Mississippi River Valley Division,
Regional Planning and Environment Division South

# Amite River and Tributaries East of the Mississippi River, Louisiana


## Draft Integrated Feasibility Study with Environmental Impact Statement

**November 2019**

# Cover Page

DRAFT INTEGRATED FEASIBILITY STUDY WITH ENVIRONMENTAL IMPACT STATEMENT

of the

Measures of Reducing the Flood Risk to Residents, Businesses, and Critical Infrastructure Within the Amite River Basin.

| | |
|---|---|
| Counties/Parishes: | Amite, Lincoln, Franklin, and Wilkinson Mississippi Counties<br>East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Louisiana Parishes |
| Lead Agency: | U.S. Army Corps of Engineers, New Orleans District |
| Cooperating Agencies: | U.S. Fish and Wildlife Service<br>U.S. Environmental Protection Agency<br>U.S. Geological Survey<br>U.S. Department of Agriculture-National Resource Conservation Agency |

For Further Information Contact the POC below before January 13, 2020:

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**Abstract:** This draft integrated feasibility report and environmental impact statement documents the analysis of proposed actions related to the feasibility of flood risk reduction measures within the Amite River Basin and tributaries. Alternatives, including the proposed tentatively-selected plan and the No Action Alternatives, are discussed.

# Executive Summary

The U.S. Army Corps of Engineers (USACE), Mississippi River Valley Division, Regional Planning and Environment Division South (RPEDS), prepared this Draft Integrated Feasibility Report (IFR) and Environmental Impact Statement (DEIS) for the Amite River and Tributaries East of the Mississippi River, Louisiana (ART). The non-Federal sponsor is the Louisiana Department of Transportation and Development. This supplemental feasibility study, funded through the Bipartisan Budget Act of 2018, is 100 percent federally funded up to $3,000,000. A Feasibility Cost Sharing Agreement was executed on October 3, 2018. The report and the Tentatively Selected Plan (TSP) reflect sponsor, agency, stakeholders, and public input. It presents solutions to reduce damages from flood risk in the Amite River Basin (ARB). The NFS is in support of the tentatively selected plan with the inclusion of optimization for additional flood events.

This DEIS documents a Federal interest in implementation of structural and nonstructural measures. This supplemental study was conducted in response to the Bipartisan Budget Act of 2018, H. R. 1892—13, Title IV, Corps of Engineers—Civil, Department of the Army, Investigations, where funds are being made available for the expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection studies, which are currently authorized or which are authorized after the date of enactment of this the act, to reduce risk from future floods and hurricanes. The study is based on the August 2016 flooding over southeast and south-central Louisiana, and is a continuing investigation under the authorization provided by the Resolution of the Committee on Public Works of the United States Senate, adopted on April 14, 1967.

**Study Area -** The study area is the ARB and its tributaries. The ARB begins in southwest Mississippi and flows southward, crossing the state line into southeastern Louisiana. The ARB includes 2,200 square miles flowing into the Amite River and its tributaries. It includes portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana. The study area is similar to the 1984 Amite Rivers and Tributaries Flood Control Initial Evaluation Study by USACE; however, it has been expanded to include areas that are impacted by backwater flooding to the southeast and east because they are hydraulically connected to the ARB and its tributaries.

No significant flood risks associated with the ARB and its tributaries were identified within Mississippi. The Mississippi Soil and Water Conservation Commission preliminary confirmed on November 19, 2018, that there are “no major flood risk problems in Mississippi from the ARB but may be some minor ones associated with bank carving/sloughing from periodic heavy rains.” Therefore, the project area is limited to the study area located within Louisiana and modeling and development of alternatives was focused on Louisiana.

**Problem -** The primary problem identified in the study area is the risk of flood damages from the Amite River and its tributaries to industrial, commercial, and agricultural facilities and residential and nonresidential structures. Critical infrastructure throughout the region is also at risk of flood damages, including the I-10 and I-12 transportation corridors, government facilities, and schools. This critical infrastructure is expected to have increased risk of damaging rainfall events.

**Planning Objectives/Constraints** - The primary goal is to develop alternatives to reduce the severity of flood risk and damages and risk to human life along the ART to residents, businesses, and critical infrastructure. The federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Planning objectives represent desired positive changes to future conditions. All of the objectives focus on alternatives within the study area and within the 50-year period of analysis from 2026 to 2076. The planning objectives are:

- Reduce risk to human life from flooding;
- Reduce flood damages in the ARB to industrial, commercial, and agricultural facilities  and to residential and nonresidential structures;
- Reduce interruption to the nation's transportation corridors, particularly the I-10/I-12 infrastructure;
- Reduce risk to critical infrastructure (e.g. medical centers, schools, transportation etc.).

