 above. An analysis of the direct, indirect, and cumulative impacts of the Alternatives on fisheries in general can be found in Section 7.6 above.
3. **Federal agency's conclusions regarding the effects of the action on EFH.** Despite some adverse impacts to EFH, the project is expected to result in only minor short-term

adverse effects on EFH when compared to the No Action Alternative. Specific conclusions regarding the effects on EFH can be found within the analysis of direct, indirect, and cumulative impacts of each Alternative in Sections 7.7.2 and 7.7.3 below.

4. **Proposed mitigation, if applicable.** No mitigation is proposed. Environmental commitments to minimize impacts are listed in Section 7.7.4.

7.7.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 – NO ACTION ALTERNATIVE – Without implementation of the proposed action, there would be no actions taken to lift the LPV levees. However, maintenance activities would continue to occur. Two hundred and twelve acres of lake bottom would not be impacted for approximately 1.5 to 2.5 years by dredging, stockpiling and re-placing foreshore protection.

PROPOSED ACTION ALTERNATIVES – Impacts of Alternative 2 and 3 are expected to be identical for EFH.

Direct Effects – Dredging of access channels, adjacent stockpiling, and placement of stone foreshore protection along the shore of Lake Pontchartrain would disturb 212.5 acres of lake bottom and would permanently impact 75.1 acres of shallow lake bottom habitat. These localized construction activities could cause mobile aquatic species to temporarily avoid impacted areas and seek refuge in nearby suitable habitat. Several of the less motile Federally managed species occurring in Lake Pontchartrain, such as shrimp, would have the potential to be directly impacted by dredging and stockpiling activities through the loss of individuals. A temporary loss of invertebrates could also occur with construction activities, causing a temporary loss of forage habitat for finfish and shrimp. Temporary access channels and stockpile areas would be returned to previously existing grade upon completion of construction. This would allow for re-colonization by benthic organisms. Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language. Overall, the temporary impacts and permanent removal of habitat associated with construction activities represent a proportionately very small area (approximately 287 acres) of similar aquatic habitat within the expanse of Lake Pontchartrain, which has an area of over 400,000 acres.

Indirect Effects – Indirect, minor, short-term, construction-related impacts on EFH may include decreased DO levels in the waters immediately surrounding the construction site, increased turbidity due to construction runoff and sedimentation, and increased water body temperature due to increased suspended solids produced during construction that could absorb incident solar radiation. Temporary, minor water quality impacts could occur due to increased nutrient loading, miscellaneous debris, and accidental spills from construction equipment. Any of these localized changes in water quality could cause mobile aquatic species to temporarily avoid impacted areas and seek refuge in nearby suitable habitat. Water quality impacts in the project area would be temporary during project construction and would be minimized by the movement of the tides and the use of silt curtains and other BMPs. After construction, conditions would be expected to stabilize and return to conditions similar to pre-construction. No conversion of aquatic habitat to upland habitat is anticipated in designated EFH areas so no permanent loss of EFH is anticipated with construction of levee lifts or floodwall raises.

GENERALIZED BORROW AREAS – Impacts on EFH or managed species would not occur with use of existing borrow areas known to be used from within and outside the study area because they are not located in intertidal or estuarine areas. Borrow areas are anticipated to be located in uplands so no direct impacts to EFH are anticipated. Indirect impacts on EFH from future borrow area excavation could occur if borrow areas are located near aquatic habitat. If necessary, specific impacts on EFH would be identified in site-specific NEPA documents prepared after borrow areas have been identified.

Due to the localized nature of impacts related to the proposed action, it is anticipated that Alternatives 2, 3 and potential borrow areas would have less than significant impacts to EFH.

7.7.3 CUMULATIVE IMPACTS

The combination of past and ongoing regional work would contribute to cumulative loss of EFH in the vicinity of the study area. Regional projects would adversely impact EFH by causing direct habitat loss through the filling of waterways and marshes and dredging of waterways. Indirect cumulative effects include alterations of habitats and hydrology, which could result in changes in salinity and nutrient loads in EFH leading to further degradation of EFH. Past, present, and future flood risk reduction projects and other regional projects occurring near EFH would cause damage to EFH and adjacent wetlands vegetation, disturbance of fisheries and sediments, and would increase turbidity and sedimentation in the adjacent aquatic habitat and drainage canals.

Risk reduction projects directly alter existing shoreline habitat and hydrologically impact marshes by impacting the natural process of erosion, subsidence, and saltwater intrusion. The historic construction of flood risk reduction projects in southeast Louisiana is responsible for limiting water flow between the protected side of the levee and the flood side of the levee, altering freshwater and sediment input into estuaries, and contributing to wetland fragmentation and loss. Future flood and storm risk reduction projects cumulatively add to these impacts on EFH. Large-scale coastal and wetlands restoration projects are anticipated to restore these habitats in the future and would offset some of these historic losses of EFH.

The incremental cumulative effect of the Proposed Actions were determined to be less than significant.

7.7.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to EFH, the following environmental commitments shall be implemented:

- BMPs to reduce sedimentation and erosion into adjacent water bodies during construction
- Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.
- Continued coordination with natural resources agencies to ensure final design of features enhance fish habitat to the fullest extent practicable

7.8 WILDLIFE

7.8.1 REGULATORY FRAMEWORK

This wildlife resources section addresses compliance for the following applicable environmental laws and regulations:

- Fish and Wildlife Coordination Act
- Bald and Golden Eagle Act of 1940, as amended
- Migratory Bird Treaty Act of 1918
- EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

Impacts to wildlife would be considered significant if an alternative resulted in substantial loss of native wildlife habitat or the direct loss of wildlife within the study area as a result of implementing the proposed actions.

7.8.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 – NO ACTION ALTERNATIVE – Without implementation of the proposed action, there would be no actions taken to lift the LPV levees or raise floodwalls. However, maintenance activities associated with HSDRRS would continue to occur. Wildlife that currently utilize the levees would continue to do so with negligible temporary disturbance from maintenance activities.

Under the No Action Alternative, no borrow areas would be utilized for the improvement of LPV levees. However, because known borrow sites are existing operating businesses, these borrow sites may continue to be used for activities by others. As the sites are excavated, wildlife would be temporarily displaced. Once the sites have been fully excavated, they may be converted to ponds and small lakes which may provide some wildlife habitat. Any excavated borrow pits that remain dry would be expected to be colonized by vegetation and woody plants. As vegetation density increases, the pit could attract a variety of wildlife including birds, reptiles, amphibians, and small mammals.

RSLR, human encroachment and development, and other factors would continue and result in the continued loss of habitat. RLSR would increase saltwater intrusion and exacerbate ongoing conversion of marsh habitat to shallow open water. Figure 4-10 (above) depicts the anticipated wildlife habitat landscape of the study area and vicinity in 2067 based on CPRA 2017 Master Plan data. As habitat loss continues, migratory avian species would have less suitable stopover habitat forcing them to fly further to suitable habitat. Most mammalian, amphibian, and reptilian species would migrate to habitats that are more suitable. Wildlife would benefit from restoration activities implemented by other programs; however, these activities are not likely to be enough to keep up with the current trends in habitat loss and RSLR.

PROPOSED ACTION ALTERNATIVES – Impacts of Alternatives 2 and 3 are expected to be identical.

***Direct Effects* –** Wildlife in the vicinity of the study area may be temporarily stressed as a result of construction from increases in noise and traffic. Wildlife would be directly impacted by the loss of habitat in bottomland hardwoods areas adjacent to Mississippi River levees. Mobile

wildlife species, such as rodents and birds, would be expected to leave the area during construction activities. Mortality rates for smaller, less mobile wildlife species such as amphibians and reptiles may increase during turf removal and grading activities on the levees. Following completion of construction, occasional direct and indirect impacts to less mobile species would continue to occur during routine maintenance. Most species of mobile organisms would likely relocate to nearby extensive wetlands and shoreline habitats. The habitat value of the maintained levees is limited, and large wildlife species, predominantly birds and small mammals that hunt and forage in the levee turf grass and adjacent vegetation, do not generally shelter or nest there. These species would be expected to move to nearby habitat for these activities during construction. Given the extent of similar or higher quality habitats in the vicinity of the levee lifts, wildlife movement would not result in impacts to the carrying capacity of nearby environments. Re-vegetating the area with turf grass would restore this temporarily lost terrestrial habitat, and wildlife species would return once construction activities are complete.

Protected species that may occur in the coastal parishes of this study area include colonial nesting water/wading birds including the formerly listed brown pelican (*Pelecanus occidentalis*) and various raptors including the formerly listed bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrines*).

Indirect Effects – The presence of construction-related activities, machinery, and noise would be expected to cause wildlife to avoid the area during construction; therefore indirect impacts would occur on wildlife currently inhabiting the study area, and wildlife would migrate to other adjacent habitats.

GENERALIZED BORROW AREAS – As borrow sites are excavated, wildlife would be displaced. Once the material is excavated, however, the areas would be converted to aquatic habitat or scrub/shrub communities, which would offer habitat to some terrestrial and aquatic species. The lands surrounding potential borrow areas likely contain a variety of mammals, birds, reptiles, and amphibians. Species likely inhabiting the area include nutria, muskrat, raccoon, white-tailed deer, rabbits, squirrels, and a variety of smaller mammals. If borrow areas hold water and water quality is adequate then herons, egrets, wood ducks, and migratory waterfowl may use these waters. Lands surrounding open waters and borrow pits may offer habitat to mammals, birds, reptiles, and amphibians; however, wildlife habitat within an active borrow area is limited. Any potential borrow site used for the proposed action would require environmental clearance and coordination with state and Federal agencies.

Alternatives 2 and 3 are anticipated to have significant impacts to wildlife resources due to the loss of BLH-wet habitat adjacent to Mississippi River levees.

7.8.3 CUMULATIVE IMPACTS

The work on the LPV reaches discussed in this EIS, combined with previous HSDRRS construction, ongoing development and work on the additional reaches in the vicinity, could impact similar wildlife species. Loss of wetlands and BLH habitat from activities would affect local and regional wildlife species through a loss of foraging, nesting, and rookery habitat and fragmentation of habitat. Aquatic species (*e.g.*, marine mammals) could experience temporary adverse effects from decreased water quality, noise, and other disturbances. The displacement of wildlife from turf grass habitat would be temporary during the construction period, and the

displaced individuals likely would return following project completion. Secondly, this habitat is similar to that which covers extensive areas in the New Orleans region, such as residential lawns and parks, and is not expected to exceed the carrying capacity of this adjacent habitat, so cumulative impacts to wildlife are expected to be minimal. Lastly, the reaches discussed in this EIS are not in close enough proximity to the majority of the other reasonably foreseeable levee lifts, so they are not likely to impact the same local populations of wildlife utilizing the levees in those other areas.

Thus, the potential cumulative impacts on wildlife from the proposed action in conjunction with other construction projects in the region would be significant due to the loss of BLH-wet habitat.

7.8.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to wildlife resources, the following environmental commitments shall be implemented:

1) Biological monitoring during construction activities
2) Use of dust suppression methods such as watering of construction sites
3) Pre-construction colonial nesting bird surveys conducted by USFWS and USACE and avoidance of active nests
4) Prevention of colonial nesting birds from establishing active nests within the project construction right-of-way to prevent nesting close to the noise and disturbance caused by the construction activities. If birds were allowed to establish nests in these areas, they could ultimately abandon eggs or hatchlings.
5) Recommendations to minimize potential project impacts to eagles and their nests are provided by the USFWS in their National Bald Eagle Management Guidelines and these recommendations would be followed during construction of the proposed actions.
6) USFWS recommends that a qualified biologist inspect the proposed work sites for the presence of undocumented nesting colonies during the nesting season (e.g. February through September depending on the species). If colonies exist, work should not be conducted within 1,000 feet of the colony during the nesting season.

7.9 THREATENED & ENDANGERED SPECIES

7.9.1 REGULATORY FRAMEWORK

This Threatened and Endangered Species section addresses compliance for the following applicable environmental laws and regulations:

- Endangered Species Act Section 7 (See Appendix L for full compliance details)

Significant Impacts to Threatened and Endangered Species are:

- A direct, adverse effect on a species protected under the ESA or an unmitigated loss of critical habitat that diminishes a regional population
- An unmitigated net loss of habitat value or sensitive habitat of special biological significance
- A substantial loss to the population of any protected species

7.9.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Degradation and loss of important fish and wildlife habitats would continue due to human development and natural forces. Many different fish and wildlife species use these habitats for shelter, nesting, feeding, roosting, cover, nursery, and other life history requirements. The loss and deterioration of transitional wetland habitats would continue to adversely impact all listed species in and near the vicinity of the study area. It is assumed the positive impacts of Federal, state, local, and private restoration and recovery projects and programs would offset, to some degree, the adverse cumulative impacts on listed species.

PROPOSED ACTION ALTERNATIVES AND GENERAL BORROW AREAS – Alternatives 2 and 3 are expected to have identical impacts to Threatened and Endangered Species. Appendix G provides additional details on direct and indirect impacts to Threatened and Endangered Species. Table 7-5 summarizes the impacts for proposed action alternatives and generalized borrow areas.

1) *West Indian Manatee* – USACE determined that the potential for a manatee to be in the project area during construction was unlikely, and that the proposed action was not likely to adversely affect this species. USACE committed to implement BMPs to further reduce the potential effects. These measures include, but are not limited to, reducing vessel traffic speed, posting signs of the potential presence of manatees, and halting construction activities in the event a manatee is observed in the area.
2) *Gulf Sturgeon* - During construction, temporary, minor impacts to water quality would occur. Construction of foreshore protection would have a minor, permanent impact to approximately 24.3 acres of critical habitat along the Lake Pontchartrain shoreline that was previously impacted by foreshore protection placement. Construction of access channels and adjacent stockpiles would temporarily impact approximately 178.2 acres of critical habitat. Mitigation measures to minimize impacts to Gulf sturgeon would be necessary to minimize any potential impacts. Overall impacts to Gulf sturgeon and Gulf sturgeon critical habitat are expected to be insignificant due to their temporary nature and the relatively small footprint in comparison to the size of other available habitat. USACE determined that the proposed action is not likely to adversely affect this species.
3) *Pallid Sturgeon* – During construction, potential impacts could include increased turbidity, noise, and disruption of migration path. Mitigation measures to minimize impacts to pallid sturgeon would be necessary to minimize any potential impacts. These effects are expected to dissipate upon completion of construction. USACE determined that the proposed action was not likely to adversely affect this species.
4) *Sea Turtles* – Five species of sea turtles have the potential to be affected by water quality impacts or by direct injury of mortality. The study team determined that the proposed action was not likely to adversely affect these species but committed to implement BMPs to further reduce the potential effects. These measures include, but are not limited to, construction personnel instruction, siltation barrier requirements, reducing vessel traffic speed, and halting construction in the event a sea turtle is observed.

Overall, the Proposed Actions, including borrow areas, would be less than significant for Threatened and Endangered Species.

Table 7-5 Lake Pontchartrain and Vicinity Summary of Threatened and Endangered Species ESA Determination

Common Name	Alternative		Generalized Borrow Areas
	2	3	
West Indian Manatee	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect
Gulf Sturgeon and Gulf Sturgeon Critical Habitat	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect
Pallid Sturgeon	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect
Sea Turtles	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect	No effect

7.9.3 CUMULATIVE IMPACTS

Past, ongoing, and future construction of hurricane and storm damage reduction project and flood risk reduction projects and the associated excavation of borrow areas contribute to cumulative impacts on water quality of protected species habitat in the study area.

Direct impacts on protected species habitat would occurred as a result of past filling of waterways and wetlands for right-of-way for the HSDRRS. The direct cumulative impacts on protected species habitat are associated with construction activities likely causing increased sedimentation of waterways from stormwater runoff during rain events. The direct impacts include changes in water temperature, salinity, turbidity, DO, hydrology, and water velocity. These water quality impacts would impact the protected species by degrading their aquatic habitat and potentially impacting their food sources, abilities to forage, and visibility for migration and escape from predators. Within much of the study area, no cumulative direct or indirect impacts on protected species would be expected to occur. Cumulative indirect, long-term impacts from the conversion of natural areas could increase marsh fragmentation, alter hydrology, and in turn affect habitat quality, degrading habitat for some protected species.

Other projects proposed in southeastern Louisiana could potentially lessen impacts from implementation of LPV, including other coastal and wetland restoration projects. Projects such as these would provide cumulative long-term beneficial impacts on protected species. Some of these projects in southeastern Louisiana would include restoration projects which create numerous acres of marsh through the beneficial placement of dredged sediments from the Mississippi River. Enhancement of habitat through wetlands and coastal restoration projects would provide long-term benefits to the area and would be beneficial to protected species.

The work on the LPV reaches discussed in this EIS, combined with work on the additional reaches in the vicinity, may affect but is not likely to adversely affect threatened and endangered species resulting in less than significant cumulative impacts.

7.9.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to threatened and endangered species, the following environmental commitments shall be implemented:

1) Use specific construction times to avoid threatened and endangered species
2) BMPs to reduce sedimentation and erosion into adjacent water bodies during construction
3) During construction, standard manatee protection measures as outlined in Appendix L would be implemented to minimize potential impacts to manatees.
4) During construction, standard Gulf sturgeon protection measures as outlined in Appendix G would be implemented to minimize potential impacts to Gulf sturgeon.
5) During construction, standard sea turtle protection measures as outlined in Appendix G would be implemented to minimize potential impacts to sea turtles.
6) Potential impacts to SAV in Lake Pontchartrain would be avoided. Pre-construction surveys would be required to delineate existing SAV to facilitate avoidance of impacts. SAV surveys and avoidance of impacts would be included in construction contract solicitation language.

7.10 INVASIVE SPECIES

7.10.1 REGULATORY FRAMEWORK

This invasive species section addresses compliance for the following applicable environmental laws and regulations:

- EO 13112, Invasive Species
- EO 13751, Safeguarding the Nation from the Impacts of Invasive Species

Impacts to invasive species would be considered significant if an alternative resulted in a substantial spread or introduction of invasive species into the study area as a result of the proposed action.

7.10.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Invasive species would likely continue to pose a threat in and near the study area. Landscape disturbances and deteriorations would be expected to continue into the future allowing for continued and expanded invasions by non-native species. Existing native vegetative communities would be expected to degrade and become vulnerable to infestation. Invasive species would replace native vegetation, forming monoculture stands of dense vegetation. Habitats may realize some benefit from establishment of invasive species in some areas. For example, the robust above and belowground production of cogongrass (*Imperata cylindrical*) may provide substrate stabilization and biomass contributions; or water hyacinth (*Eichhornia crassipes*) may provide potential water quality improvement through nutrient uptake and retention. However, it is expected that the overall adverse impacts of invasive species spread and abundance into the future outweigh the potential benefits. Expected adverse impacts may include reduced vegetative biodiversity, alteration of soil properties and ecosystem processes, and reduction in wildlife food and

habitats. The existing invasive species found in the study area would likely continue and new invasive species may become established in the future. Federal, state, and local laws, programs, and regulations aimed at invasive species management and control would be expected to continue.

PROPOSED ACTION ALTERNATIVES AND GENERALIZED BORROW AREAS – Alternatives 2 and 3 are expected to have identical impacts to invasive species. It is expected that the existing invasive species found in the study area would not be affected by the proposed actions. Invasive species are expected to persist with or without any of the proposed actions. The indirect adverse effect documented post HSDRRS construction was the potential for unchecked growth of Chinese tallow and other invasive plant species in borrow areas and this indirect effect may also occur with LPV construction.

The Proposed Action Alternatives and potential borrow areas would have less than significant impacts on invasive species.

7.10.3 CUMULATIVE IMPACTS

Past and ongoing construction projects have contributed to the introduction and spread of invasive species in the study area. The cumulative adverse impacts to the region include reduced biodiversity and altered ecosystem processes. Periodic eradication of invasive/nuisance plant species within the study area are expected to continue by private, non-Federal, and Federal entities. Ongoing mitigation enhancement projects and coastal and wetland restoration projects target eradicating of invasive and nuisance plants followed by plantings of native species. These efforts would lessen the adverse impacts locally; regionally, however, invasive species are expected to continue to have adverse impacts to the environment.

The proposed action, when considering the past, ongoing, and future actions would have negligible, less than significant cumulative impacts on invasive species.

7.10.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to invasive species, the following environmental commitments shall be implemented:

1) During construction, steps would be taken to prevent the introduction and spread of invasive species to stay in compliance with EO 13751 (*Safeguarding the Nation from the Impacts of Invasive Species*) and EO 13112 (*Invasive Species*).

7.11 CULTURAL & HISTORICAL RESOURCES

7.11.1 REGULATORY FRAMEWORK

This cultural and historic resources section addresses compliance for the following applicable environmental laws and regulations:

- National Historic Preservation Act Section 106
- Cultural Resources Management Presidential Memorandum regarding Government to Government Relations (April 29, 1994)

- EO 13007, Indian Sacred Sites
- EO 11593, Protection and Enhancement of the Cultural Environment
- Native American Graves Protection and Repatriation Act 43 CFR 10
- Archaeological Resources Protection Act of 1989
- National Register of Historic Places

Impacts to cultural resources would be considered significant if an alternative resulted in a substantial adverse effect to a historic property such that implementation of the alternative would result in the destruction of the property or the loss the property's eligibility

7.11.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Without implementation of the proposed action the existing levees and floodwalls would not be modified. Routine maintenance of the existing levee would have no effect on cultural resources. There would be no direct impacts to cultural or historic resources from implementation of the no action alternative. Without the increased level of protection from the implementation of the proposed action, cultural and historic resources that may exist within the study area would be at higher risk for adverse impacts associated with hurricane storm surge, flood events, and land loss.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts to cultural and historic resources.

Direct Effects: Less than significant direct impacts on cultural and historical resources are expected from implementation of the proposed actions within the existing LPV footprint. The proposed levee shifts of the Mississippi River Levee outside of the existing right of way, yet-to-be identified borrow areas, and other project features outside of the existing footprint have the potential to impact known and unknown cultural resources. To comply with Section 106 of the NHPA the USACE would develop a programmatic agreement, if necessary, pursuant to 36 CFR 800.14(b) in consultation with the SHPO, Tribes, and other interested parties.

Indirect Effects: Implementing the proposed action would have beneficial indirect impacts to cultural and historical resources by providing an added level of storm damage risk reduction to known and unknown archaeological sites in the project vicinity on the protected side of the levees, thereby reducing the damage caused by storm events. Erosion of ground deposits during storm events can result in severe damage and destruction of archaeological sites. The proposed alterations to the LPV and MRL projects would have less than significant visual effects to cultural and historical resources as the visibility of the existing project features would not be significantly changed. If any unrecorded cultural resources are determined to exist within the proposed project boundaries, then no work would proceed in the area containing these cultural resources until a USACE archaeologist has been notified and final coordination with the SHPO and THPO has been completed.

All proposed actions for LPV are committed to minimizing any potential for cultural resources impacts by USACE through the Section 106 process. **Therefore, impacts of Proposed Actions would be less than significant for cultural and historic resources.**

GENERALIZED BORROW AREAS – With implementation of the proposed action, borrow material would be removed from the borrow locations identified in the future. Any undiscovered cultural resources could be impacted by borrow activities. All new borrow areas would require Section 106 to determine the existence of known cultural resources eligible for the National Record of Historic Properties. If borrow areas have not been surveyed for cultural resources, Phase I or Phase II cultural investigations would be necessary. If needed, cultural resources surveys would be conducted within the borrow locations and any identified potentially significant cultural resources will be avoided or mitigated. **The potential impacts would be negligible and less than significant as all impacts on cultural resources would be minimized through the Section 106 process.**

7.11.3 CUMULATIVE IMPACTS

Projects controlled by, and projects that acquire their funds from, Federal sources are subject to Section 106 guidelines and processes under the National Historic Preservation Act. Under these laws, the Federal entity is required to consider the effects of their projects upon cultural resources. Cultural resources or historic properties include any prehistoric or historic district, archaeological site, structure, or object included or eligible for listing on the NRHP. All Federal hurricane and coastal storm risk reduction, flood risk reduction, coastal and wetland restoration, and transportation projects are subject to these guidelines and processes, and therefore such Federal projects should not cumulatively adversely affect cultural resources.

While many cultural resources surveys have been conducted within the vicinity of the proposed action, future and concurrent regional projects still have the potential to adversely affect cultural resources by the destruction of all or part of eligible archaeological sites, modification of historic structures, or alteration of the view shed of historic districts. However, for Federal projects, if any unrecorded cultural resources are determined to exist within a project's boundaries, then no work will proceed in the area containing these cultural resources until the SHPO and Federally recognized Tribes have been notified. **As such, other Federal current and future regional projects would potentially have minor, less than significant, direct and indirect cumulative adverse impacts on cultural resources.**

7.11.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to cultural and historic resources, the following environmental commitments shall be implemented:

1) General cultural resources mitigation measures as outlined in Section 5.2.1.12.1 of the CED, Phase 1 (USACE, 2013) would be followed.

2) USACE will develop a programmatic agreement, if necessary, pursuant to 36 CFR 800.14(b) in consultation with the SHPO, Tribes, and other interested parties.

7.12 AESTHETICS

7.12.1 REGULATORY FRAMEWORK

This aesthetic resources section addresses compliance for the following applicable environmental laws and regulations:

- National Environmental Policy Act, 23 USC Section 109(h)
- 1988 Visual Resources Assessment Procedure
- Wild and Scenic Rivers Act
- Scenic Byways
- Louisiana Scenic Streams Act

Impacts to aesthetics (visual) would be considered significant if an alternative substantially degraded any existing institutionally, technically or publically significant visual resource.

7.12.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Under the No Action Alternative, the proposed action would not be constructed. The visual environment attributed to cultural landscapes and historic structures existing within the study area would be at risk for adverse impacts associated with storm events and land loss. Other visual resources would evolve from existing conditions as described in forecasting of future conditions (Section 4.12.2.).

Existing borrow sites are actively used by private individuals, non-Federal, and Federal entities seeking borrow and are visually unappealing. Once abandoned, those sites may convert to lake or ponds. No change to aesthetic or visual resources values from the No Action Alternative would be expected.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

***Direct Effects* –** The visual attributes of the study area would be temporarily impacted by construction activities at the project sites and by transport activities needed to move equipment and materials to and from the sites. Temporary impacts on visual resources would occur during actual implementation of the proposed actions when the area would contain construction equipment and staging areas. The levees and floodwalls would be similar in design and scale to the existing conditions and therefore permanent impacts would be negligible and less than significant. Turf grass would be re-established on the levees after construction, and the appearance of the levees would remain similar to the existing conditions.

***Indirect Effects* –** Maintaining the earthen levees and floodwalls would provide a continued benefit to aesthetic quality due to a reduction in properties damaged by both storm surge and flood events. The visual environmental surrounding would also indirectly affect the surrounding recreational and cultural and historic resources which are further discussed in Sections 7.11 and 7.13 of this document.

Therefore, the proposed action impacts on aesthetics would be less than significant.

GENERALIZED BORROW AREAS – The majority of the existing borrow areas are remote and inaccessible to the public. New borrow sites would be expected to further reduce the study area's aesthetic quality through the introduction of more disturbed borrow sites. Currently, the number and location of potential new borrow sites are unknown. If necessary, site-specific impacts will be discussed in site-specific NEPA documentation once specific sites have been identified.

7.12.3 CUMULATIVE IMPACTS

Short-term adverse cumulative impacts on visual resources has occurred and would continue to occur during all construction activities. Direct cumulative long-term impacts on visual resources from improvements to the risk reduction measures would be minor, as most of the proposed actions remain similar to what previously existed, only at a higher elevation. Additionally, the cumulative impact of the reduction of threat to property posed from flooding would be beneficial to the regional aesthetic resources.

The use of borrow sites for proposed actions would have a cumulative minor impact on visual resources, because most borrow sites would be located on private land with limited to no public access, and where borrow sites are not backfilled, open water habitats would remain and in many cases are also aesthetically pleasing.

Cumulative long-term impacts on visual resources are still evident from Hurricanes Katrina and Rita in some parts of the study area and include degraded, damaged, or destroyed homes, facilities, and recreational parks in some of the areas. In general, all regional projects would have short-term moderate construction impacts on aesthetic resources. Most storm damage and redevelopment projects in the region would have beneficial cumulative impacts on visual quality after the post-construction phase. Hurricane and coastal storm risk reduction projects, flood risk reduction projects, and coastal restoration projects would beneficially impact aesthetic resources and the overall visual view sheds within the study area, as the risk of coastal storm damage and flooding would be reduced and marshes are created or restored. New and restored infrastructure redevelopment projects would also benefit the aesthetic resources in the study area by upgrading aging or failing infrastructure, which often contributes to a blighted visual quality within the area.

The proposed action and use of borrow sites would contribute to the permanent cumulative impacts on visual resources, but regionally, the cumulative impacts on aesthetics would be negligible and less than significant.

7.12.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to aesthetic resources, the following environmental commitments shall be implemented:

- Soil borrow sites for levee building material needed to construct the proposed levees are not specifically identified in this study; therefore, if the visual impacts caused by borrow areas differ from the generalized impacts documented here, further evaluation will be conducted during PED, as necessary.
- Architectural design concepts for floodwalls and other hard structure hurricane and coastal storm damage risk reduction features are not identified in this study; therefore, the visual impacts caused by hard structure hurricane and coastal storm damage risk reduction features will be evaluated during PED.
- If new borrow sites are selected, USACE would be required to fully investigate the proposed borrow area's setting and any impacts on the aesthetic quality of the surrounding area per the NEPA.

7.13 RECREATIONAL RESOURCES

7.13.1 REGULATORY FRAMEWORK

This recreational resources section addresses compliance for the following applicable environmental laws and regulations:

- CEQ 1508.27(b)(3)
- Wild and Scenic Rivers Act
- Louisiana Scenic River Act

Impacts to recreation would be considered significant if an alternative resulted in a substantial effect to the long-term provision of, or access to, recreational uses in the area.

7.13.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Under the no action alternative, the LPV and MRL levee lifts and floodwall raises would not occur. No direct, indirect or cumulative impacts would occur to recreational uses or facilities in the project area. Routine maintenance would continue to cause negligible interference with recreational activities in the vicinity of the LPV project area. Borrow operations would continue at the existing various sites in the vicinity of the study area. Land-based recreational resources, including camps, park structures, and recreation facilities would be susceptible to a higher risk of inundation in the FWOP condition. Water-based recreational resources, such as fishing and hunting, would also be affected from deposits of salt laden waters into interior estuaries thereby affecting fishing opportunities, especially in the short-term. Over time, water-based recreational resource opportunities would return to baseline conditions.

PROPOSED ACTION ALTERNATIVES –- Alternatives 2 and 3 are expected to have identical impacts. Under the proposed action, the levee lifts and floodwall raises would be confined to the existing levee right-of-way except along the MRL where flood-side shifts to levee alignments are anticipated.

Direct Effects – No direct impacts to state or locally-owned recreational facilities are expected because they are far enough from the work areas to avoid impacts. Walking, jogging, biking, dog-walking, and recreating on levee reaches could be prohibited temporarily during construction and access for bank fishing might be limited.

Indirect Effects –There could be minimal, indirect construction-related impacts to recreational resources in the study area, including temporary congestion of traffic corridors. Temporary closures of Lake Pontchartrain lakefront green space would be expected. The MRL levee construction near the Industrial Canal will impact use of the green space on the protected side. The area, adjacent to an historic residential neighborhood, is very popular for dog walking and river site-seeing and active recreational use, including jogging. Use of the area may not be available for the duration of construction activities. The conditions would return to normal after the construction activity is completed.

Adverse impacts on recreational resources from levee lifts and floodwall raises would be negligible and would be limited to short-term recreational access closures during the actual

construction activities. No permanent adverse impacts on recreational resources are anticipated from the proposed actions.

Therefore, impacts from the Proposed Action Alternatives to recreational resources would be less than significant.

GENERALIZED BORROW AREAS – With implementation of the proposed action, borrow material would be removed from the borrow locations to be identified in the future. Existing borrow areas are actively used by private individuals, non-Federal, and Federal entities seeking borrow and are heavily impacted. Upon depletion of a given borrow area, depending how the end site is left, the habitat may be suitable to support some recreation activities (e.g., wildlife viewing and fishing). These benefits are expected to be minimal and sites would remain private, restricting their recreational value to the public. Therefore, there would be no direct, indirect, or cumulative impacts to recreational resources in the region related to existing borrow areas. If new borrow sites are required, then these new areas would need to be investigated and evaluated under NEPA.

7.13.3 CUMULATIVE IMPACTS

Present and future actions by USACE, other agencies, businesses, or the public would likely contribute to cumulative improvement to recreational resources, as many projects in the area include ecosystem and recreational infrastructure improvement. The CED, Phase I (USACE, 2013) discusses the cumulative impacts of present and future regional storm damage reconstruction, redevelopment, coastal, and wetland restoration, and transportation actions on recreational resources and is incorporated by reference here.

Temporary cumulative adverse impacts on recreational resources have occurred in the study area; temporary impacts primarily associated with access closures are expected to occur for the life of the project. Access and navigation to land- and marine-based recreational opportunities and resources have been affected by past and ongoing actions. Noise and water quality issues from past and ongoing flood risk reduction construction activities cumulatively reduce fishing and hunting opportunities within the study area. In addition, the displacement of wildlife due to construction impacts would limit outdoor nature activities such as bird watching, hiking, and photography.

Cumulative impacts from construction might be noticeable to individuals who use the levees for walking or access to bank fishing, but park, field, and trail users would only be affected if a major event generating a lot of traffic were held at the same time that construction traffic is on the roads.

The proposed action in association with past and ongoing flood risk reduction projects provides cumulative benefits for recreational resources in the study area by reducing flood and storm damage risk to recreation facilities, museums, sporting arenas, recreational paths, park infrastructure, and green space.

Cumulatively, the proposed action construction and future borrow site excavation would have negligible permanent impacts on recreational resources. Where construction projects cross recreational areas, temporary closures of access can occur. Some green space and other recreational areas may be permanently lost or impacted, but cumulatively, improvements

offered through these regional projects would provide beneficial effects on recreational resources in the study area. **Regionally, the permanent cumulative impacts on recreational resources would be negligible and less than significant.**

7.13.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to recreational resources, the following environmental commitments shall be implemented:

- Continued coordination with LDWF, Scenic Rivers Program regarding any additional permits or conditions that may be required.
- Continued coordination with NPS
- The CEMVN would ensure that impacts and encroachments onto public lands are avoided.
- USFWS recommends the Corps should avoid impacts to public lands, if feasible. If not feasible, the Corps should establish and continue coordination with agencies managing public lands that may be impacted by a project feature until construction of that feature is complete and prior to any subsequent maintenance.
- As noted in IER #3, lighted marine buoys would be placed in Lake Pontchartrain to delineate the hazard of the stockpiled dredged sediment for the project work.

7.14 AIR QUALITY

7.14.1 REGULATORY FRAMEWORK

This air quality resources section addresses compliance for the following applicable environmental laws and regulations:

- Clean Air Act
- General Conformity Rule (see Appendix G for full compliance details)

Impacts to air quality would be considered significant if an alternative resulted in emissions that exceeded the General Conformity de minimis thresholds associated with the Clean Air Act.

7.14.2 IMPACTS OF PROPOSED ACTION

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Under the No Action Alternative, there would be no potential for direct, indirect, or cumulative effects to air quality because construction of the proposed action would not occur, and the attainment area status for the study area is not anticipated to change from current conditions. St. Bernard Parish is expected to continue to be in non-attainment for sulfur dioxide.

Existing borrow areas are actively used by private individuals, non-Federal, and Federal entities seeking borrow. On-going air quality impacts form activities at the borrow sites would include temporary diesel and gasoline emissions from the operation of construction equipment and the creation of particulate emissions generated by activities that disturb and suspend soils. However, the attainment area status of the parishes is not anticipated to change from the current conditions.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct Effects – Probable direct impacts to air quality would include temporary diesel and gasoline emissions from the operation of construction equipment and temporary creation of particulate emissions during project construction. Construction workers would temporarily increase the combustible emissions during their commute to and from work. The emissions from supply trucks and workers commuting to work would temporarily impact air quality in the vicinity of the project area. Operation of construction equipment and support vehicles would also generate Volatile Organic Compounds (VOCs), Particulate Matter $(PM)_{10}$, $PM_{2.5}$, Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Ozone (O_3) and Sulfur Oxides (SO_X) emissions from diesel engine combustion. During the construction of the proposed action, proper and routine maintenance of all vehicles and other construction equipment would be implemented to ensure that emissions are within the design standards of all construction equipment. Due to the short duration of the construction project, any increases or impacts on ambient air quality would be expected to be short-term and minor and would not be expected to cause or contribute to a violation of Federal or state ambient air quality standards. Long term, there is no anticipated effect to air quality. Regional air quality standards would not be violated. The proposed project would be in conformance with NAAQS.

Indirect Effects – The indirect effects to air quality of implementing the proposed action would be related to the emissions from transportation of personnel and equipment to and from the job site on a daily basis until the completion of construction.

CONFORMITY DETERMINATION –

The General Conformity Rule (40 CFR Part 93) ensures that the actions taken by Federal agencies in nonattainment and maintenance areas do not interfere with a state's plans to meet national standards for air quality. A conformity determination evaluates whether a Federal action meets the requirements of the general conformity rule and must be performed when a Federal action generates air pollutants that would exceed conformity threshold ("de minimis") levels in a region designated as a non-attainment or maintenance area for one or more NAAQS. If emissions would not exceed de minimus levels, a conformity determination is not required. The study team performed a conformity evaluation for the proposed action for sulfur dioxide emissions in St. Bernard Parish and determined that emissions would not exceed *de minimis* thresholds. See Appendix G for details on the conformity analysis.

GENERALIZED BORROW AREAS – For generalized borrow locations, impacts resulting from implementation of the proposed action would be expected to be similar to the FWOP conditions. There would be short-term impacts to air quality that would result from the operation equipment to excavate, move and transport borrow. Air emissions would be controlled by implementation of BMPs. Air quality impacts would be limited to those produced by heavy equipment and suspended dust particles generated by bulldozing, dumping, and grading. Operation of construction equipment and support vehicles would generate VOCs, PM_{10}, $PM_{2.5}$, NO_x, CO, O_3, and SO_x emissions from diesel engine combustion. The construction equipment should have the same emissions as local traffic in the areas. Duration of the impacts to air quality would depend upon the daily frequency of trucks, weather, and the amount of borrow available.

Air emissions from the proposed action would be temporary and would have less than significant impacts to air quality in the region and are not expected to cause or contribute to a violation of Federal or State ambient air quality standards.

7.14.3 CUMULATIVE IMPACTS

Cumulative effects to air quality may be noticeable if construction activities and borrow operations are conducted simultaneously. The limited temporal and quantitative contribution of emissions from the proposed action to cumulative air emissions from other area sources such as vehicles and other potential levee lifts in the vicinity of the study area would not be expected to alter the existing attainment status of these parishes.

A number of construction projects are occurring or are planned for the study area that would produce air emissions, including hurricane storm damage risk reduction projects, flood risk reduction projects, Sections 404/10/408 permitted actions, several hotels and high-rise housing projects, and riverfront development[11]. Present and future regional actions, along with the proposed action, would increase the ambient air pollution levels in the New Orleans Metropolitan Area, and local citizens may experience an increased exposure to air pollution. Other storm and flood risk reduction construction projects could potentially increase and extend the time that local residents are exposed to an elevated air pollution level. However, most of these emissions would occur primarily during construction activities and therefore would cause only short-term cumulative impacts on air quality. **The ambient air quality should return to pre-construction conditions once completed, and permanent cumulative impacts on air quality would be negligible and less than significant.**

7.14.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to air quality, the following environmental commitments shall be implemented:

1) Dust suppression methods would be implemented to minimize fugitive dust emissions.
2) Standard construction BMPs would be used during construction of the proposed action, including proper and routine maintenance of all vehicles and other construction equipment to ensure that emissions were within the design standards of all construction equipment.
3) Construction equipment and haul trucks would have catalytic converters and mufflers to reduce exhaust emissions.
4) Conformity analyses would be conducted for borrow areas located in non-attainment areas.