A planning constraint is a restriction that limits plan formulation or that formulation must work around. It is a statement of things the alternative plans must avoid. One planning constraint was identified in this study:

- Avoid induced development, to the maximum extent practicable, which contributes to increased life safety risk.

Additionally, several planning considerations were identified for plan formulation that would not require the removal of an alternative plan, but were assessed as part of the plan formulation process:

- Avoid or minimize negative impacts to:
    - threatened and endangered species and protected species;
    - critical habitat, e.g., threatened and endangered species (T&E);
    - water quality;
    - cultural, historic, and Tribal resources;
    - recreation use in the ARB.
- Recognition/awareness that reaches of the Amite and Comite Rivers are Scenic Rivers, which may require legislative changes in order to implement alternatives.
- Consistency with local floodplain management plans by not inducing flooding in other areas.

**Alternatives Considered -** The planning process went through several iterations and evaluated management measures and subsequently alternatives ranging from a large regional scale (i.e. across the study area) to a smaller localized scale (i.e. at the community level). A nonstructural assessment was also completed that looked at the effectiveness of implementing measures such as structure elevations or floodproofing, as well as management measures such as flood warning systems.

The ARB primarily has flooding from two different sources. The upper basin flooding is caused from headwater flooding from rainfall events. The lower basin flooding is caused by a combination of drainage from headwaters and backwater flooding from tides and wind setup.

Thirty-four nonstructural and structural management measures of a variety of scales were identified for evaluation to reduce the risk of flood damages within the ARB. The range of management measures was refined to 19 based on preliminary analyses of effectiveness, efficiency, acceptability, and completeness. The initial array of alternatives were identified using one or more of the 19 management measures that were carried forward after the screening evaluation. Fifteen alternatives were assembled for the initial array of alternatives through the plan formulation process, which include alternatives for No Action and Nonstructural. Two additional alternatives were identified through public scoping.

Most alternatives assessed had very little reduction in flood risk and limited benefits. Topographic relief features in the geomorphology of the ARB have significant influence over flooding in the upper and lower basins. In the upper basin, water flows to the south and in the central/lower basin, the geomorphology is very flat, which limited the effectiveness of alternatives. Additionally, many of the alternatives were located where there were not many structures, so there were limited benefits. The parishes in the study area have a combined population of about 900,000 with more than half of the population living in East Baton Rouge Parish. The study area has over 260,000 structures and of those, about 80 percent are in the central portion of the ARB, north of Bayou Manchac. Many of the alternatives were located where there were not many structures, so there were limited benefits. The remaining alternatives, that were not screened, were those that provided storage of water to attenuate flooding downstream in heavily developed areas. Those alternatives are the focused array of alternatives.

An economic analysis of the focused array of alternatives was performed (Table ES-1) based on the Hydraulics and Hydrology (H&H) model outputs and the economics functions. Water surface profiles were provided for eight annual exceedance probability (AEP) events: 0.50 (2-year), 0.20 (5-year), 0.10 (10-year), 0.04 (25-year), 0.02 (50-year), 0.01 (100-year), 0.005 (200-year), and 0.002 percent (500-year). Annualized costs and benefits were calculated and the Benefit Cost Ratio (BCR) was estimated for each alternative. Each of the alternatives should have benefits long into the future but guidance limits it to the 50-year period of analysis from 2026 to 2076. The economic analysis yielded several alternatives that are in the Federal interest and from which a TSP can be identified. Three alternatives were screened due to negative net benefits: the nonstructural plan for a 0.02 AEP floodplain, large scale 0.04 AEP wet Darlington Dam, and the three 0.01 AEP dry dams on the Darlington, Lilley, and Bluff

Creeks. The remaining alternatives are presented in Table ES-2 as the final array of alternatives, which were further evaluated to identify the TSP.

*Table ES-1. Summary of Costs and Benefits for Focused Array of Alternatives*

| Alternative | Non-structural 0.04 AEP | Non-structural 0.02 AEP | Darlington 0.04 AEP Wet Dam | Darlington 0.04 AEP Dry Dam | Sandy Creek Dry Dam 0.01 AEP | 3 Tributary Dry Dams 0.01 AEP |
|---|---|---|---|---|---|---|
| **Total Project Costs** | | | | | | |
| **First Cost** | $1,335,282 | $2,160,836 | $1,788,531 | $1,278,523 | $270,977 | $349,981 |
| **Interest During Construction** | $4,536 | $7,34 | $100,590 | $71,907 | $7,477 | $9,658 |
| **Total Investment Cost** | $1,339,818 | $2,168,176 | $1,889,121 | $1,350,430 | $278,455 | $359,638 |
| **Estimated Annual Costs** | | | | | | |
| **Annualized Project Costs** | $49,628 | $80,311 | $69,975 | $50,021 | $10,314 | $13,321 |
| **Annual OMRR&R** | $0 | $0 | $658 | $439 | $220 | $659 |
| **Total Annual Costs** | $49,628 | $80,311 | $70,633 | $50,461 | $10,534 | $13,980 |
| **Average Annual Benefits** | | | | | | |
| **Total Annual Benefits** | $53,547 | $63,542 | $65,066 | $65,066 | $13,649 | $6,131 |
| **Net Annual Benefits** | $3,919 | -$16,769 | -$5,567 | $14,605 | $3,115 | -$7,849 |
| **Benefit to Cost Ratio** | 1.08 | 0.79 | 0.92 | 1.29 | 1.30 | 0.44 |