7.15 NOISE

7.15.1 REGULATORY FRAMEWORK

This noise section addresses compliance for the following applicable environmental laws and regulations:

- Noise Control Act of 1972, as amended by Quiet Communities Act of 1978

[11] Available online at: https://nola.curbed.com/maps/new-orleans-riverfront-development-construction-mapped. Accessed 19 November 2019.

- NEPA
- Local Noise Ordinances

Impacts to noise would be considered significant if an alternative resulted in:

- Substantial permanent increase in ambient noise levels for adjacent sensitive receptors
- Exposure of persons to or generation of noise and vibration levels in excess of standards established by local/regional noise ordinances or applicable standards of other agencies

7.15.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Noise impacts would be similar to those under existing conditions because there would be no direct or indirect impacts from construction equipment. Future maintenance activities could result in a slight increase in noise levels from equipment and activities associated with maintenance activities but any increase in noise levels is anticipated to be temporary.

Existing borrow sites would be actively used by private individuals, non-Federal, and Federal entities seeking borrow. Noise levels would be expected to be similar to existing conditions of continued operation of borrow areas. These noise impacts related to borrow operation would continue until the borrow area is depleted.

Local and temporary noise typically associated with human activities and habitations such as car and truck traffic, operation of commercial and recreational boats, water vessels, airboats, and other recreational vehicles; operation of machinery and motors; and human residential-related noise (air conditioners, lawn mowers, etc.) would likely continue to affect humans and animals in the study area in the future. Noise levels may increase slightly with increasing population and industrialization in the study area. Changes in local noise ordinances may also increase or decrease future noise levels.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct and Indirect Effects – Noise along the existing right-of-way would increase due to the temporary operation of equipment and vehicles used in the construction of the levee lifts and floodwall raises. While noise impacts may cause a temporary inconvenience to residents and facilities in the immediate area, noise levels associated with construction activities would be temporary and monitored to ensure acceptable standards are maintained. No permanent noise impacts as a result of LPV construction is anticipated, and all noise emissions are expected to be short-term, lasting only as long as construction activities. No long-term indirect effects on noise are anticipated with implementation of proposed actions.

Noise levels associated with construction activities have the potential to temporarily impact wildlife that may be present in the area, but would not be significantly different from noise associated with other human activities that occur on a daily basis. After completion of the proposed action, noise levels would be expected to return to pre-action levels. Future maintenance activities could result in a slight increase in noise levels from equipment and

activities associated, but any increase in noise levels associated with maintenance activities is anticipated to be lower and of shorter duration.

Table 7-6 describes noise emission levels for construction equipment that would be expected to be used during the proposed construction activities. As can be seen from this table, the anticipated noise levels at 50 feet range from 76 dBA to 83 dBA based on data from the Federal Highway Administration. All construction is anticipated during daytime hours. After completion of the proposed action, noise levels would be expected to return to pre-action levels. Future maintenance activities could result in a slight temporary increase in noise levels from maintenance equipment such as mowers, but would be the same as the currently existing conditions.

Table 7-6. Sound Levels (dBA) of Construction Equipment and Modeled Attenuation at Various Distances

Noise Source	Distance from Source				
	50 feet	100 feet	200 feet	500 feet	1,000 feet
Dump Truck	76 dBA	70 dBA	64 dBA	56 dBA	50 dBA
Compactor/ Roller	83 dBA	77 dBA	71 dBA	63 dBA	57 dBA
Excavator	81 dBA	75 dBA	69 dBA	61 dBA	55 dBA
dBA at 50 feet is a measured noise emissions. The other distances are modeled estimates. Source: USDOT, 2006					

Table 7-7 summarizes the sensitive noise receptors located in the LPV sub-basins that would be exposed to noise emissions associated with the proposed LPV action. These noise receptors are located along the proposed levee raises and were previously identified by USACE (2013). Noise emissions would be expected throughout the construction period for each project feature. Construction periods may range from 1 to 2 years. Construction would only occur during times allowed by applicable noise ordinances (see Section 4.15.) While the noise emissions would create major impact to sensitive receptors during construction activities, they would be temporary and limited to active construction windows and sporadic (over 50 years), making long-term impacts from noise emissions negligible and less than significant.

Table 7-7. Number of Sensitive Noise Receptors Impacted from Proposed Action (USACE, 2013)

Sub-Basin	Number of Sensitive Noise Receptors				
	Single-Family Homes	Apartment Buildings	Churches	Schools	Hospitals
St. Charles	4	0	0	0	0
Jefferson East Bank	632	45	3	2	1
Orleans East Bank	460	46	2	6	2
Jefferson East Bank & Orleans East Bank	98	4	1	0	0
New Orleans East	1,206	23	2	2	0
Chalmette Loop	13	0	0	0	0
TOTAL	**2,413**	**118**	**8**	**10**	**3**

GENERALIZED BORROW AREAS – Temporary noise would occur during construction and hauling activities associated with equipment such as bulldozers, excavators, and dump trucks. It is assumed that excavation and hauling would be limited to daylight hours (10 – 14 hours per day) seven days a week. However, this may change due to construction schedules, weather conditions, and project borrow needs. Nearby residential areas may be impacted by elevated noise levels due to excavation and hauling. Actual noise impacts would depend on locations of borrow sites relative to sensitive receptors, construction schedules, which are dependent on weather conditions and specific borrow area characteristics, which are not known at this time.

Therefore, the noise impacts of the proposed action alternatives would be less than significant.

7.15.3 CUMULATIVE IMPACTS

Cumulative noise impacts associated with LPV construction activities would be periodically major due to the number of sensitive noise receptors adjacent to proposed action; however, these impacts would be short-term and would end when construction is completed. No permanent cumulative impacts would occur from LPV construction.

A number of construction projects are occurring or planned for the region that would produce noise emissions. The construction activities for these projects would potentially increase the ambient noise levels in the study area and extend the time that local residents are exposed to elevated noise levels.

Storm damage reconstruction and redevelopment projects would potentially cause temporary adverse impacts in the study area; should pile driving operations occur, those impacts could be major. If LPV construction projects coincide with other construction projects, then the short-term adverse cumulative impacts would occur on sensitive noise receptors in the region.

Overall, noise associated with LPV construction and other regional projects would be limited to specific locations of construction activities and would be temporary in nature. **Regional, long-term cumulative noise impacts would be negligible and less than significant.**

7.15.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts from noise, the following environmental commitments shall be implemented:

1) Adherence to the local noise ordinances.
2) Construction equipment would be routinely checked to ensure that the equipment is operating properly.

7.16 TRANSPORTATION

7.16.1 REGULATORY FRAMEWORK

This transportation section addresses compliance for the following applicable environmental laws and regulations:

- Federal Aid Highway Act

Impacts to traffic would be considered significant if an alternative resulted in an increase in traffic which is substantial in relation to the existing traffic load and capacity of the local road network.

7.16.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – Under the No Action Alternative, the levee lifts and floodwall raises would not occur. The routine maintenance of public roads around the project area would continue. It is assumed that major transportation corridors within the study area would likely become more vulnerable to storm damage in the future without action. Some transportation routes may also become more vulnerable due to future loss of coastal marshes, which act as natural buffers to tropical storms and hurricanes.

Under the No Action Alternative, known borrow area sites are likely to continue to be used by private individuals, non-Federal, and Federal entities seeking borrow. The use of these borrow areas is anticipated to continue until they have exhausted the borrow supply, and the current impact of borrow pit use on area roads would continue until the pit is exhausted.

It is anticipated that there would be no direct, indirect, or cumulative impacts to transportation as the result of taking no action.

PROPOSED ACTION ALTERNATIVES – The impacts on transportation between Alternatives 2 and 3 are expected to be identical unless otherwise noted.

Direct Effects – Use of the area's roads would increase during construction due to the presence of construction related vehicles and activities. It is assumed the same transportation corridors would be used for construction of LPV as previously used during HSDRRS construction. The CED, Phase I describes the estimated transportation impacts and is incorporated by reference (USACE, 2013) and only briefly summarized here. Construction equipment such as bulldozers and graders would need to be delivered to the construction sites. Haul trucks would be entering and exiting the areas on a daily basis during the period of construction. The truck hauling would temporarily impede vehicle traffic and result in minimal reduction of the level of service on some local road segments. Any increase in traffic would be moderate and temporary. After construction is complete, transportation would return to pre-construction levels.

Assuming a 14 cubic yard dump truck, Alternative 2 would require approximately 592,000 truck trips to haul approximately 8.3 million cubic yards of in-place borrow material to the project sites. For Alternative 3, approximately 664,000 truck trips to haul approximately 9.3 million cubic yards of in-place borrow material to the project sites. The number of miles and the transportation route for each truck trip would depend upon the borrow pit selected for each reach. The increase in truck traffic would have a short-term temporary impact on the direct travel routes to/from the borrow sites and would result in localized congestion at the construction site.

Indirect Effects – With implementation of the proposed action, indirect effects on transportation would include increased use of existing transportation corridors within the study area.

Overall, the impacts on transportation from implementing the proposed action would be significant.

GENERALIZED BORROW AREAS – With implementation of the proposed action, haul trucks would be entering and exiting the areas on a daily basis during the period of construction. The truck hauling would temporarily impede vehicle traffic and result in a minimal reduction of the level of service on some local road segments. Impacts on roads that are used near borrow areas would occur. Adverse short-term, congestion-related impacts and degradation of the roads would likely be moderate to major during construction period.

7.16.3 CUMULATIVE IMPACTS

The HSDRSS construction and associated excavation of borrow areas contributed directly and indirectly to cumulative impacts on the transportation system throughout the study area. Cumulative moderate adverse impacts such as damage and degradation of infrastructure and roadway wear-and-tear due to increased truck traffic occurred in the study area. Likewise, lower hurricane and coastal storm risk to a portion of the Greater New Orleans Metropolitan Area upon completion of LPV is expected to cause additional economic and population growth in the region and thus increase the demand for transportation resources, which could lead to cumulative indirect long-term adverse impacts. Indirectly, traffic congestion caused by truck traffic on some roadways likely altered traffic patterns of commuters and residents, increasing traffic congestion on roads not directly used for LPV-related transportation.

During construction of HSDRRS, an estimated 1.5 million truck trips were used to deliver the required borrow material. This past action, along with proposed action and other known construction activities, could contribute to cumulative impacts on transportation on major roads such as Interstate 10. However, this cumulative impact would be short term and is not considered significant given the existing high traffic volumes present on these major roads.

Short-term cumulative adverse impacts on transportation caused by increased construction traffic, congestion from transporting materials (primarily borrow material) to project construction locations, and temporary road closures resulting from the implementation of the proposed action. Damage to pavement from increased truck traffic may occur. Short-term cumulative impacts on residents from construction and traffic noise occurred during HSDRRS improvements and ongoing redevelopment construction activities and transportation improvement projects. Similar impacts are expected with the proposed actions.

If one or more of the levee lift projects in the vicinity uses the same borrow pit at the same time as the LPV reaches, local roads in the immediate vicinity of the borrow pit would see a cumulative impact of a further reduction in level of service or traffic congestion. This cumulative impact would be temporary and would return to pre-project conditions once the hauling of material for the levee lifts is complete.

Present and future actions by USACE and other agencies for project construction and maintenance would likely further contribute to cumulative degradation of roadway pavement and traffic congestion, since many projects require the use of heavy trucks and construction equipment. The CED, Phase I describes other present and future regional actions and is incorporated by reference (USACE, 2013), and only summarized here. The combination of LPV construction, excavation of borrow areas, and other regional projects (*e.g.*, transportation, storm damage reconstruction, coastal and wetland restoration, and flood risk reduction projects) would contribute directly and indirectly to cumulative impacts on transportation in the study area.

Cumulative moderate adverse impacts such as increased traffic, damage and degradation of infrastructure, and roadway wear-and-tear due to increased truck traffic, in conjunction with concurrent regional construction projects, would be expected within the LPV study area. Likewise, lower flood and coastal storm damage risk in the Greater New Orleans Metropolitan Area upon completion of the LPV would cause additional economic and population growth in the region and thus would increase the demand for transportation resources, which could lead to cumulative indirect long-term adverse impacts. Construction of the LPV would also provide beneficial impacts on transportation resources in the region, as it reduces flood and coastal storm damage risk and future storm damage to these resources. The LPV construction has the long-term potential to save millions of dollars in repair costs for highways, roads, bridges, railroads, airports, and public transit systems (streetcar lines) that could otherwise be damaged by future flooding.

The cumulative impacts on transportation would be significant for implementation of the proposed action.

7.16.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to transportation resources, the following environmental commitments shall be implemented:

1) Use of flagmen, signage, cones, barricades, temporarily re-routing roads during construction, and installation of temporary turn lanes near construction areas
2) Appropriate measures to ensure safety and facilitate the movement of traffic would be implemented at all approved borrow areas
3) Use of dust suppression methods such as watering of construction sites
4) Traffic coordination meetings with local and state transportation departments would be held to discuss traffic situations, conditions, and traffic management strategies.

7.17 HUMAN ENVIRONMENT

7.17.1 REGULATORY FRAMEWORK

This section addresses compliance for the following applicable environmental laws and regulations:

- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

Impacts to the human environment would be considered significant if:

- Socioeconomic impacts resulted in a substantial shift in population trends or adversely affected regional spending and earning patterns
- Environmental Justice impacts resulted in a disproportionate adverse environmental impact to a minority or low-income population.

7.17.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – The No Action Alternative would not raise the levees to provide hurricane and storm damage risk reduction for a 1% AEP storm. There

would be no direct impact on minority and/or low-income population groups or the human environment under this alternative since construction of levee lifts would not occur. However, since this alternative fails to provide full flood risk reduction for a 1% AEP storm at year 2073, the actual and perceived risks to minority and/or low-income population groups under this alternative would be higher than under the with-project alternatives.

Indirect impacts under the No Action Alternative include a higher potential for permanent displacement of minority and/or low-income population groups as compared to the with-project alternatives as residents relocate to areas with higher levels of storm risk reduction. There would be no indirect impacts to the human environment.

PROPOSED ACTION ALTERNATIVES – Alternatives 2 and 3 are expected to have identical impacts.

Direct Effects – There are no direct impacts to socioeconomic resources from the LPV and MRL projects. No permanent adverse direct impacts on population and housing, business and industry, employment and income, community and regional growth, or community cohesion is expected to occur as a result of Alternatives 2 and 3. All of the LPV construction activities would take place in existing ROWs and within areas already environmentally assessed for NEPA (USACE, 2013) and would not directly impact the human environment. MRL improvements would take place on the flood-side of the system, sparing impacts to the human environment. Additionally, no permanent disproportionate impacts are expected to occur on any minority or low-income community from LPV and MRL construction.

Indirect Effects – The socioeconomic indirect impacts from LPV and MRL projects would be primarily beneficial and include hurricane and coastal storm risk reduction resulting from increasing the heights of the levees/floodwalls for the 1% AEP or 0.5% AEP storm events. Indirect impacts include temporary, minor inconveniences from construction activities to those living near the HSDRRS or Mississippi River levees, such as increases in traffic and noise and inability to recreate in areas affected by construction.

The HSDRRS CED Phase I study identifies EJ communities and EJ resource impacts from construction of the HSDDRS for LPV and those findings are incorporated into this analysis. The link, https://www.mvn.usace.army.mil/Missions/Environmental/NEPA-Compliance-Documents/HSDRRS-Projects/ provides the IERs, the CED report and the EJ analysis for the five parish HSDRRS study area. The following is a brief summary of the EJ findings presented in the CED Phase I report.

St. Charles Parish consists of levee sections that are assessed in IER #1, and includes the low-income and minority communities of Norco, New Sarpy, Destrehan, and St. Rose, and IER #2 which does not have EJ communities adjacent to the proposed levee work. The largest census block group near the project corridor does not have a population because it encompasses mostly marshland and part of the Shell Chemical industrial complex. Jefferson Parish consists of levee segments that were assessed in IER #3 which does not have minority communities along the levee corridor but there are several low-income neighborhoods. Orleans Parish consists of levee segments that were assessed in IER #4, #5, #6 and #7 and includes EJ communities meeting the minority and low-income criteria.

St. Bernard Parish consists of levee segments along the MRL which were not assessed in the CED Phase I report. The communities along the LPV MRL segment in St. Bernard include Chalmette, Meraux, Violet and Poydras. Violet, Chalmette and Poydras have a majority of population identifying as a minority or are low-income. EJ neighborhoods are near the proposed levee MRL lifts and all of the levee improvements that are on the protected side will be completed within the existing ROW.

Table 7-8 LPV MRL Minority Population

Subject	Chalmette CDP	Meraux CDP	Violet CDP	Poydras CDP	St. Bernard Parish
Total population	22,907	7,073	5,705	2,695	45,067
Minority	29.7%	19.9%	67.0%	17.1%	30.1%
HISPANIC OR LATINO					
Hispanic or Latino (of any race)	12.1%	7.9%	8.2%	6.8%	9.9%

Note: Red font identifies minority population exceeding 50 percent, which is an Indicator of an EJ community.
Source: 2017 U.S. Census Bureau ACS.

Table 7-9 LPV MRL Low-Income Population

Place	Estimate*	Below Poverty Level	Percent Below Poverty Level
Chalmette CDP	22,556	4,589	20.30%
Meraux CDP	7,066	649	9.20%
Violet CDP	5,705	1,337	23.40%
Poydras CDP	2,695	993	36.80%

*Population for whom poverty status is determined

Note: Red font identifies low-income population exceeding 20 percent, which is an Indicator of an EJ community.
Source: 2017 U.S. Census Bureau ACS.

Indirect adverse impacts to EJ communities that are adjacent to the LPV levee and MRL projects may include short-term construction impacts, such as noise during daylight hours, dust, temporary road closures and increases in truck traffic. High, adverse short-term or permanent adverse impacts are not expected to occur as a result of the federal action. Best management practices will be utilized during construction activities that should reduce and minimize noise levels and dust and transportation routes for material delivery will be identified, before construction activities commence, to limit impacts to EJ communities. Short-term adverse

impacts will be felt by communities adjacent to the levee lifts, but also to those in the general metropolitan area as trucks will be using roads to deliver levee material from borrow source sites. All residents in the study area, regardless of race or income level, could be impacted by short-term construction activities. Hurricane and storm damage risk reduction benefits will be conferred to all residents within the HSDDRS. No disproportionate high, adverse impacts on low-income or minority communities are expected from construction, because all residences and businesses could be impacted to some extent and are provided an equal level of risk reduction. Further, all floodwalls and levees are being built adjacent to communities composed of all income levels and races.

In the short-term, construction activities related to proposed action directly provide jobs, benefit businesses through the purchases of materials and supplies, and provide sales tax revenue to local governments. In the long-term, providing a level of risk reduction to communities in southeast Louisiana would improve the confidence of residents and the business community and generate further interest in redevelopment of storm-damaged neighborhoods.

Therefore, implementation of the proposed actions would have less than significant impacts to socioeconomics and environmental justice as related to the implementation of levee lifts and floodwall raises.

GENERALIZED BORROW AREAS – Impacts on socioeconomics and environmental justice may occur as a result of the additional borrow, but until borrow sites are selected, the total impacts cannot be estimated.

7.17.3 CUMULATIVE IMPACTS

Cumulative impacts under the No Action Alternative include the potential for a steady decline in minority and/or low-income population groups and other groups as residents move to areas with lower storm risks as well as continued financial and emotional strain placed on these groups as they prepare for and recover from flood events.

The impacts of past, proposed action, and actions of others associated with raising levees, floodwalls, floodgates, and new construction collectively would continue to have a cumulative beneficial impact on the socioeconomics of southeast Louisiana because these projects are tied directly to regional recovery projects, enhance flood risk reduction, or contribute to wetland and coastal restoration. The CED, Phase I discusses the cumulative socioeconomic and environmental justice impacts of present and future regional actions within the study area and is incorporated by reference (USACE, 2013), and only briefly described here.

The cumulative long-term benefits of the long-term confidence in risk reduction brings are not truly quantifiable, but providing greater safety for everyone with investment interests in southeast Louisiana is a beneficial cumulative economic benefit to Louisiana and the U.S.

Cumulatively, large construction projects have short-term socioeconomic impacts regionally on residents and businesses from increased noise, dust, and traffic congestion. Periodic lane and road closures that delay and idle traffic have indirect cumulative economic adverse impacts due to time lost from other economic-generating activities. All of these projects have the potential to disproportionately impact low-income and minority communities. However, although there would be adverse cumulative impacts on socioeconomic resources within the study area, most of

these impacts would be short-term and occur only during ongoing construction activities of the LPV and other regional projects.

Many Federal agencies have authorized spending in the hurricane-affected areas. Short-term and long-term benefits on community and regional growth would result as local, state, and Federal agencies and non-profits in the region continue to spend money in the region on storm damage reconstruction, redevelopment, coastal and wetland restoration, and other flood and coastal storm risk reduction projects. These tens of billions of dollars of investments all have an economic multiplier benefit which, when combined with the proposed action, would result in long-term beneficial impacts in the region in jobs, sales of materials and supplies, housing values, and other expenditures. Additionally, the greater level of risk reduction provided by LPV and other risk reduction projects regionally would cumulatively improve economic conditions in the long-term through reduced insurance costs and greater investment (USACE, 2013). **Thus, the long-term regional cumulative impacts on socioeconomic resources would be predominately beneficial and are considered by the majority in the region and the nation as essential**.

7.17.4 ENVIRONMENTAL COMMITMENTS

Although there is no requirement through regulations to minimize socioeconomic impacts from construction of LPV, adverse impacts on socioeconomic resources are minimized primarily by designing the footprint of risk reduction work within existing ROWs, thereby reducing the need to acquire additional property or to “take” property.

To minimize impacts to socioeconomic and environmental justice, the following environmental commitments shall be implemented:

1) Minimize impact on the overall footprint
2) Temporary construction easements would be returned to pre-construction conditions and consistent with the 1% AEP level of risk reduction.
3) All project features would be designed so that the visual and human-cultural values associated with the project are protected, preserved, maintained, or enhanced to the maximum extent practicable.

7.18 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

7.18.1 REGULATORY FRAMEWORK

Under ER 1165-2-132, the type and extent of all HTRW contamination within the vicinity of the proposed actions are assessed during feasibility stage to inform the choice among alternative plans. USACE policy is to avoid the use of project funds for HTRW removal and remediation activities.

This HTRW section addresses compliance for the following applicable environmental laws and regulations:

- Resource Conservation and Recovery Act
- Comprehensive Environmental Response, Compensation, and Liability Act
- Solid Waste Disposal Act

Impacts associated with HTRW would be considered significant if an alternative resulted in:

- The creation of a public health hazard involving the use, production, dispersal, or disposal of a hazardous material posing a health risk to human, animal, or plant populations
- The creation of a hazard to the public or environment through reasonably foreseeable upset or accident conditions involving the release of a hazardous material

7.18.2 IMPACTS OF PROPOSED ACTIONS

ALTERNATIVE 1 - NO ACTION ALTERNATIVE – The probability of encountering RECs during future levee and floodwall improvements would remain low. Should HTRW concerns or RECs arise at any time during future project improvements, USACE would coordinate with the appropriate Federal and state authorities to implement an approved response action.

PROPOSED ACTION ALTERNATIVES – An abridged Phase I ESA was conducted during the feasibility phase of this study. This abridged Phase I ESA was conducted in the current HSDRRS levee and floodwall ROW and the results are presented directly below. The abridged Phase I ESA included the following tasks: 1) the review of previous HSDRSS HTRW Phase I ESAs to identify previously recorded RECs that may have been found prior to the construction of the HSDRRS features and 2) a field survey to determine if new RECs are within the HSDRRS levee and floodwall ROW. A full Phase I ESA will be performed on the TSP during feasibility level design and the results will be included in the final report. The abridged Phase I ESA tasks and results are:

Task 1 Results – According to the 2013 HSDRRS CED Phase I Volume I, RECs were avoided and the probability of encountering HTRW in the project area was low, and no impacts from HTRW were anticipated. If a REC was not avoided, then the non-Federal sponsor was responsible for remediation. If construction revealed the existence of previously unknown HTRW, then work in that area stopped until the risk from HTRW was evaluated and an appropriate response was determined. After a thorough review of previous Phase I ESAs related to the original HSDRRS construction, only one REC was found within the LPV floodwall ROW. This was an abandoned drum filled with unknown material located on the canal side of the West Return Levee Floodwall (drum coordinates: 30º00’29.8” N, 90º16’45.9” W). The contractor recommended the removal and disposal of all wastes and vehicles and soil sampling near drums and vehicles to confirm no impact from spills/leaks. These actions would have been completed prior to any construction activities. Other than this one abandoned drum, the previous Phase I ESAs indicate that no RECS fell within the LPV levee or floodwall ROWs.

Task 2 Results – USACE study team personnel made a site visit to the LPV levee and floodwall ROWs on 03 April 2019, 04 April 2019, and 10 April 2019. The LPV levee and floodwall ROWs were inspected for the presence of pipes, containers, tanks or drums, ponds or lagoons, car bodies, tires, refrigerators, trash dumps, electrical equipment, oil drilling equipment, gas or oil wells, discoloration of vegetation or water sheens, discoloration of soils, out-of-place dirt mounds or depressions in the landscape, evidence of fire, stressed soils with lack of vegetation, discoloration of vegetation, animal remains, unusual animal behavior, biota indicative of a disturbed environment, and odors indicative of poor water quality or chemical

presence. None of the aforementioned indicators were found during the site visits. Specifically, the REC location discovered under Task 1 above was visited on 03 April 2019, and the abandoned drum filled with unknown material was no longer present at the location. As mentioned above, REC removal and/or remediation would have occurred prior to HSDRRS construction activities.

The proposed action occurs within existing ROWs and any RECs previously identified in the Phase I ESAs for HSDRRS construction would be reflected in the project documents. Any previously-identified RECs would have been remediated or avoided and would be unlikely to affect LPV work, personnel working on the project, or the public. Additionally, new Phase I ESAs would be required within a 6 month period prior to the start of construction to ensure that no additional RECs are present. The probability of encountering HTRW in the study area would be low and RECs would be avoided or remediated; **therefore, no direct or indirect impacts would be expected.**

GENERALIZED BORROW AREAS – Should new borrow site excavation be needed, these sites would need environmental compliance to ensure that no RECs or HTRW issues would be encountered at these borrow sites. Therefore, although the location and number of new borrow sites are unknown, no direct or indirect impacts would be expected from HTRW.

For both borrow site excavation and levee and floodwall construction, spills and the potential to produce HTRW are a possibility. Storage, fueling, and lubrication of equipment and motor vehicles associated with construction activities would be conducted in a manner that affords the maximum protection against spill and evaporation. Fuel, lubricants, and oil would be managed and stored in accordance with all Federal, state, and local laws and regulations. Used lubricants and used oil would be stored in marked, corrosion-resistant containers and recycled or disposed in accordance with appropriate requirements. Construction contractors would be required to develop a Spill Prevention Control and Countermeasures Plan.

7.18.3 CUMULATIVE IMPACTS

Ongoing and future regional projects would likely contribute to cumulative beneficial impacts on HTRW, since many projects in the area, which include ecosystem restoration, infrastructure improvements, and a large storm rebuilding and reconstruction effort, would identify, evaluate, and potentially remediate existing HTRW issues. These present and future regional actions are discussed in the CED, Phase I and are incorporated by reference (USACE, 2013). However, storm reconstruction, redevelopment, and transportation projects could also temporarily adversely impact natural resources, such as water quality in surface waters, because of the mobilization of HTRW due to stormwater runoff from construction. The cumulative effects of these projects on HTRW problems would be temporary and minor. Coastal and wetland restoration, as well as flood and storm risk reduction projects, could potentially cause contaminated sediment suspension, which would result in adverse effect and indirect HTRW impacts during construction. However, a reduced risk of flooding and storm damage afforded by the proposed action would offer long-term beneficial HTRW impacts by lessening risk of storm surge devastation in the region.

The cumulative effects of all types of regional projects on HTRW would be temporary and minor and primarily during construction activities. Compliance with Federal, state, and local laws and

regulations would minimize any potential HTRW impacts. **Therefore, no long-term HTRW direct or indirect cumulative impacts would be expected within the LPV study area.**

7.18.4 ENVIRONMENTAL COMMITMENTS

To minimize impacts to HTRW, the following environmental commitments shall be implemented:

1) Containment of fuel and construction-required chemicals
2) For borrow areas, the contractor would be required to collect, characterize, label, store, transport, and dispose of all non-recyclable hazardous and regulated wastes, as regulated by the USEPA, and to comply with the Response Conservation and Recovery Act and other applicable laws and regulations.
3) Solid waste receptacles would be maintained at all staging areas. Non-hazardous solid waste (trash and waste construction materials) would be collected and deposited in on-site receptacles.

7.19 PROBABLE UNAVOIDABLE ADVERSE IMPACTS (ON ALL RESOURCES)

During construction of the proposed action, there would be temporary unavoidable adverse impacts on the existing flora and fauna, soil, and traffic in those locations where construction would occur adjacent to an existing roadway or would be along the transportation corridor between borrow areas and construction sites. Some of these impacts may occur, on a lesser scale, during maintenance of the proposed the action. Temporary, unavoidable adverse impacts including increased turbidity and noise would result from construction activities. These impacts would return to normal when construction is completed. Longer-term, non-temporary adverse impacts related to operation and maintenance of the proposed action includes loss of prime farmland within the borrow areas and loss of soil and habitat from borrow areas. However, benefits from an improved hurricane and coastal storm damage risk reduction system for the New Orleans Metropolitan Area would outweigh these unavoidable adverse impacts.

Where unavoidable construction impacts (including borrow areas) to the environment occur, mitigation would occur to replace loss of wetland habitats (*i.e.,* BLH-wet, fresh and intermediate marsh, and brackish marsh). At this time, Alternative 2 would require 17.2 AAHUs of BLH-Wet mitigation to offset impacts while Alternative 3 would require 17.7 AAHUs. These estimates will be refined during feasibility level of design. If unavoidable impacts to non-wetland habitat occur (such as dry bottomland hardwood forest), in accordance with WRDA 1986, Section 906 (as amended), compensatory mitigation would also be required.

7.20 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

This section discusses the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This section discusses whether construction and operation of the proposed project could cause short-term uses of the environment that would affect, either positively or negatively, the long-term productivity of the environment. “Short-term” generally refers to more immediate periods of time during which the proposed action would be constructed, whereas, “long-term” refers to an indefinite period beyond this timeframe.

Short-term uses of the environment associated with the proposed actions are generally the same as the environmental impacts described in the previous sections (Section 7.2-7.18) of this EIS. These impacts include both temporary and permanent “use” of the physical environment as a result of developing the proposed action and energy and resource use during project construction and maintenance. In considering the effect of these uses on long-term productivity, four main types of long-term productivity are considered: soil productivity, hydrological productivity, biological productivity, and economic productivity.

7.20.1 SOIL PRODUCTIVITY

While maintenance of long-term soil productivity is mainly a concern in areas that are in agricultural use, this concern also can arise anywhere that soils provide an economic or ecological benefit. Construction of the proposed action would affect soil productivity by borrow excavation, clearing, and grading. At borrow areas, long-term negative effects on soil productivity would be expected since these soils would be taken out of use. However, long-term positive effects on soil productivity for soils within the protected levee system are expected due to reduced risk of storm surge and flooding.

7.20.2 HYDROLOGICAL PRODUCTIVITY

Wetlands, groundwater resources, and floodplains contribute to long-term hydrological productivity by providing filtration, habitat for sensitive species, and essential recharge for agricultural and municipal use. Wetlands would lose productivity in those areas requiring mitigation, but productivity would be replaced through compensatory mitigation. Water bodies and floodplain would lose some productivity in the short-term from increased sedimentation from erosion during construction and increased amounts of potential pollutants that could enter construction sites from construction equipment and soil-disturbing activities.

7.20.3 BIOLOGICAL PRODUCTIVITY

Plant communities, fish, and wildlife contribute to biological productivity; their long-term productivity provides an ecological and recreational benefit in sensitive or remote areas. Proposed construction would affect biological resources through land clearing, grading, and borrow area excavation.

During construction, clearing and grubbing along existing levees would occur. After construction, levee vegetation would be restored. Excavation of borrow areas would

permanently remove vegetation. After the borrow area is depleted, natural cover and/or vegetation restoration could take place. Borrow area excavation would also impact wildlife. Substantial habitat could be permanently lost, altered, and fragmented. The noise and increased human activity related to construction could decrease some wildlife species' breeding success and in some cases cause direct mortality. At the same time, habitat alteration can encourage the increase of species that can best adapt to the altered habitats. Over the long-term, species that are highly adaptable or avoid areas during short-term construction activities are expected to return once construction is complete.

7.20.4 ECONOMIC PRODUCTIVITY

Agriculture, urban and suburban development, and industrial uses can contribute to economic productivity. Risk reduction measure construction and maintenance could affect the economic productivity of some resources by limiting their long-term revenue potential but could contribute to long-term revenue potential in sectors that benefit from an improved hurricane and coastal storm damage risk reduction system. Proposed construction would affect economic productivity through borrow area excavation, construction of levee lifts, and raising of flood walls. At borrow areas, there would be long-term negative effects on land used for agriculture since these areas may be taken out of agricultural production. The proposed project is expected to create a long-term increase in economic productivity by providing a more reliable hurricane and coastal storm damage risk reduction system for a portion of the Greater New Orleans Metropolitan Area. Increased reliability could create a long-term economic benefit to existing businesses that rely on reduced flooding for production. An improved hurricane and coastal storm damage risk reduction could also attract new industrial and commercial business to the study area, which would provide a long-term increase in economic productivity through increased revenue and jobs.

7.21 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

This section discusses likely irreversible and irretrievable commitments of resources for the project. The impact of the proposed actions on resources that would be forever lost or altered also is discussed. No mitigation specific to the irreversible and irretrievable commitment of resources discussed below has been identified to date for the proposed actions.

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long run (Shipley, 2010). Simply stated, once the resource is removed it can never be replaced. For the action alternatives considered, there are no irreversible commitments to natural resources. This study is in the planning stage. Money has been expended to complete this planning document and pre-project data collection and modeling. No construction dollars, which are considered irreversible, have been expended for the study. Fossil fuels consumed during construction of proposed actions would be irreversibly expended since their use cannot be reversed or resources replenished. Lastly, human power and funding used to construct the proposed action would result in irreversible fiscal resource commitments. When time and money are dedicated to the project and used, these expenditures cannot be restored or dedicated to another project.

Irretrievable commitments are those that are lost for a period of time (Shipley, 2010). The proposed action alternatives require a vast commitment of construction materials, fuel, energy, land, funding, and labor. Construction materials used to build the proposed action, such as aggregate, steel, and petroleum would be irretrievably committed to the project. These materials cannot be retrieved until they are removed, recycled, and used elsewhere. In addition, water used directly in concrete mixtures or through dust abatement would effectively be an irreversible expenditure. Although concrete can be retrieved through recycling and reuse, the water used to make it is irreversibly locked in solid form. Water quality in adjacent water bodies may be degraded by the proposed actions. This degradation would constitute an irretrievable commitment of water resources because water quality improvements could conceivably be retrieved if future restoration strategies would be implemented.

7.22 COMPLIANCE WITH ENVIRONMENTAL STATUTES

There are many Federal and state laws pertaining to the enhancement, management, and protection of the environment. Federal projects must comply with environmental laws, regulations, policies, rules, and guidance.

A 55-day public review ends on February 7, 2020. Public meetings will occur in January 2020. Comments received will be documented in Appendix L, *Coordination.* Appendix G provides additional environmental compliance documentation. Environmental compliance will be achieved upon approval of the associated Record of Decision.

Table 7-10 provides a list of the relevant laws and regulations, including the agency tasked with the jurisdiction for each and the respective permit, license and compliance, or other review.

Table 7-10. Relevant Laws and Regulations

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
Sound/Noise			
Noise Control Act of 1972 (42 USC 4901 *et seq.*) as amended by Quiet Communities Act of 1978 (PL 95-609)	USEPA	Compliance with surface carrier noise emissions	Construction and operations
Air			
Clean Air Act and amendments of 1990 (42 USC 7401(q)) 40 CFR 50, 52,93.153(b)	USEPA	Compliance with NAAQS and emission limits and/or reduction measures	Construction and operations
Water			
Clean Water Act of 1977 (33 USC 1341 *et seq.*) 40 CFR 121	LDEQ	Section 401 Water Quality Certification	Potential discharge into waters of the state (including wetlands and washes)
Clean Water Act of 1977 (33 USC 1342) 40 CFR 122	USEPA	Section 402(b) National Pollutant	Construction sites with greater than 1

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
		Discharge Elimination System General Permit for Stormwater Discharges for Construction Activities	acre of land disturbed
Clean Water Act of 1977 (33 USC 1344) 40 CFR 230	USACE	Section 404(b)1	Discharge of dredge or fill material to a watercourse
Coastal Zone Management Act of 1972 (16 USC 1456(c)) Section 307	Administered by LDNR	Consistency Determination	Consistency with the Louisiana Coastal Management Program
EO 11988 (Floodplain Management), as amended by EO 12608	Water Resources Council, FEMA, and CEQ	Compliance	Construction in or modification of floodplain
EO 11990 (Protection of Wetlands), as amended by EO 12608	USACE and USFWS	Compliance	Construction in or modification of wetlands
Soils			
Resource Conservation and Recovery Act of 1976 (42 USC 6901(k)), as amended by Hazardous and Solid Waste Amendments of 1984 (PL 98-616; 98 Statute 3221)	USEPA	Proper management, and in some cases, permit for remediation	Current operation involving hazardous waste and/or remediation of contamination site
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (42 USC 9601), as amended by Emergency Planning and Community Right-To-Know-Act of 1986 (42 USC 1101 *et seq.*)	USEPA	Development of emergency response plans, notification, and cleanup	Release or threatened release of a hazardous substance
Farmland Protection Policy Act of 1981 (7 USC 4201 *et seq.*) 7 CFR 657-658	NRCS	NRCS Determination via form AD-1006	Prime and unique farmlands
Soil Conservation Act (16 USC 590(a) *et seq.*)	NRCS	Compliance	Soil conservation of Federal Lands
Natural Resources			
Endangered Species Act of 1973, as amended (16 USC	USFWS, NMFS	Compliance by lead agency and/or	Protection of threatened and

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
1531) Sections 7 and 9 50 CFR 17.11-17.12		consultation to assess impacts and, if necessary, develop mitigation measures	endangered species and their critical habitats
Migratory Bird Treaty Act of 1918 (16 USC 703) 50 CFR Chapter 1	USFWS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, develop mitigation measures	Protection of migratory birds
Bald and Golden Eagle Act of 1940, as amended (16 USC 688(d)) 50 CFR 22.3	USFWS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, obtain permit	Protection of bald and golden eagles
Fish and Wildlife Coordination Act (16 USC 2901)	USFWS, NMFS	Compliance	Conserve and promote conservation of non-game fish and wildlife and their habitats
Marine Mammal Protection Act of 1972 (16 USC 1361)	NMFS	Compliance by lead agency and/or consultation to assess impacts and, if necessary, develop mitigation measures	Protection of marine mammals
EO 13112 (Invasive Species)	USACE and Port of New Orleans	Compliance	Requires agencies to restrict the introduction of exotic organisms into natural ecosystems
Health and Safety			
Occupational Safety and Health Act of 1970 (29 USC 651) 29 CFR 1975	OSHA	Compliance with guidelines, including Material Safety Data Sheets	Health and safety standards
Cultural/Archaeological			
NHPA (16 USC 470 *et seq.*) 36 CFR 800 Army Regulation 200-4, Cultural Resources Management Presidential Memorandum regarding Government to Government Relations (April 29, 1994)	USACE, SHPO, ACHP, and Tribes	Section 106 Consultation	Assessment of cultural resources and avoidance of disturbance of historic properties

Relevant Laws & Regulations	Agency	Permit, License, Compliance, or Review/Status	Action Requiring Permit, Approval, or Review
EO 13007 (Indian Sacred Sites)			
Native American Graves Protection and Repatriation Act 43 CFR 10	USACE, SHPO, ACHP, and Tribes	Compliance	Protection of Native American sites, graves, and sacred objects
Archaeological Resources Protections Act of 1989 (16 USC 470(a)(a)-470(ii)) 43 CFR 7	Affected land-managing agency	Permits to survey and excavate/remove archaeological resources on Federal lands; Native American tribes with interests in resources must be consulted prior to issue of permits	Investigations and excavation on Federal lands
Socioeconomics			
EO 14045 (Protection of Children from Environmental Health Risks and Safety Risks)	USEPA	Compliance	Identify and assess environmental health risks and safety risk that may disproportionately affect children
EO 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations)	USEPA	Compliance	Identify and address disproportionately high and adverse human health or environmental effects on minority and low-income populations

7.22.1 FISH AND WILDLIFE COORDINATION ACT

The following fish and wildlife conservation recommendations were provided by the U.S. Fish and Wildlife Service as part of their draft Fish and Wildlife Coordination Act Report (Appendix L).