FY19 Price Level, $ 1,000s

*Table ES-2. Final Array of Alternatives*

| **Alternative** |
|---|
| No Action |
| Dry Dam along tributary: Sandy Creek Dry Dam 0.01 AEP |
| Large scale dam: Darlington Dry Dam 0.04 AEP |
| Nonstructural: 0.04 AEP Floodplain (NS-1 and NS-2) |

Based on the economic analysis of the focused array (Table ES-3), the NED plan is the Darlington Dry Dam. The flood risk that remains in the floodplain after the proposed alternative is implemented is known as the residual flood risk. Nonstructural measures can be used to reduce the residual risk associated with the TSP. The residential and nonresidential structures damaged under the with-project conditions in year 2026 that incurred flood damages by the stage associated with the 0.04 AEP event, were considered eligible for acquisition, elevation, and floodproofing.

A preliminary analysis found a total of 3,252 residential structures and an additional 314 non-residential structures in the 0.04 AEP floodplain. The nonstructural measures will be refined by assessing the Darlington Dam as the new base condition for the hydrology, which will include assessment of residual flood risk. Table ES-3 shows the expected annual net benefits for the TSP of Darlington Dry Dam with elevation and floodproofing in the 0.04 AEP floodplain to address residual risk. As plans are refined, the costs and benefits of acquisitions within the floodplain will be developed and addressed in the Final IFR and EIS.

*Table ES-3 Summary of Costs and Benefits of the Tentatively Selected Plan*

| **Darlington Dry Dam with 0.04 AEP Nonstructural Measures Total Expected Annual Net Benefits (FY19, $1,000's, 2.75% Discount Rate)** | |
|---|---|
| **Item** | **Expected Annual Benefits and Costs** |
| Damage Category | |
| Structure, Contents, Vehicles, and Debris Removal | $109,066 |
| Total Benefits | $109,066 |

| | |
|---|---|
| Structural First Costs | $1,278,524 |
| Nonstructural First Costs* | $1,024,198 |
| Total First Costs | $2,302,722 |
| Interest During Construction | $78,887 |
| Annual Operation & Maintenance Costs | $439 |
| Total Annual Costs | $90,817 |
| *Not including acquisitions | |
| B/C Ratio | 1.20 |
| Expected Annual Net Benefits | $18,249 |

**TSP/NED Plan -** Per USACE Guidance, the TSP for flood risk management projects should be the plan that maximizes net benefits, which is also called the NED Plan. In order to determine which alternative is the NED Plan, the costs and benefits for the Focused Array of Alternatives are compared. The alternative with the greatest net benefits is the apparent NED Plan, and thus the TSP.

The TSP identified from the final array is the Dry Darlington Dam combined with nonstructural measures.

The Dry Darlington Dam is an earth embankment dam consisting of a clay core with a random fill outer layer. The constructed dam has a footprint of approximately 205 acres and a flood pool of approximately 12,600 acres, located north of the dam between St. Helena and East Feliciana Parishes. The outlet would consist of three 10x10 feet concrete box culverts with sluice gates that would be closed to prevent flow and allow for water to pool behind the dam prior to release. An emergency spillway would be placed at the flood control pool max elevation. Approximately 1,000 acres of suitable borrow material would be required for construction of the dam, consisting of approximately 10,710,000 cubic yards of random fill and 856,000 cubic yards of clay fill. The Dry Darlington Dam scale will be optimized during the feasibility study design. Final determination for abutment requirements, control tower, sedimentation basin, diversion channel dimensions, outlet channel dimensions to existing Amite River, and spillway location and size (currently evaluating different sizes in an effort of optimization) will need to be determined, along with the staging area(s) for construction. Access road paving and/or surfacing including the crest of the dam and shops needed to maintain the dam will also need to be determined. The evaluation of potential borrow sites and staging areas will also consider environmental impacts and will identify compensatory mitigation requirements for unavoidable impacts.