We do not oppose the Corps' plan to implement alternative 2 for the LPV HSDRRS provided that the following fish and wildlife conservation recommendations are incorporated into future project planning and implementation efforts:

> *1. Impacts to Essential Fish Habitat (EFH) should be avoided and minimized to the greatest extent possible. Because impacts to designated EFH habitat may need to be mitigated the Corps should coordinate with the NMFS regarding this need.*
>
> *2. To the greatest extent possible, situate final flood protection features so that impacts to wetlands and non-wet bottomland hardwoods are avoided or minimized.*

3. Avoid adverse impacts of bald eagle nesting locations and wading bird colonies through careful design of project features and timing of construction. Forest clearing associated with project features should be conducted during the fall or winter to minimize impacts to nesting migratory birds, when practicable.

4. The Service recommends that the USACE contact the Service for additional consultation if: 1) the scope or location of the proposed project is changed significantly, 2) new information reveals that the action may affect listed species or designated critical habitat; 3) the action is modified in a manner that causes effects to listed species or designated critical habitat; or 4) a new species is listed or critical habitat designated. Additional consultation as a result of any of the above conditions or for changes not covered in this consultation should occur before changes are made and or finalized.

5. Further detailed planning of project features (e.g., Design Documentation Report, Engineering Documentation Report, Plans and Specifications, Water Control Plans, or other similar documents) should be coordinated with the Service, NMFS, LDWF, EPA and Louisiana Department of Natural Resources (LDNR). The Service shall be provided an opportunity to review and submit recommendations on the all work addressed in those reports.

6. The Corps should avoid impacts to public lands, if feasible. If not feasible the Corps should establish and continue coordination with agencies managing public lands that may be impacted by a project feature until construction of that feature is complete and prior to any subsequent maintenance. In addition all mitigation proposed to occur on public lands should be coordinated with the respective land managing agency. Points of contacts for the agencies potentially impacted by project features are: National Park Service (NPS), contact Superintendent Chuck Hunt, (504) 589-3882 extension 137 (Charles_Hunt@nps.gov) or Chief of Resource Management Guy Hughes (504) 589-3882 extension 128, (Guy_Hughes@nps.gov) and for Bayou Sauvage NWR, the following people should be coordinated with; Shelly Stiaes, (Shelly_Stiaes@fws.gov) Refuge Manager, Barret Fortier (Barret_Fortier@fws.gov) Southeast Refuges Complex Biologist and Neil Lalonde (Neil_Lalonde@fws.gov) Southeast Refuge Complex Supervisor. The telephone number for the Southeast Refuge Complex is (985)882-2000.

7. If applicable, a General Plan for mitigation should be developed by the Corps, the Service, and the managing natural resource agency in accordance with Section 3(b) of the FWCA for mitigation lands.

8. The Corps should maintain full responsibility for all mitigation projects until the projects are found to be fully compliant with success and performance requirements.

9. The Corps should fully compensate for any unavoidable losses of wetland habitat or non-wet bottomland hardwoods caused by project features.

10. Borrow sites should be designed to avoid and minimize impacts to fish and wildlife habitat; in the event new borrow sites are identified, guidelines for borrow site selection are found in Appendix A.

11. Identified impacts shall have a fully defined mitigation plan that is included in the integrated National Environmental Policy Act document. The mitigation plan should be developed, including locations and AAHUs vetted through the natural resource agencies. Existing mitigation banks and existing credits released by Corps Regulatory Branch should be considered in accordance with Department of the Army, Corps of Engineers Compensatory Mitigation for Losses of Aquatic Resources; Final Rule (33 CFR Parts 325 and 332).

12. If the local project-sponsor is unable to fulfill the financial mitigation requirements for operation and/or maintenance of mitigation lands, then the Corps should provide the necessary funding to ensure mitigation obligations are met on behalf of the public interest.

13. Any proposed change in mitigation features or plans should be coordinated in advance with the Service, NMFS, LDWF, EPA and LDNR.

14. The Corps should finalize mitigation plans and proceed to mitigation construction so that it will be concurrent with project construction. If construction is not concurrent with mitigation implementation then revising the impact and mitigation period-of-analysis to reflect additional temporal losses will be required.

7.23 LIST OF PREPARERS

Name	Role	Years of Experience
Heather Achord	Structural Engineering	13
Max Agnew	Hydraulic Engineering	10
Michele Aurand	GIS	20
Aven Bruser	Office of Counsel	10
Troy Cosgrove	Risk Assessment	24
Rob Dauenhauer	Structural Engineering	25
Bradley Drouant	Project Management	13
Jason Emery	Tribal Liaison	20
Pamela Fischer	Real Estate	10
Noah Fulmer	Cultural Resources	4
Daryl Glorioso	Office of Counsel	22
Lauren Hatten	Civil Engineering	25
Diane Karnish	Socioeconomics	31
Michelle Kniep	Plan Formulation	24
Ben Logan	Economics	10
Steven Lowrie	Cost Engineering	11
Kat McCain	Environmental Compliance	11
Rachel Mesko	Plan Formulation	10
Joe Musso	HTRW; Air Quality	30
Landon Parr	HTRW	20
Andrew Perez	Environmental Justice; Recreation	20
Bich Quach	Geotechnical Engineering	13
Richard Radford	Aesthetics (Visual)	17
Matthew Roe	Public Affairs	12
Stephan Roth	District Counsel	18
Kip Runyon	Environmental Compliance	22
Monique Savage	Plan Formulation	10
Frank Spiess	Project Management	5

8 EVALUATE & COMPARE ALTERNATIVE PLANS

This section evaluates and compares the final array of alternatives.

Four accounts have been established to facilitate evaluation and display of effects of alternative plans:

a) (a) The **NED** account displays changes in the economic value of the national output of goods and services.
b) The **EQ** account displays non-monetary effects on significant natural and cultural resources.
c) The **RED** account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
d) The **OSE** account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

Display of the NED and EQ accounts is required by USACE policy. Display of the regional economic development and other social effects accounts is discretionary and based on project-specific considerations. For this project, life-safety will also be considered and displayed under the OSE account.

Evaluation and comparison of alternatives is based on the four Principles and Guidelines criteria: completeness, acceptability, efficiency, and effectiveness. Resilience, redundancy, robustness, and sustainability contribute to completeness, efficiency, and effectiveness of plans and are accounted for in the evaluation of alternatives. In some cases, the evaluation may be qualitative.

The alternatives are evaluated based on the following decision criteria:

- **Economic costs and benefits –** quantitative estimates of the costs of each alternative and the NED benefits, resulting in display of benefit-to-cost ratios and net economic benefits.
- **Environmental effects –** quantitative estimates of mitigation requirements and costs.
- **Life safety risk reduction –** quantitative estimates of 1) reduction in overtopping life safety risk for each alternative, 2) annual probability of failure for the levee system including all PFMs, and 3) average annual life loss for the levee system including all PFMs.
- **Contributions to meeting the four TRGs –** qualitative assessment of the degree to which each TRG is achieved by each alternative (met, partially met, or not met).

This evaluation and comparison step was based on a conceptual level of design and associated cost estimates. A summary of the evaluation and comparison of the final array of alternatives is presented below.

8.1 ALTERNATIVES DESIGN

For purposes of developing the initial cost estimate and evaluating potential environmental impacts, the following levee and floodwall design assumptions were made:

- Due to the size and scope of the study area, levee design was based on representative reaches.
- Multiple levee lifts would be constructed over time to incrementally address the combined effects of levee settlement, rising sea levels, and regional subsidence. These lifts would be "straddle lifts" wherever possible. The use of straddle levee lifts reduces the need for additional real estate acquisition and potential environmental impacts. Figure 8-1 illustrates the concept of levee lifts performed over time.
- Some levee reaches have concrete paved transitions from levee to floodwall. It is assumed that with each lift, the slope paving would need to be removed, lifted and replaced to match the required design elevation.
- It is assumed that all previously placed armoring for each reach would need to be removed before each lift and then replaced after construction of each lift. All MRL levees have concrete slope paving on the flood side slope. It is assumed that the slope paving will need to be removed and replaced with any expansion of the levee footprint.
- Floodwalls falling below target design elevations were assumed to be modified if the deficiency was less than 2 feet and replaced if the deficiency was greater than two feet.
- No changes to interior ponding or pumping capacity.
- No additional utility relocations are required.
- No increased resiliency or robustness actions were considered at this time.

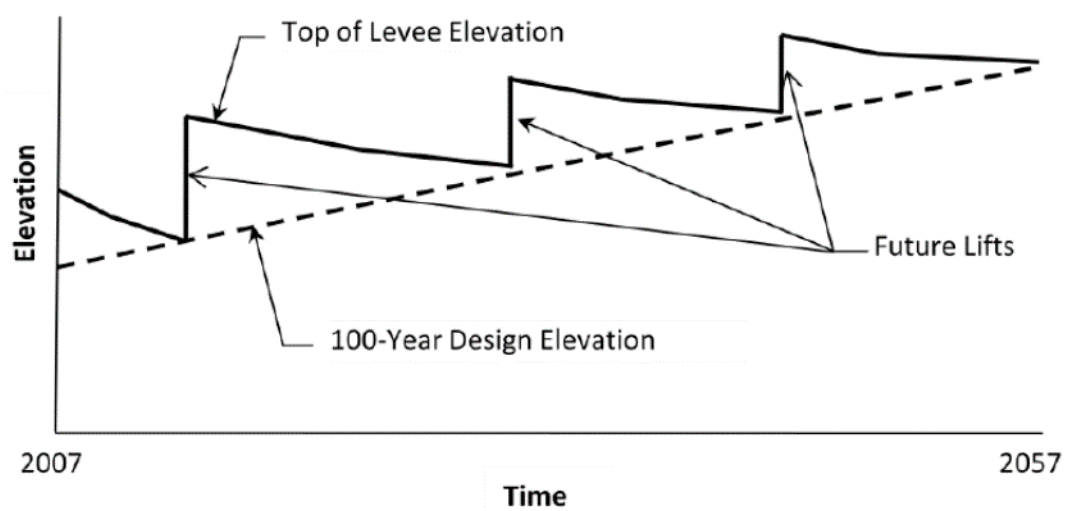

Figure 8-1. Conceptual Levee Lifts

8.2 ECONOMIC COSTS AND BENEFITS OF ALTERNATIVES

The HEC-FDA Version 1.4 USACE-certified model was used to calculate expected annual damages and benefits over the period of analysis. The economic and engineering inputs necessary for the model to calculate damages include structure inventory, content-to-structure value ratios, vehicles, first-floor elevations, depth-damage relationships, ground elevations, and stage-probability relationships. More information about these economic and engineering inputs are described in Appendix E (Economics).

8.2.1 FIRST COSTS OF ALTERNATIVES

Table 8-1 identifies the first costs of the final alternatives array by account and includes contingencies. Contingencies were determined by performing an abbreviated cost risk assessment for each action alternative, which considered uncertainties related to each input to the cost estimate.

Table 8-1. First Costs of Final Array of Alternatives (October 2019 Price Level)*

Account	LPV No Action	LPV ALTERNATIVE 2	LPV ALTERNATIVE 3
01 Lands and Damages	$0	$9,200,000	$9,700,000
06 Fish and Wildlife Facilities	$0	$3,700,000	$4,100,000
11 Levees and Floodwalls	$0	$2,154,500,000	$2,362,100,000
30 Planning, Engineering and Design	$0	$259,000,000	$283,900,000
31 Construction Management	$0	$172,700,000	$189,300,000
Total	$0	$2,599,000,000	$2,849,000,000

*All numbers have been individually rounded and, therefore, may not appear to add correctly to the total.

8.2.2 ECONOMIC BENEFITS

As discussed in Section 3.3 (Existing Economic Damages), the estimate of economic benefits assumes that there is no system failure (non-performance) prior to overtopping. Additionally, the benefits do not include any potential increases to the structure inventory (see Section 5.4 – Future Economic Damages). Table 8-2 displays the economic costs and benefits of the final array of alternatives.

Table 8-2. Costs and Benefits of Final Array of Alternatives (October 2019 Price Level)

	LPV No Action	LPV ALTERNATIVE 2	LPV ALTERNATIVE 3
Costs			
Total Project First Cost	$0	$2,599,000,000	$2,849,000,000
Average Annual Investment Cost	$0	$57,000,000	$63,000,000
Annual O&M Costs	$0	$24,000,000	$27,000,000
Total Average Annualized Costs	$0	$82,000,000	$89,000,000
Economic Benefits - NED			
Without Project Damages	$233,000,000	$233,000,000	$233,000,000
With Project Damages	$0	$30,000,000	$26,000,000
Damages Reduced (Benefits)	$0	$203,000,000	$207,000,000
Net Benefits	$0	$122,000,000	$118,000,000
Residual Damages	$233,000,000	$30,000,000	$26,000,000
Benefit-to-Cost Ratio (BCR)	N/A	2.5	2.3

8.3 LIFE SAFETY RISK REDUCTION OF THE ALTERNATIVES

Due to the late development of Alternative 3, the risk assessment did not directly evaluate the life safety risk reduction of Alternative 3. However, it did estimate with-project levee risk for two designs: 1% AEP with intermediate RLSR (Alternative 2) and 1% AEP with high RSLR. In both cases, the total life safety risk plots below the tolerable risk reference lines on the risk matrix. Since the with-project risks for the 1% AEP storm with both intermediate and high RSLR scenarios are both below the TRGs, it is assumed that the 0.5% AEP (Alternative 3) risks will also be tolerable. Table 8-3 summarizes the levee performance (APF) and consequences (AALL) for both the No Action Plan and both designs that were evaluated.

Table 8-3. Levee Performance and Consequences

Alternative	APF	AALL
No Action	1E-06 to 1E-05	1E-03
With Project Alternative 2 (1% AEP design at 1.8 ft. RSLR)	1E-07 to 1E-06	1E-04
With Project 1% AEP design at 3.4 ft. RSLR	1E-07 to 1E-06	1E-04

The results of the risk assessment show that both alternatives reduce the risk below TRG-1. In consideration of TRG-4, the study team considered whether additional actions were warranted to further reduce life safety risk. The risk assessment's consideration of a plan to reduce risk from the 1% AEP storm at 3.4 ft. RSLR estimates that this has the same level of risk reduction

as Alternative 2, so additional actions may not be effective at reducing risk. In this case, given the higher urban population, better evacuation plans and better communication of those plans could reduce risk.

Critical infrastructure inundation is also reduced for both alternatives. Table 8-4 compares the effects of each plan with regard to critical infrastructure. Critical infrastructure data was obtained from the Homeland Security Infrastructure Program (HSIP) Gold 2015 database, which is a data inventory assembled by the National Geospatial-Intelligence Agency in partnership with the Department of Homeland Security.

Table 8-4. Comparison of Critical Infrastructure Risk Reduction

	Without Project	Alt 2 1% AEP	Alt 3 0.5% AEP
Category	**Number**	**Number**	**Number**
Agriculture	0	0	0
Chemicals	51	8	8
Communications	7	0	0
Education	60	3	3
Emergency Services	15	2	2
Energy	65	6	6
Law Enforcement	2	0	0
Manufacturing	35	9	9
National Symbols	0	0	0
Public Venues	89	27	24
Transportation-Air	2	0	0
Transportation-Ground	498	64	61
Transportation-Water	48	45	43
Water Supply	1	0	0
Total	**873**	**164**	**156**

8.4 COMPLETENESS, EFFECTIVENESS, EFFICIENCY & ACCEPTABILITY

Completeness, effectiveness, efficiency, and acceptability are four basic criteria used in the evaluation and screening of alternative plans. Alternatives considered in any planning study should meet minimum subjective standards of these criteria to qualify for further consideration and comparison with other plans.

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 planning objectives, including actions by other Federal and non-Federal entities. Part of the evaluation of

completeness will include the contribution of the plan towards the resilience in the engineered infrastructure, as well as in the community, economy, and environment.

Resilience is generally defined as the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or anthropogenic, under all circumstances of use. Completeness also considers sustainability, which is an evaluation of whether the plans include the features and resources to meet the study objectives in the study area beyond the period of analysis and the impact of the proposed project.

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities. Effectiveness will also consider the resiliency of the plan, the contribution of redundant features to overall plan effectiveness, and the robustness of the plan.

Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe. Robustness is the ability of a system to continue to operate as intended across a wide range of foreseeable operational conditions with minimal damage, alteration, or loss of functionality and to fail in a predictable way outside of that range.

Efficiency is the extent to which an alternative plan is a cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation‘s environment. Efficiency will also consider redundancy and robustness in the alternatives and should describe any potential trade-offs with economic efficiency.

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

Table 8-5 compares the final array of alternatives as well as optimized scales of the final array against these criteria.

Table 8-5. Evaluation of Alternatives using Principles and Guidelines Criteria

Alternative	Complete	Effective	Efficient	Acceptable
No Action Alternative	No	No	No	No
Alternative 2	Yes	Yes	Yes	Yes
Alternative 3	Yes	Yes	No	Yes

Completeness – Both of the action alternatives are complete in that they include all of the necessary investments to achieve the objectives. They all include appropriate levee resilience and are all sustainable if properly operated, maintained, repaired, rehabbed, and replaced when necessary. The No Action plan is not complete because it does not address any of the objectives.

Effectiveness – Both of the action alternatives are effective in achieving the economic and life safety risk reduction objectives. None of the action plans contain redundant features. The No Action Plan is not effective because it does not achieve any of the objectives.

Efficiency – Both of the action alternatives reduce the life safety risk by different amounts for different levels of investment. Increased investment does result in additional decrease in life

safety risk but Alternative 2 is more cost-effective from an economic standpoint and has similar life safety risk reduction achievements. The No Action plan is not efficient because it does not achieve any of the objectives.

Acceptability – Both of the action alternatives have been designed to be acceptable in terms of laws, regulations, and public policies. They are likely to have varying levels of public acceptance (from the general public, the sponsor, affected communities, and governmental entities), which will be discussed further following the public review period. The No Action plan is unlikely to be acceptable to the public.

8.5 COMPARISON SUMMARY

The results of the evaluation of the final array are presented in Table 8-6. The costs are presented at fiscal year (FY) 19 price levels and the economic calculations utilize the FY 20 discount rate of 2.75%.

Table 8-6. Evaluation of Final Array (October 2019 Price Level)

Key Factor	LPV No Action (Intermediate RSLC)	LPV ALTERNATIVE 2 System Levee Lifts to the Projected 1% AEP Event at 2073 (Intermediate RSLC)	LPV ALTERNATIVE 3 System Levee Lifts to the Projected 0.5% AEP Event at 2073 (Intermediate RSLC)
Costs			
Total Project First Cost	$0	$2,599,000,000	$2,849,000,000
Annual O&M Costs	$0	$24,000,000	$27,000,000
Average Annual Costs	$0	$82,000,000	$89,000,000
Economic Benefits - NED			
Damages Reduced (Benefits)	$0	$203,000,000	$207,000,000
Net Benefits	$0	$122,000,000	$118,000,000
Benefit to Cost Ratio	N/A	2.5	2.3
Life Safety Risk - OSE	Life safety risk will be above tolerable levels	The plan is anticipated to reduce life safety risk below TRG1	The plan is anticipated to reduce life safety risk below TRG1
Environmental Impacts - EQ			
Mitigation BLH-Wet AAHUs	N/A	17.2	17.7
Mitigation Costs	N/A	$3,713,000	$4,125,000
Real Estate*			
Temporary Road Access and Work Area	N/A	16	16
Perpetual Levee	N/A	27	27
Borrow	N/A	321	362
Residual Risk			

Key Factor	LPV No Action (Intermediate RSLC)	LPV ALTERNATIVE 2 System Levee Lifts to the Projected 1% AEP Event at 2073 (Intermediate RSLC)	LPV ALTERNATIVE 3 System Levee Lifts to the Projected 0.5% AEP Event at 2073 (Intermediate RSLC)
Life Safety	Life safety risk will remain above tolerable levels.	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.
Economic Damages	$233,000,000	$30,000,000	$26,000,000
Critical Infrastructure (#)	873	164	156

* Requirements for ROW will continue to be evaluated during feasibility design to determine whether temporary or permanent easements are most advantageous to the Government.

8.6 TENTATIVELY SELECTED PLAN / NATIONAL ECONOMIC DEVELOPMENT PLAN

The primary decision criteria for identifying the NED Plan includes reasonably maximizing net benefits while remaining consistent with the Federal objective of protecting the nation's environment. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

Based on the evaluation and comparison analysis summarized above, Alternative 2 is identified as the NED Plan and the TSP. The TSP has a total project first cost of approximately $2.6 billion and a benefit-to-cost ratio of 2.3.

9 TENTATIVELY SELECTED PLAN (TSP)

This chapter discusses the details of the TSP.

9.1 DESCRIPTION

Alternative 2 is the TSP which includes system levee lifts to the projected 1% AEP event at 2073. Construction of the TSP would generally occur in the same footprint as the existing LPV project and existing MRL levees. Project features consist of 50 miles of levee lifts along the existing levee alignment to be constructed as-needed before the combined effects of consolidation, settlement, subsidence and sea level rise reduce the levee elevations in each levee reach below the required design elevation. In some reaches, levee lifts may need to occur more than once during the period of analysis. Additionally, the TSP includes 19 miles of floodwall modifications and replacements along the existing alignment to be constructed as-needed prior to the combined effects causing the design requirements to be exceeded for each structure. Mitigation is anticipated to be required to address potential impacts to habitat along the Mississippi River. Finally, the TSP includes targeted areas of foreshore protection along Lake Pontchartrain in areas where foreshore protection already exists. This will require some dredging and temporary material stockpiling to provide access to deliver and place the stone for foreshore protection, and bring it back up to the required elevation for levee protection. Figure 9-1 depicts the location of features included in the TSP.

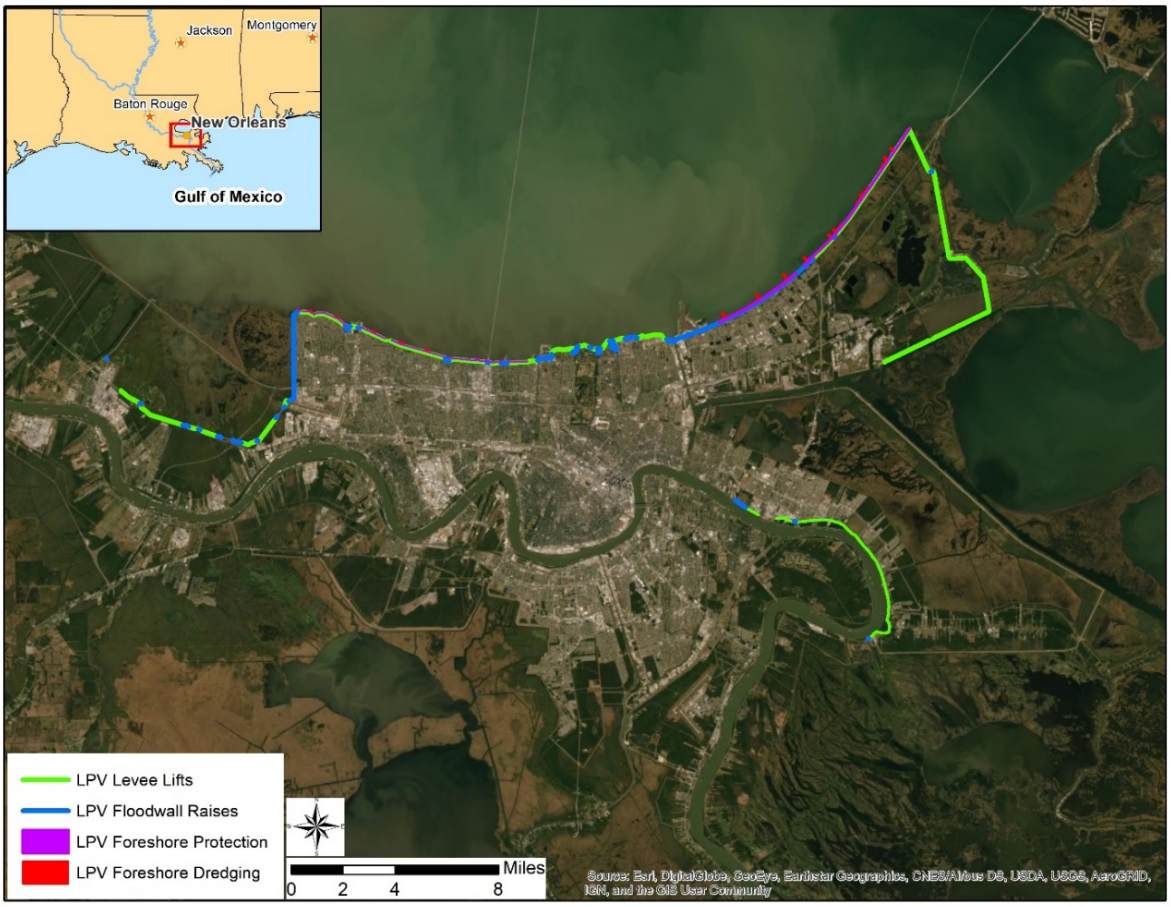

Figure 9-1. Location of features included in the TSP

The new design elevation will require areas of LPV levee co-location with the MRL along the Mississippi River. The current and estimated new crossover points can be seen in Figure 9-2. The existing east bank crossover point (which is not currently within the LPV system) is in black at River Mile 77.3 and the east bank TSP crossover point is in yellow at River Mile 90.5.

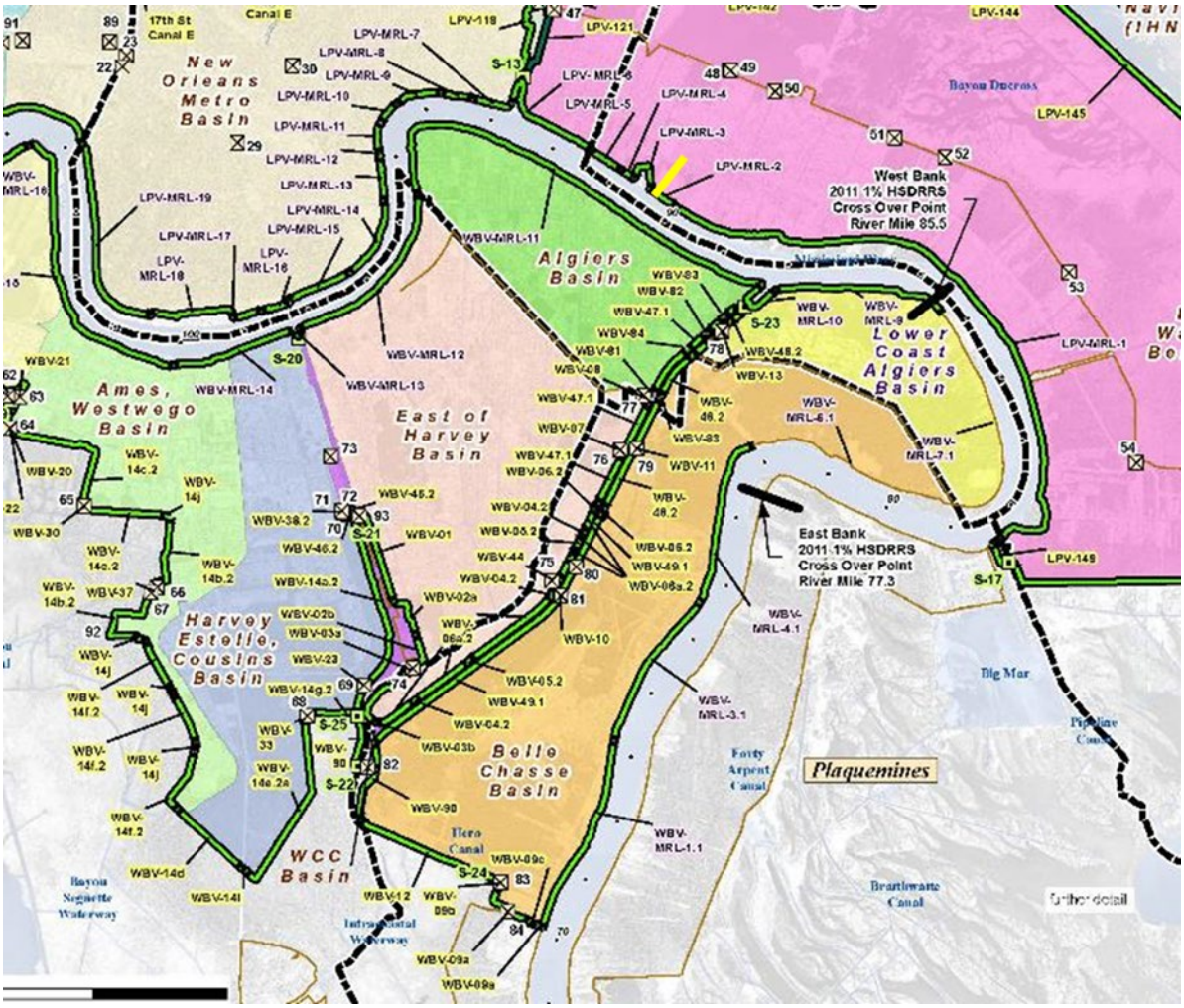

Figure 9-2. Existing (black) and With-Project (yellow) Crossover Points on the MRL

9.2 COSTS

Based on October 2019 price levels, the total first cost of the TSP is estimated to be $2.6 billion. In accordance with the cost share provisions of Section 104 of the WRDA of 1986, as amended (33 U.S.C. 2213), the Federal share (65%) of the project first cost is estimated to be $1.7 billion and the non-Federal share (35%) is estimated to be $910 million, which includes $9 2 million in lands, easements, rights-of-way, relocations, and disposal (LERRD) funds. Additionally, the sponsor will maintain OMRR&R responsibility for the LPV and additionally assume responsibility for OMRR&R upon physical construction completion of each initial project feature or functional portion construction, and each incremental lift of each project feature or functional portion, at no cost to the Government, and in perpetuity, currently estimated to be approximately $24 million annually.

9.3 ECONOMIC AND LIFE SAFETY BENEFITS

The TSP reduces annual economic damages by $203,000,000 and has net benefits of $122,000,000. Additionally, it reduces the future life safety risk associated with overtopping to a

level below the societal life safety TRG. It reduces the risk of damages to 70 critical infrastructure structures.

9.4 REAL ESTATE REQUIREMENTS

Most of the TSP will be constructed on land already acquired for the LPV project. The exception is the area along the MRL between the existing crossover point and the new crossover point, as well as a small area along the Lake Pontchartrain lakefront to the west of the Seabrook floodgate. Additional acquisition and rights of way will be required in this area. Project implementation requirements for lands, easements, rights-of-way, relocations, and disposal (LERRD) include approximately 7 acres for temporary road access, approximately 9 acres for temporary work areas, approximately 27 acres for perpetual levee easements, and approximately 321 acres for borrow.

9.5 CULTURAL RESOURCES REQUIREMENTS

The proposed levee shifts of the Mississippi River Levee outside of the existing right of way, unidentified borrow areas, and other project features have the potential to impact known and unknown cultural resources. To comply with Section 106 of the NHPA the USACE would develop a programmatic agreement, if necessary, pursuant to 36 CFR 800.14(b) in consultation with the SHPO, Tribes, and other interested parties.

9.6 MITIGATION REQUIREMENTS

Most of the TSP will be constructed on land already impacted by the LPV project. One exception is the area along the MRL between the existing crossover point and the new crossover point. The proposed mitigation plan assumes the 17.2 AAHUs of flood side bottomland hardwood-wet impacts (approximately 27 acres) would be mitigated through the purchase of mitigation bank credits. The proposed mitigation plan is detailed in Appendix K.

9.7 RISK & UNCERTAINTY

At the planning level, there is always uncertainty about the extent to which the tentatively selected plan will meet the planning objectives. Even when project performance uncertainty is negligible, there is some retained risks. In addition there can be new or transferred risks associated with the tentatively selected plan. It is important to evaluate, communicate, and manage these risks.

9.7.1 REMAINING STUDY RISKS

Overtopping flow boundary conditions – As discussed in Section 3.2, ADvanced CIRCulation (ADCIRC) and Simulating Waves Nearshore (SWAN) simulations were processed with the ERDC JPM-OS statistical code to produce exterior surge and wave statistics for design elevations. It is assumed that the datasets from the ADCIRC model sufficiently forecast exterior surge conditions to compute feasibility level design elevations. Additionally, the overtopping calculations and resulting inundation estimates are 50%, or, average value deterministic estimates.

- Management: To reduce the uncertainty associated with the existing ADCIRC model results the 2017 CPRA storm surge and wave modeling (2017 Coastal Master Plan: Storm Surge) water levels, wave heights, and wave periods results were used in the overtopping calculations. This reduced the study risk to a tolerable level but further design refinement utilizing the most current hazard analysis during PED is recommended.

HEC-RAS model limitations – No rainfall time-series are available for the synthetic storms utilized in the ADCIRC model; therefore, no data on rainfall was included in the HEC-RAS simulation. Because the additional flood damage associated with rainfall was not quantified economic damages are assumed to be conservative. This limitation is assumed not to be a significant risk since traditionally storm intensity (which causes greater surge and waves) is inversely related to rainfall amounts. Additionally, sub-surface drainage features were not accounted for in HEC-RAS geometry, which could reduce the amount of rainfall accumulation.

- Management: During feasibility level design a sensitivity analysis will be conducted to evaluate the impact rainfall may have on economic damages.

Floodwall design assumption –- Modification to existing floodwalls can create stability issues so a conservative design estimate, based on historic information, was used for floodwall modifications. Currently, costs assume floodwalls will be replaced if design elevation increase more than 2 feet above existing design elevation. This assumption ensures that project cost estimates captured all potential costs, however, this floodwall design maybe too conservative.

- Management: During feasibility level design further analysis will refine floodwall design and may decrease project cost.

Economic analysis assumes levees do not breach prior to overtopping – Damages associated with a levee breach (due to non-performance or design exceedance) are not included in the economic analysis, possibly resulting in conservative damage estimates. However, it is assumed that damages caused by a breach would not be a significant contributor to overall annual expected damages because the probability and frequency of occurrence is low.

- Management: Fragility curves, if identified via the SQRA, will be used in the FDA model to more accurately reflect potential damages.

Induced flooding assumption – As identified previously, this is a highly urbanized area at high risk for coastal and river flooding. Since design elevations will increase above the current design, there is a moderate risk that these new elevations may impact surrounding areas. Currently it is assumed there is no cost to mitigate potential induced flooding since impacts have not yet been determined.

- Management: During feasibility level design an analysis on the impacts to surrounding areas will need to be completed to ensure any issues are identified and addressed.

Intermediate Sea Level Rise Scenario – As discussed, it is assumed that an intermediate relative sea level rise will occur in the future. The intermediate sea level rise includes not only the extrapolation of historical tidal gauge rate but future acceleration of global mean sea level. It

does not include changes to accommodate potential rapid loss of ice from Antarctica and Greenland. Due to the physical characteristics of the study area it was determined that the level of uncertainty regarding future relative sea level rates could significantly affect projected benefits.

- Management: All three relative sea level rate scenarios were calculated and evaluated. It was determined that the low and intermediate relative sea level rise scenarios were similar at 1.3 ft. and 1.8 ft. respectively and therefor the risk of under or over estimating benefits based on scenario selection was low. However, it was uncertain how variances to the foot and half difference between the intermediate (1.8ft) and high (3.4 ft.) sea level rise scenarios affect benefits. Sensitivity of the TSP to the low and high sea level rise scenarios is discussed briefly in Section 9.6.3 but additional analyses will be completed during feasibility level design.

9.7.2 IMPLEMENTATION RISKS

Real estate and NEPA compliance assumes similar construction footprint and access to the original project – A change to relocations, permanent or temporary construction and/or access easements, as well as incorrect assumptions regarding related NEPA effects could affect project construction.

2. Management: In order to reduce the risk, additional real estate coordination and NEPA compliance activities will be pursued during feasibility level design.

Availability of specific borrow areas during construction window – Real Estate and NEPA compliance assume the sponsor will procure the necessary real estate in a timely manner on lands that avoid environmental impacts over the lengthy construction period. Impacts of borrow areas for the proposed actions were evaluated based on the list of assumptions outlined in Table 7-2. Because there are multiple projects in the area, the area is highly urbanized, and borrow sites are relatively shallow there is risk that real estate acquisition and NEPA analysis could delay project implementation if not managed.

- Management: In order to reduce the risk, additional coordination with USFWS and the local sponsor will be pursued during feasibility level design and PED to ensure areas identified for borrow avoid impacts to wetlands and minimize impacts to sensitive areas. The recommendations provided from USFWS would be followed as much as practicable when identifying future borrow sites (See Appendix L, *Coordination*).

  Prior to construction, additional NEPA documentation and associated public review would be conducted, as necessary, to address impacts associated with borrow areas including compliance with all environmental laws and regulations.

9.7.3 OUTCOME RISKS

Alternatives development and evaluation utilized an intermediate RSLR scenario to establish potential damages in the future, the necessary design heights (and thereby costs) of alternatives, and the reduction in damages (benefits) in the future if the alternatives were implemented. There is a relatively high risk that this estimate of RSLR in the year 2073 will not be accurate. The study considered the uncertainty surrounding the intermediate RSLR

assumption in three ways: 1) consideration of a high RSLR FWOP and a high RSLR 1% AEP event design; 2) performance of the TSP related to loading at the high and low RSLR scenarios, and 3) performance of the TSP over time related to the high and low RLSR scenarios.

TSP Risk Reduction Performance Related to Loading – One performance consideration asks this question: If the project is designed to reduce risk for a 1% AEP event at intermediate RSLR, what level of risk reduction will it provide if a high or a low RSLR actually occurs? To answer this question, Figure 9-3 was developed, which relates the surge elevation (vertical axis) to the AEP (or return period – horizontal axis) for the three RSLR projections, along with a zero RSLR surge elevation in blue. This relationship varies around the system but the Lake Borgne Surge Barrier was chosen for illustration purposes. On this figure, the TSP is represented by the vertical dashed orange line located at the 100-year (1% AEP) return period on the horizontal axis where it intersects the intermediate RSLR line (green) at approximately 18 feet on the vertical axis. The horizontal dashed orange line traces the 18-foot surge elevation to the high RSLR line (red) and the low RSLR line (black), where we can see that an 18-foot surge is approximately equivalent to a 75-year event (1.3% AEP) in the high RSLR scenario and a 120-year event (0.8% AEP) in the low RSLR scenario. This tells us that in 2073 we may have a little bit more than the 1% AEP risk reduction or a little less if one of the other two scenarios is realized.

- Management: Recommend further evaluation of the 1% AEP at high RSLR and 1% AEP at intermediate RSLR alternatives to the intermediate and high sea level rise scenario once feasibility level analysis has been completed to further refine outcome risk due to relative sea level rise.

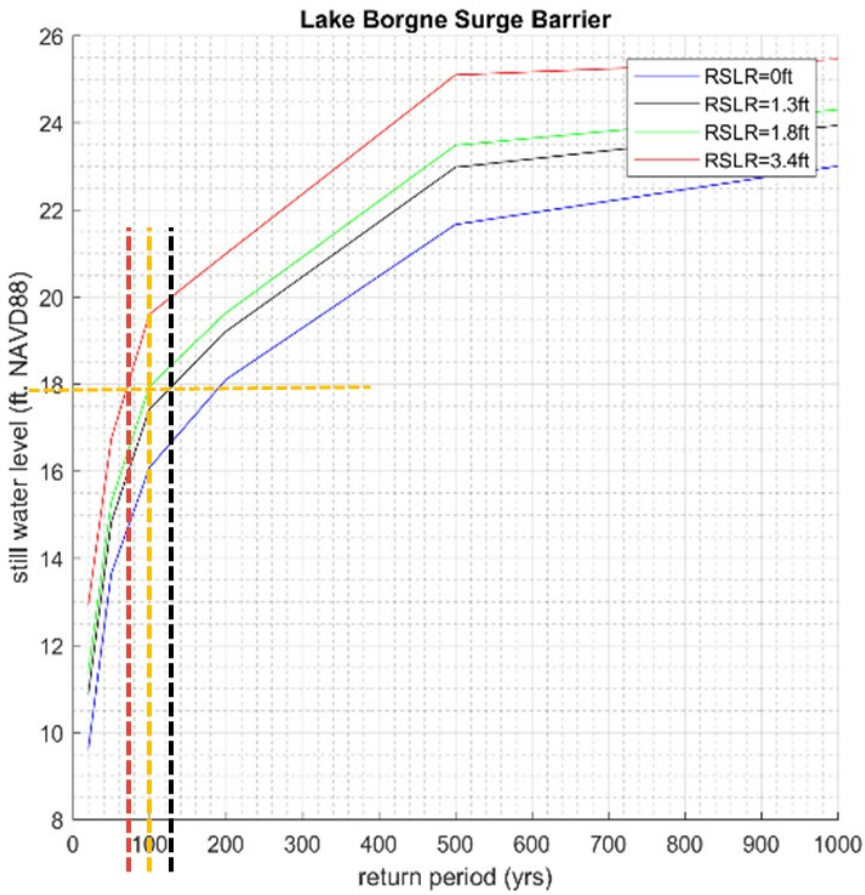

Figure 9-3. Illustration of TSP Risk Reduction Performance for Different RSLR Scenarios

TSP Performance Over Time – A second performance consideration asks: "How does the levee perform over time if a different RLSR scenario is realized?" Figure 9-4 shows the 3 RSLR scenarios over time, projected out to the year 2123. It should be noted that projections out that far are highly uncertain. The green vertical dashed line shows the end of the study's period of analysis in the year 2073 and corresponds the RSLR projections of 1.3 feet (low), 1.8 feet (intermediate), and 3.4 feet (high). The horizontal dashed line tracks the 2073 intermediate RSLR projection (assumed for the TSP design) to the low and high scenarios.

From this graph of RSLR over time, the following observations were made:

1) If the low RSLR scenario is realized in the future, the "low" projection will reach 1.8 feet (the 2073 intermediate projection) around approximately 2093. This can be interpreted to mean that the 2073 1% AEP design for intermediate RSLR could address a "low" scenario for approximately 70 years.
2) If the high RSLR scenario is realized in the future, the high projection will reach the 2073 intermediate projection (1.8 feet) around approximately 2053. This can be interpreted to mean that the 2073 1% AEP design at the intermediate RSLR would address a high scenario for approximately 30 years.

3) Additionally, if the intermediate RSLR scenario is realized in the future, it will reach the 2073 high RSLR projection (3.4 feet) around the year 2108. This is 35 years beyond the study's 50-year period of analysis

- Management: Further analysis on potential optimization of the TSP during feasibility level design may reveal resiliency to RSLR.

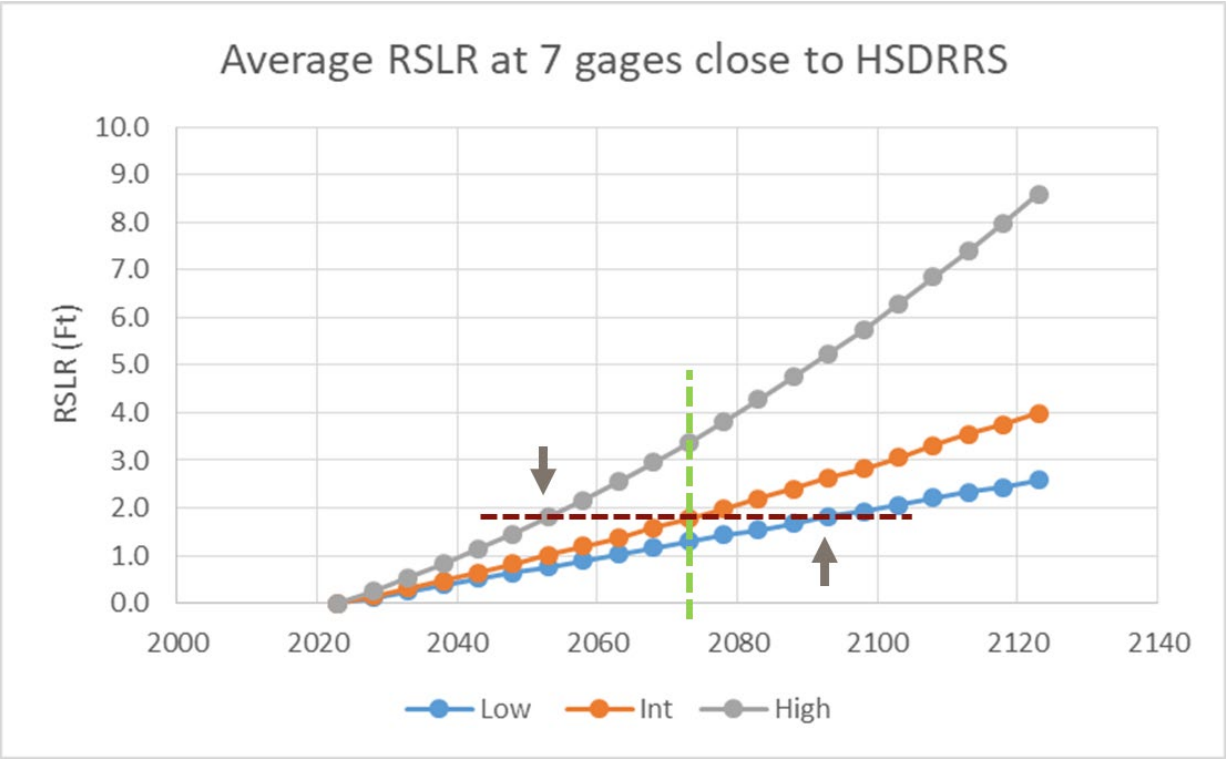

Figure 9-4. Illustration of TSP Performance Over Time for Different RSLR Scenarios

9.8 RESIDUAL RISK

Implementation of flood risk reduction measures does not remove all risks due to flooding. The risks that remain are referred to as residual risks. Flood risk or residual flood risk is defined as the risk of flooding in a leveed area that remains at any point in time after accounting for the flood risk reduction contributed by the levee system. There is always a residual risk of economic damages or life safety consequences associated with any project. This risk stems from the possibility of the project design being exceeded or the possibility that the project will not perform as intended due to some unforeseen circumstance.

9.8.1 PERFORMANCE RISK

With any hurricane and storm risk reduction project, there is the potential for project non-performance (some form of physical failure) or design exceedance. In an extreme case, non-performance (for example, a levee breach) can result in sudden localized high velocity flows and rapid increases in flood depth on the interior of the system. Design exceedance occurs when a lower-probability event brings higher surge levels and greater wave overtopping rates

than the system was designed to address. Design exceedance impacts can range from increased interior flooding of the system to project non-performance.

The tentatively selected plan is designed to prevent surge overtopping and significantly limit (but not completely prevent) wave overtopping for the 1% AEP event. Figure 9-5 and Figure 9-6 display the estimated locations and depths of flooding if a 1% or 0.2% AEP event occurs and the project performs as designed.

Figure 9-5. Residual Flooding for the 1% AEP Event with Full Performance of the TSP

Figure 9-6. Residual Flooding for the 0.2% AEP Event with Full Performance of the TSP

9.8.2 LIFE SAFETY RISK

With any hurricane and storm risk reduction project, there remains life safety risk after project completion. This risk arises from the possibility (however small) that the project may not perform as designed or that the design may be exceeded. The residual life safety risk for the recommended plan is estimated in Appendix D, which is not provided for public review due to the sensitive nature of the information contained within the appendix.

9.8.3 ECONOMIC DAMAGES

With any hurricane and storm risk reduction project, there remains the risk for economic damages after project completion. This residual economic risks estimated for the TSP are related to events that exceed the project design (events greater than 1% AEP) but do not result in project non-performance. These damages are estimated to be $2.7 million annually.

9.9 EXECUTIVE ORDER 11988

EO 11988 requires Federal agencies to recognize the significant values of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. It is the general policy of USACE to formulate projects that, to the extent possible, avoid or minimize adverse impacts associated with use of the base floodplain and avoid inducing

development in the base floodplain unless there is no practicable alternative that meets the project purpose. Screening of measures and alternatives for this study considered impacts to the floodplain and minimizing induced development. Per the procedures outlined in ER 1165-2-26 (Implementation of EO 11988 on Flood Plain Management), the study team has analyzed the potential effects of the NED plan on the overall floodplain management of the study area. USACE implementation guidance in ER 1165-2-26 states the following in Paragraph 6:

EO 11988 has as an objective the avoidance, to the extent possible, of long-and short-term adverse impacts associated with the occupancy and modification of the base floodplain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative. Under the Order, USACE is required to provide leadership and take action to:

- Avoid development in the base flood plain unless it is the only practicable alternative;
- Reduce the hazard and risk associated with floods;
- Minimize the impact of floods on human safety, health and welfare; and
- Restore and preserve the natural and beneficial values of the base floodplain.

There are eight steps reflecting the decision making process required in this EO. The eight steps and responses to them are summarized below.

Step 1. Determine if the proposed action is in the base floodplain.

The proposed actions are located within the base floodplain for the Mississippi River.

Step 2. If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain.

As the primary objective of the project is coastal storm risk management, there are no practicable alternatives completely outside of the base floodplain for the proposed features that would achieve this objective.

As part of the analysis conducted for the NED described throughout this report, the study team completed analysis of residual risks including any induced or transferred flood risks to determine whether coastal storm risk management measures are economically justified as providing greater benefits than costs.

Step 3. Provide public review.

The public will have the opportunity to review and comment on the draft report during the 45-day public review period which will begin in December 2019. Public meetings are planned for January 2020 to present the TSP and allow the public to respond and ask questions. Responses to public comments on the draft GRR will be included in the final GRR.

Step 4. Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values.

Chapters 6, 7, and 8 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated and potential impacts and benefits were evaluated both qualitatively and quantitatively. The anticipated impacts associated with the TSP are summarized in Chapters 7 and 8 of this report. For each resource analyzed in Chapter 7,

wherever there is a potential for adverse impacts, appropriate best management practices or other mitigation considerations were identified. Best management practices are also described in Chapter 7.

Step 5. Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.

Implementing the TSP would have a significant reduction to flooding impacts on human health, safety, and welfare. The proposed project is not anticipated to induce development in the floodplain above and beyond development that is expected to occur in the FWOP condition as described in Chapter 4. It is further assumed that new development will be built above the base 1% AEP floodplain to comply with building codes of local municipalities and to maintain participation in the National Flood Insurance Program. Flood insurance is recommended for both without project and with the TSP as insurance provides greater resiliency by providing financial risk management for residual risks.

Step 6. Reevaluate alternatives.

Chapters 6, 7, and 8 of this document presents an analysis of alternatives. There are no practicable alternatives completely outside of the base floodplain for the features included in the TSP that would achieve study objectives of reducing coastal storm risks.

Step 7. Issue findings and a public explanation.

Public meetings are planned for January 2020 to present the TSP and allow the public to respond and ask questions. The public will be advised that no practicable alternative to locating the proposed action in the floodplain exists with a public notice and involvement under NEPA to fulfill this requirement as indicated in Item 3 above.

Step 8. Implement the action.

The proposed project on its own does not contribute to increased development in the floodplain and does not increase coastal storm risk. The TSP is consistent with the requirements of this EO.

9.10 MEETING ENVIRONMENTAL OPERATING PRINCIPLES

USACE has reaffirmed its long-standing commitment to environmental conservation by formalizing a set of Environmental Operating Principles (EOPs) applicable to decision-making in all programs. The EOPs outline the USACE role and responsibility to sustainably use and restore natural resources in a world that is complex and changing. The recommended plan meets the intent of the EOPs.

The TSP supports each of the seven USACE EOPs. The recommended plan strives to achieve environmental sustainability by implementing a project to provide flood risk management while minimizing negative changes to the natural environment. Developing alternatives which were sensitive to environmental effects was key during the plan formulation process. While recognizing the life safety and economic benefits to be gained from hurricane and coastal storm risk reduction, the recommended plan has been developed to be sustainable but sensitive to the balance and synergy between development and nature through the use of USACE design

criteria and guide specifications while striving to reduce the amount of disruption to wetland habitats. In developing mitigation solutions, coordination was conducted with multiple public resource agencies such as the USFWS, Department of Natural Resources, LDEQ, CPRAB, Louisiana Department of Transportation and Development, the NOAA, and USEPA to build knowledge to understand environmental impacts in order to collaboratively develop innovative, win-win solutions that also protect and enhance the environment. For each adverse effect identified, a responsible mitigation or action to minimize the adverse effect is identified in the Integrated EIS and will be implemented to reflect USACE commitment to accept responsibility and accountability for its actions.

9.11 LESSONS LEARNED DURING HURRICANES KATRINA AND RITA

The selected plan will be consistent with each of the Chief of Engineers' Actions for Change for Applying Lessons Learned during Hurricanes Katrina and Rita issued 24 August 2006. The twelve actions are grouped into four themes.

Actions in the first theme, Comprehensive Systems Approach, include employing integrated, comprehensive systems-based approaches; employing adaptive planning and engineering systems; and focusing on sustainability. The study evaluated LPV as both as an individual project and how it effects adjacent systems and levees. The team considered all components of the levee system which entailed analyzing and discussing data and pertinent features to ensure that they would not indirectly affect other areas.

Actions in the second theme, Risk Informed Decision Making, include employing risk based concepts in planning, design, construction, operations, and major maintenance and reviewing and inspecting completed works. The TSP for LPV was selected using a risk informed-decision making process. The TSP will reduce risk of life loss due to hurricane and storm damage and will reduce life safety risk below the USACE TRGs. The TSP was designed and informed by a methodology that takes into account not only the performance and potential failure modes that cause the increased risk to the system, but also accounts for the consequences of said failure modes.

Actions in the third theme, Communication of Risk to the Public, include effectively communicating risk and establishing public involvement risk reduction strategies. The report establishes the current condition of LPV levee system and also how this condition relates to public safety. These findings are based on exploration and analysis. The Integrated EIS will be available for review on the USACE project webpage. Several meetings took place during the study process between USACE, the sponsor, the public, and other stakeholders.

Actions in the fourth theme, Professional and Technical Expertise, include continuously reassessing and updating policy for program development, planning guidance, design and construction standards; dynamic independent reviews; assessing and modifying organizational behavior; managing and enhancing technical expertise and professionalism; and investing in research. The report will be continuously reassessed during its development. The analysis has undergone District Quality Control (DQC) and ATR (Agency Technical Review) reviews for existing and future conditions, as well as DQC of the draft report with TSP. Additional DQCs and ATR will occur in the future for the final report. There will also be a constructability review and

an Independent External Peer Review where a panel of subject matter experts outside of the agency (USACE) will provide comments and recommendations to the study team that will be considered for implementation.

9.12 USACE CAMPAIGN PLAN

The USACE Campaign Plan provides goals, objectives, and actions for improving the USACE contribution to the nation in the areas of warfighting; civil works processes and delivery systems; risk reduction from natural events; and preparation for the future. The four primary goals are to 1) Support National Security, 2) Deliver Integrated Water Resources Solutions, 3) Reduce Disaster Risks, and 4) Prepare for Tomorrow. The LPV TSP supports the Campaign Plan with contributions to Goals 2 and 3. The project does not make significant contributions to the other two goals.

Goal 2 (Deliver Integrated Water Resource Solutions) includes the following objectives: 2a - Deliver quality water resource solutions and services; 2b - Deliver the civil works program and innovative solutions; 2c - Develop the civil works program to meet the future needs of the nation; and 2d - Manage the life-cycle of water resources infrastructure systems to consistently deliver reliable and sustainable performance. The LPV Project supports Goal 2 by:

- identifying a plan to reduce existing and future economic and life safety hurricane and coastal storm risk within the LPV Project,
- coordinating with significant stakeholder groups throughout the study process, and
- recommending a sustainable and resilient hurricane and coastal storm risk management plan, with appropriate consideration and identification of the long term operation and maintenance of the risk reduction features.

Goal 3 (Reduce Disaster Risks) includes the following objectives: 3a – Enhance interagency disaster response and risk reductions capabilities; 3b – Enhance interagency disaster recovery capabilities; 3c – Enhance interagency disaster mitigation capabilities; and 3d – Deliver and advance Army Geospatial Engineering. The LPV Project supports Goal 3 by:

- contributing significantly to interagency efforts to reduce coastal storm risks in the study area before, during, and after plan implementation, and
- increasing awareness of the potential coastal storm risks among the project stakeholders through coordination and increased communication with other relevant agencies, thus enhancing interagency disaster capabilities and coordination relative to disaster preparation and response.

9.13 SPONSOR SUPPORT

The sponsor for construction is the CPRAB, who has indicated it may enter into Cooperative Endeavor Agreements or other sub-agreements for performance of the NFS's obligations and responsibilities, including the acquisition of LERRDs, OMRR&R, and other items of local cooperation with the local levee districts or other state entities. The CPRAB is fully supportive of the TSP.

9.14 TOTAL PROJECT COST AND BENEFIT-TO-COST-RATIO

Table 9-1. Details of the TSP

Key Factor	LPV ALTERNATIVE 2 System Levee Lifts and Floodwall Modifications to the Projected 1% AEP Event at 2073 (Intermediate SLC)
Costs	
Total Project First Cost	$2,600,000,000
Average Annual O&M Costs	$24,000,000
Average Annual Costs	$82,000,000
Economic Benefits - NED	
Average Annual Damages Reduced (Benefits)	$203,000,000
Average Annual Net Benefits	$122,000,000
Benefit-to-Cost Ratio (BCR)	2.5
Life Safety Risk - OSE	The plan is anticipated to reduce life safety risk below TRG1
Residual Risk	
Life Safety	Residual risks are high due to the extensive population protected by the levee system, even with good evacuation procedures.
Residual Economic Damages	$30,000,000
Critical Infrastructure (remaining/FWOP)	164 / 873

10 PROJECT IMPLEMENTATION

Implementation of the project depends on approval of this report, Congressional authorization, appropriation of sufficient Federal design and construction funding, and matching sponsor contributions in the form of cash, land acquisition credit, or work-in-kind credit. A PPA will also need to be executed with the CPRAB.

10.1 REAL ESTATE CONSIDERATIONS

This section will be fully developed following feasibility level design efforts which will further reduce uncertainties in the real estate requirements.

10.2 DESIGN CONSIDERATIONS

This section will be fully developed following feasibility level design efforts which will further reduce uncertainties in the TSP design. Feasibility level design will also include considerations for additional project resiliency and robustness. This section will document remaining uncertainties and design requirements that need to be considered and addressed during the PED phase.

10.3 CONSTRUCTION CONSIDERATIONS

This section will be fully developed following feasibility level design efforts which will further reduce uncertainties in the TSP design. This section will document construction considerations related to the feasibility level design that need to be considered and addressed during the PED and construction phases.

10.4 OMRR&R REQUIREMENTS

Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) requirements will be a non-Federal responsibility and will be fully documented following feasibility level design. In general, it is expected that the current OMRR&R responsibilities will be largely unchanged except for the requirement that, upon project completion, any additional levee lifts will be accomplished by the non-Federal sponsor.

10.5 MITIGATION REQUIREMENTS

The proposed mitigation plan is detailed in Appendix K. The proposed mitigation plan assumes the 17.2 AAHUs of flood side BLH-wet impacts (approximately 27 acres) would be mitigated through the purchase of mitigation bank credits equaling 17.2 AAHUs. Purchase of credits would be dependent on the receipt of an acceptable proposal and total purchase cost. No particular bank(s) is (are) proposed for use at this time. The bank(s) from which credits would be purchased would be selected through a solicitation process, through which any mitigation bank meeting eligibility requirements and having the appropriate resource type of credits could submit a proposal to sell credits. If appropriate and cost-effective, USACE may choose to purchase mitigation bank credits from more than one bank to fulfill compensatory mitigation requirements. The mitigation bank must be in compliance with the requirements of the USACE Regulatory Program and its Mitigation Bank Instrument, which specifies the management, monitoring, and

reporting that would be required by the bank. Purchase of mitigation bank credits relieves USACE and non-Federal sponsor of the responsibility for monitoring, adaptive management, and demonstrating mitigation success.

10.6 IMPLEMENTATION SCHEDULE

A preliminary implementation plan has been developed to support calculations for construction and economic costs. This plan lays out the levee lifts by decade over the 50-year period of analysis and includes the following: 11 lifts for a total of 17 miles of levee in the first decade (2023-2033); 4 lifts for a total of 24 miles of levee in the second decade (2034-2043); 15 lifts for a total length of 61 miles in the third decade (2044-2053); and 3 lifts for a total length of 6 miles in the fourth decade (2054-2065).

A project schedule will be developed following additional design refinements and will be based upon the assumption that this Report will be approved in the latter half of Federal FY 2021. The project schedule will estimate the timeframe for required levee lifts and lay out a plan for floodwall modifications and mitigation activities. The schedule will assume Federal funding is available in the years required, sponsor matching funds are also available, and that the real estate actions are completed on schedule.

The schedule will reflect the information currently available and the current departmental policies governing execution of projects. It will not reflect program and budgeting priorities inherent in either the formulation of a national civil works construction program or the perspective of higher review levels within the Executive Branch. Consequently, the schedule may be modified before it is transmitted to higher authority for implementation funding.

10.7 SPONSOR REQUIREMENTS

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

1) Provide 35 percent of total hurricane and coastal storm damage risk reduction costs as further specified below:
   a) Provide 35 percent of design costs allocated by the government to hurricane and coastal storm risk reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the hurricane and coastal storm risk reduction features;
   b) Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the government to hurricane and coastal storm damage risk reduction ;
   c) 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 all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary for the

construction, operation, and maintenance of the hurricane and coastal storm damage risk reduction features;

d) Provide, during construction, any additional funds necessary to make its total contribution for hurricane and storm damage risk reduction equal to at least 35 percent of total hurricane and storm damage risk reduction costs;

2) Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefor, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;
3) Not less than once each year, inform affected interests of the extent of protection afforded by the hurricane and storm damage risk reduction features;
4) Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;
5) Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the hurricane and storm damage risk reduction features;
6) Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the hurricane and storm damage risk reduction features;
7) Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the hurricane and storm damage risk reduction features afford, hinder operation and maintenance of the project, or interfere with the project's proper function;
8) 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 required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
9) For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, 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;
10) Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

11) Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
12) Keep and maintain books, records, documents, or 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, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, 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 CFR Section 33.20;
13) 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 DoD Directive 5500.11 issued pursuant thereto; 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 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.);
14) Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under 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 construction, 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;
15) Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal government determines to be required for construction, operation, and maintenance of the project;
16) Agree, as between the Federal government and the non-Federal sponsor, that 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, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
17) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable

element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

10.8 COST SHARING REQUIREMENTS

The CPRAB has stated that it intended or intends to enter into cooperation endeavor agreements or other sub-agreements, in accordance with the Constitution and Laws of the State of Louisiana, for performance of CPRAB's obligations under the PPA. Some of the state entities which CPRAB may enter into cooperation endeavor agreements or other sub-agreements with include, but are not limited to:

- The Southeast Louisiana Flood Protection Authority – East
- The Pontchartrain Levee District
- Plaquemines Parish Government
- St. Charles Parish
- St. Bernard Parish
- Jefferson Parish
- Orleans Parish
- Sewerage and Water Board of New Orleans

The cost sharing requirement for this project is 65% Federal and 35% non-Federal. In addition to cash, the sponsor is anticipated to receive work-in-kind credit for some design and construction work, as well as credit for LERRDs acquisition. The total project first cost, which includes the cost of the recommended plan from this report and all prior project expenditures, is approximately $2.6 billion. The Federal share of the project first cost is estimated to be approximately $1.7 billion and the non-Federal share is estimated to be approximately $910 million. The estimated value of LERRDs to be provided the sponsor is approximately $9.2 million and the rest of the sponsor contribution will be in cash or in-kind credit.

10.9 FINANCIAL ANALYSIS

The CPRAB has the financial capability to cost-share the estimated implementation costs and are willing to sign the PPA at the appropriate time. The organization takes advantage of both Federal and state funding including general state revenues, a State Coastal Trust fund, settlement funds, and oil and gas revenue sharing from Federal offshore waters. Sponsor self-certification of financial capability will be included in the final report.

11 PUBLIC INVOLVEMENT

This report includes an appendix documenting the performance and conclusions of a Semi-Quantitative Risk Assessment. This appendix contains sensitive information that is not releasable to the public. The appendix has an executive summary which describes the process and the general conclusions. The rest of the appendix has been omitted from the report version released to the public.

Public scoping meetings were conducted in April and May 2019. The comments received during the public comment period are included in Appendix L.

The public will have the opportunity to review and comment on the draft report during the 45-day public review period which will begin in December 2019. Public meetings are planned for January 2020 to present the TSP and allow the public to respond and ask questions.

12 RECOMMENDATION

I have considered all significant aspects of this project, including environmental, social, and economic effects and engineering feasibility. I recommend that the Recommended Plan for the Lake Pontchartrain and Vicinity, Louisiana, project area as generally described in this report be authorized for implementation as a Federal project, with such modifications thereof as in the discretion of the Commander, USACE may be advisable. The estimated total project first cost of the recommended plan is approximately $2.6 billion. OMRR&R expenses are estimated to be approximately $24 million per year. The Federal portion of the estimated total project first cost is approximately $1.7 billion. The non-Federal sponsors' portion of the estimated total project first costs is approximately $910 million.

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

STEPHEN MURPHY

Colonel, Corps of Engineers

District Commander

13 REFERENCES

Allen, A., Bernal, Y., & Moulton, R. (1996). *Pine Plantations and Wildlife in the Southeastern United States: An Assessment of Impacts and Opportunities. Information Technologies Report 3.* U.S. Department of the Interior.

Allison, M., Demas, C., Ebersole, B., Kleiss, B., Little, C., Meselhe, E., . . . Vosburg, B. (2012). A water and sediment budget for the lower Mississippi-Atchafalaya River in flood years 2008-2010: implications for sediment discharge to the oceans and coastal restoration in Louisiana. *Journal of Hydrology. 432*, 84-97.

Barras, J., Bernier, J., & Morton, R. (2008). *Land Area Change in Coastal Louisiana: A Multidecadal Perspective (from 1956 to 2006).* U.S. Geological Survey.

Boesch, D., Josselyn, M., Mehta, A., Morris, J., Nuttle, W., Simenstad, C., & Swift, D. (1994). Scientific assessment of coastal wetland loss, restoration and management in Louisiana. *Journal of Coastal Research Special Issue No. 20. 103 pp.*

Browder, J., Bartley, H., & Davis, K. (1985). A probabilistic model of the relationship between marshland-water interface and marsh disintegration. *Ecological Modeling*, 29: 245-260.

Burns, J. J., Poirrier, M., & Preston, K. (1993). *Effects of urban runoff on the environmental quality of Lake Pontchartrain, Louisiana. Sub-project: Effects of New Orleans urban runoff on the distribution and structure of submerged aquatic vegetation communities in Lake Pontchartrain, Louisiana.* Urban Waste Management and Research Center, University of New Orleans. No. 92, pp. 5.

Caffey, R., & Schexnayder, M. (2002). Fisheries implications of freshwater diversions. In P. a. Coastal Wetland Planning, *An interpretive topic series on Louisiana coastal wetland restoration.* National Sea Grant Library No. LSU-G-02-003, 7pp.

CEQ. (1997). *Considering Cumulative Effects under the National Environmental Policy Act.* Washington, D.C.: Council on Environmental Quality, Executive Office of the President.

Cho, H., & Poirrier, M. (2000). Current status of submerged aquatic vegetation in Lake Pontchartrain. *5th Annual Basics of the Basin Symposium, Technical Abstracts*, (pp. 19-20).

Conner, W., & Buford, M. (1998). Southern deepwater swamps. In e. M.G. Messina and W.H. Conner, *Southern Forested Wetlands, Ecology and Management* (pp. 261-287). Boca Raton, FL: CRC Press.

Couvillion, B., Beck, H., Schoolmaster, D., & Fischer, M. (2017). *Land Area Change in Coastal Louisiana (1932 to 2016).* U.S. Geological Survey.

Cowardin, L., Carter, V., Golet, F., & LaRoe, E. (1979). *Classification of wetlands and deepwater habitats of the United States.* Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service.

CWFCUSWG. (2005). *Conservation, Protections and Utilization of Louisianan's Coastal Wetland Forests. Final Report to the Governor of Louisiana.* Coastal Wetland Forest Conservation and Use Science Working Group.

Dahl, T., Johnson, C., & Frayer, W. (1991). *Status and Trends of Wetlands in the Conterminous United States, mid-1970's to mid-1980's.* Washington, D.C.: U.S. Department of the Interior, Fish and Wildlife Service.

Darnell, R. (1961). Trophic spectrum of an estuarine community, based on studiese of Lake Pontchartrain. *Louisiana Ecology*, 42, 553-568.

Davis, F. (2007, March 23). *Frank Davis Fishing Pier Officially Open*. Retrieved from Web log of Frank Davis 23 March 2007: http://www.beloblog.com/WWLTV_Blogs/frankdavis/

Dow, D. D., Herke, W. H., Knudsen, E. E., Marotz, B. L., & Swenson, E. M. (1985). Hydrography on the Grand Bayou, Louisiana, watershed: influence of wetland-water interactions on ecosystem function. *Symposium of Hydrolographic Society of America*, (pp. 52-71).

Duffy, K., & Baltz, D. (1998). Comparison of fish assemblages associated with native and exotic submerged macrophytes in Lake Pontchartrain estuary. *Journal of Experimental Marine Biology and Ecology*, 223: 199-221.

Faller, K. (1979). *Shoreline as a controlling factor in commercial shrimp production.* Bay St. Louis, Mississippi, USA, NASA TM-72-732: National Aeronautics and Space Administration, National Space Technology Laboratories.

GMFMC, G. o. (1998). *Generic amendment for addressing essential fish habitat requirements in the following Fishery Management Plans of the Gulf of Mexico: shrimp fishery, red drum fishery, reef fish fishery, coastal migratory pelagic resources (mackerels), stone crab fishery,.* GMFMC.

HUD. (1984). *24 CFR Part 51 - Environmental Criteria and Standards Sec. 51.103 Criteria and Standards 44 FR 40861, July 12, 1979, as amended at 49 FR 12214, March 29, 1984.*

IPCC. (2001). *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* (J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, . . . C. A. Johnson, Eds.) Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Keddy, P., Campbell, D., McFalls, T., Shaffer, G., Moreau, R., Draunguet, C., & Heleniak, R. (2007). The wetlands of Lakes Pontchartrain and Maurepas: Past, Present, and Future. *Environmental Reviews*, 15(1): 43-77.

Kesel, R. (1987). The decline in the suspended load of the Lower Mississippi River and its influence on adjacent wetlands. *Environmental Geology*, 271-281.

Kolb, C. R., Smith, F. L., & Silvia, R. C. (1975). *Pleistocene sediments of the New Orleans Lake Ponchartrain areas.* Tech Report.

LDEQ. (2018). *Louisiana Water Quality Inventory: Integrated Report.* Baton Rouge, LA: Louisiana Department of Environmental Quality.

Louisiana Comprehensive Wildlife Conserv. Strategy. (2005). Retrieved from Cypress-Tupelo-Blackgum Swamp: http://www.wlf.louisiana.gov/sites/default/files/pdf/document/32870-cypress-tupelo-blackgum-swamp/cypress-tupelo-blackgum_swamps.pdf

LSU AgCenter. (2019, March 6). *Invasive Species*. Retrieved from Louisiana State University AgCenter: https://www.lsuagcenter.com/topics/environment/invasive%20species

Mathews, D. (1983). *Soil Survey of Jefferson Parish, Louisiana.* United States Department of Agriculture, Natural Resources Conservation Service.

Minello, T., Able, K., Weinstein, M., & Hays, C. (2003). Salt marshes as nurseries for nekton: testing hypotheses on density, growth and survival through meta-analysis. *Marine Ecology Progress Series*, 246: 39-59.

New Orleans Lakefront Airport. (2019, January 28). Retrieved from www.lakefrontairport.com

New Orleans Regional Transit Authority. (2019, January 28). Retrieved from www.norta.com

Ning, Z., Turner, R. E., Doyle, T., & Abdollahi, K. K. (2003). *Integrated Assessment of the Climate Change Impacts on the Gulf Coast Region. .* Gulf Coast Climate Change Assessment Council (GCRCC) and Louisiana State University Graphic Services.

NOAA. (2019, March 28). *Marine Recreational Information Program*. Retrieved from NOAA Office of Science and Technology: https://www.st.nmfs.noaa.gov/SASStoredProcess/do?

NOAA. (2019, March 1). *Office of Science and Technology Fisheries Information Query*. Retrieved from National Marine Fisheries Service: https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200::::::

NOAA. (2019, March 28). *Storm Surge Overview*. Retrieved from National Hurricane Center: https://www.nhc.noaa.gov/surge/

O'Connell, M., Cashner, R., & Schieble, C. (2004). Fish assemblage stability over fifty years in Lake Pontchartrain estuary; comparisons among habitats using canonical correspondence analysis. *Estuaries*, 27(5):807-817.

Oswalt, S. N. (2013). *Forest Resources of the Lower Mississippi Alluvial Valley.* Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station.

Poirrier, M., Caputo, C., & Franze, C. (2017). Biogeography of Submerged Aquatic Vegetation (SAV) in the Pontchartrain Basin: Species Salinity Zonation and 1953-2016 Lake Pontchartrain Trends. *Southeastern Geographer, Volume 57, Number 3*, 273-293.

Prakken, L. B., & Lovelace, J. K. (2014). *Water resources of Jefferson Parish, Louisiana.* U.S. Department of Interior, U.S. Geological Survey.

Roberts, H. H. (1997). Dynamic Changes of the Holocene Mississippi River Delta Plain: The Delta Cycle. *Journal of Coastal Research, 13*, 605-627.

Roberts, H., Adams, R., & Cunningham, R. (1980). Evolution of the sand-dominated subaerial phase, Atchafalaya Delta, Louisiana. *American Association of Petroleum Geologists Bulletin 64*, 264-279.

Shipley. (2010). *How to Write Quality EISs and EAs.* The Shipley Group.

Smardon, R., Palmer, J., Knopf, A., Grinde, K., Henderson, J., & Peyman-Dove, L. (1988). *Visual Resources Assessment Procedure for U.S. Army Corps of Engineers, Instruction*

Report EL-88-1. Syracuse, NY: State University of New York, U.S. Army Engineers Waterway Experiment Station, Vicksburg, MS.

Southwick Associates, I. (2008). *The Economic Benefits of Fisheries, Wildlife and Boating Resources in the State of Louisiana - 2006.* Southwick Associates, Inc.

St. Charles Herald Guide. (2008, December). *5 secrets to catching fish at Seabrook*. Retrieved from Herald Guide: http://www.heraldguide.com/details_archive.php?id=4537

Trahan, L. J. (1989). *Soil Surveyof Orleans Parish, Louisiana.* United States Department of Agriculture, Natural Resources Conservation Service.

Tulane/Xavier Center for Bioenvironmental Research. (2019, March 6). *Invasive Species*. Retrieved from Tulane and Xavier Universities, Center for Bioenvironmental Research: http://is.cbr.tulane.edu/InvasiveSpecies.html

USACE. (1994). *West Bank of the Mississippi River in the Vicinity of New Orleans, La. (East of the Harvey Canal). Feasibility Report and Environmental Impact Statement Volume 1.* New Orleans District: USACE.

USACE. (2004). *Larose to Golden Meadow, Louisiana Hurricane Protection Project, Leon Theriot Lock Evaluation Report.* New Orleans District.

USACE. (2007). *Final Report to Congress and Legislative Environmental Impact Statement (LEIS) present the findings of a congressionally requested study on the de-authorization of deep draft navigation on the MRGO between the GIWW and Gulf of Mexico.* U.S. Army Corps of Engineers.

USACE. (2008). *Final Individual Enviromental Report West Bank and Vicinity: Lake Cataouatche Levee (IER #15).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2009a). *Final Individual Environmental Report West Bank and Vicinity: GIWW, Harvey, and Algiers Levees and Floodwalls (IER #12).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2009b). *Final Individual Environmental Report West Bank and Vicinity: Hero Canal Levee and Eastern Tie-In (IER #13).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2009c). *Final Individual Environmental Report West Bank and Vicinity: Harvey to Westwego Levee (IER #14).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2009d). *Final Individual Environmental Report West Bank and Vicinity Western Tie-In (IER #16).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2009e). *Final Individual Environmental Report West Bank and Vicinity: Company Canal Floodwall (IER #17).* New Orleans District: U.S. Army Corps of Engineers.

USACE. (2013). *Comprehensive Environmental Document, Phase I, Greater New Orleans Hurricane and Storm Damage Risk Reduction System.* New Orleans, LA: New Orleans District.

USDA. (2019, January 24). *Web Soil Survey*. Retrieved from https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

USEPA. (1974). *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Report 550/9-47-004.*

USEPA. (1985). *Final Determination of the U.S. Environmental Portection Agency's Assistant Administration for External Affairs Concerning the Bayou aux Carpes Sites in Jefferson Parish, Louisiana Pursuant to Section 404c of the Clean Water Act.* USEPA.

USEPA. (2019, February 20). *Bottomland Hardwoods*. Retrieved from USEPA: https://www.epa.gov/wetlands/bottomland-hardwoods

USEPA. (2019, February 20). *Classification and Types of Wetlands*. Retrieved from USEPA: https://www.epa.gov/wetlands/classification-and-types-wetlands#marshes

USEPA. (2019, February 28). *Water Quality Standards: Regulations and Resources*. Retrieved from U.S. Environmental Protection Agency: https://www.epa.gov/wqs-tech

USFWS. (2007). Protection of Eagles: Definition of "Disturb". *Federal Register, 72*(107), 31132-31139.

USFWS. (2008). *Coordination Act Report: IER #11-Tier 2 Borgne.* U.S. Department of the Interior, Fish and Wildlife Service.

USFWS. (2019, February 14). *National Wetlands Inventory*. Retrieved from http://www.fws.gov/wetlands/

USGS. (2019, March 6). *Nonindigenous Aquatic Species*. Retrieved from U.S. Geological Survey: https://nas.er.usgs.gov/queries/huc6_us.aspx

Zimmerman, R. J., Minello, T. J., & Zamora, G. (1984). Selection of vegetated habitat by brown shrimp, Penaeus aztecus, in a Galveston Bay salt marsh. *Fishery Bulletin*, US 82:325-336.