The nonstructural measures include physical and nonphysical elements. The nonphysical nonstructural measures are to reduce incremental risk with the Darlington Dam in place. An Emergency Action Plan and flood warning system, for the dam and downstream flows, will be established for future with project. Also, each parish impacted by the Darlington Dam will need to revise and/or develop their Floodplain Management Plans to include emergency response, preparedness and recovery actions necessary to manage existing and future risks. The Floodplain Management Plans are a responsibility of local governments.

The physical nonstructural measures of the TSP may include acquisitions with relocation assistance to displaced persons, elevations of residential structures, and floodproofing of non-residential structures. The nonstructural plan will be refined by assessing the Darlington Dam as the new base condition for the hydrology which will likely include structures in geographical regions that are not getting direct benefits from the Darlington Dam such as the Lower Reach of the ARB.

**Timeline -** This Draft IFR and EIS is available for public review beginning November 29, 2019. The official closing date for the receipt of comments is January 13, 2020 which is 45 days from the date on which the notice of availability of this Draft IFR and EIS appears in the Federal Register during this review period. Comments may be mailed to the address listed below. Comments may also be emailed to the email address listed below.

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# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES



# LIST OF APPENDICIES

# Section 1
# Introduction

The U.S. Army Corps of Engineers (USACE), Mississippi River Valley Division, Regional Planning and Environment Division South (RPEDS), has prepared this Draft Integrated Feasibility Report (IFR) and Environmental Impact Statement (DEIS) for the Amite River and Tributaries East of the Mississippi River, Louisiana (ART). It includes input from non-Federal sponsors, agencies, and the public.

## 1.1 STUDY SCOPE

The ART DEIS is an interim response to the study authority to investigate and determine the extent of Federal interest in plans that reduce flood risk along the Amite River Basin (ARB). The effect of flooding from the Amite River and its tributaries was studied, but localized flooding in adjacent communities was not studied. The study investigated alternatives for flood risk management (FRM) and identified and evaluated a full range of reasonable alternatives including the No Action Alternative. The results of the study are presented in this decision document, which is an integrated Feasibility Report and National Environmental Policy Act of 1969 (NEPA) Environmental Impact Statement (EIS) document, in accordance with the USACE's Planning Guidance Notebook, Engineer Regulation (ER) 1105-2-100.

## 1.2 STUDY AUTHORITY

The proposed action is authorized as part of the Bipartisan Budget Act of 2018, H. R. 1892—13, Title IV, Corps of Engineers—Civil, Department of the Army, Investigations, where funds for are being made available for the expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection studies, which are currently authorized or which are authorized after the date of enactment of this the act, to reduce risk from future floods and hurricanes. The funds are at full Federal expense and funds made available for high-priority studies of projects in states and insular areas with more than one flood related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S. Code [U.S.C.] 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017.

The ART study area is included based on the August 2016 flooding over southeast and south-central Louisiana, and is continuing investigation under the authorization provided by the Resolution of the Committee on Public Works of the United States Senate, adopted on April 14, 1967.

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors,

> created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the chief of Engineers on Amite River and Tributaries, Louisiana, published as House Document Numbered 419, Eighty-fourth Congress. And other pertinent reports, with a view to determining whether the existing project should be modified in any way at this time with particular reference to additional improvements for flood control and related purposes on Amite River, Bayou Manchac, and Comite River and their tributaries." Committee on Public Works, 1967."

## 1.3 NON-FEDERAL SPONSOR

The non-Federal sponsor (NFS) is the Louisiana Department of Transportation and Development (LADOTD). This supplemental feasibility study, funded through the Bipartisan Budget Act of 2018, is 100 percent federally funded up to $3,000,000. A Feasibility Cost Sharing Agreement was executed on October 3, 2018.

## 1.4 STUDY AREA AND MAP

The study area is the ARB and its tributaries. The ARB begins in southwest Mississippi and flows southward, crossing the state line into southeastern Louisiana. The ARB includes 2,200 square miles flowing into the Amite River and its tributaries (Figure 1-1). It includes portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana.

The study area is similar to the 1984 Amite Rivers and Tributaries Flood Control Initial Evaluation Study by USACE; however, it has been expanded to include areas that are impacted by backwater flooding to the southeast and east because they are hydraulically connected to the ARB and its tributaries. No significant flood risks associated with the ARB and its tributaries were identified within Mississippi. The Mississippi Soil and Water Conservation Commission preliminary confirmed on November 19, 2018 that there are "no major flood risk problems in Mississippi from the ARB but may be some minor ones associated with bank carving/sloughing from periodic heavy rains." Therefore, the project area is limited to the study area located within Louisiana and modeling and development of alternatives was focused on Louisiana.

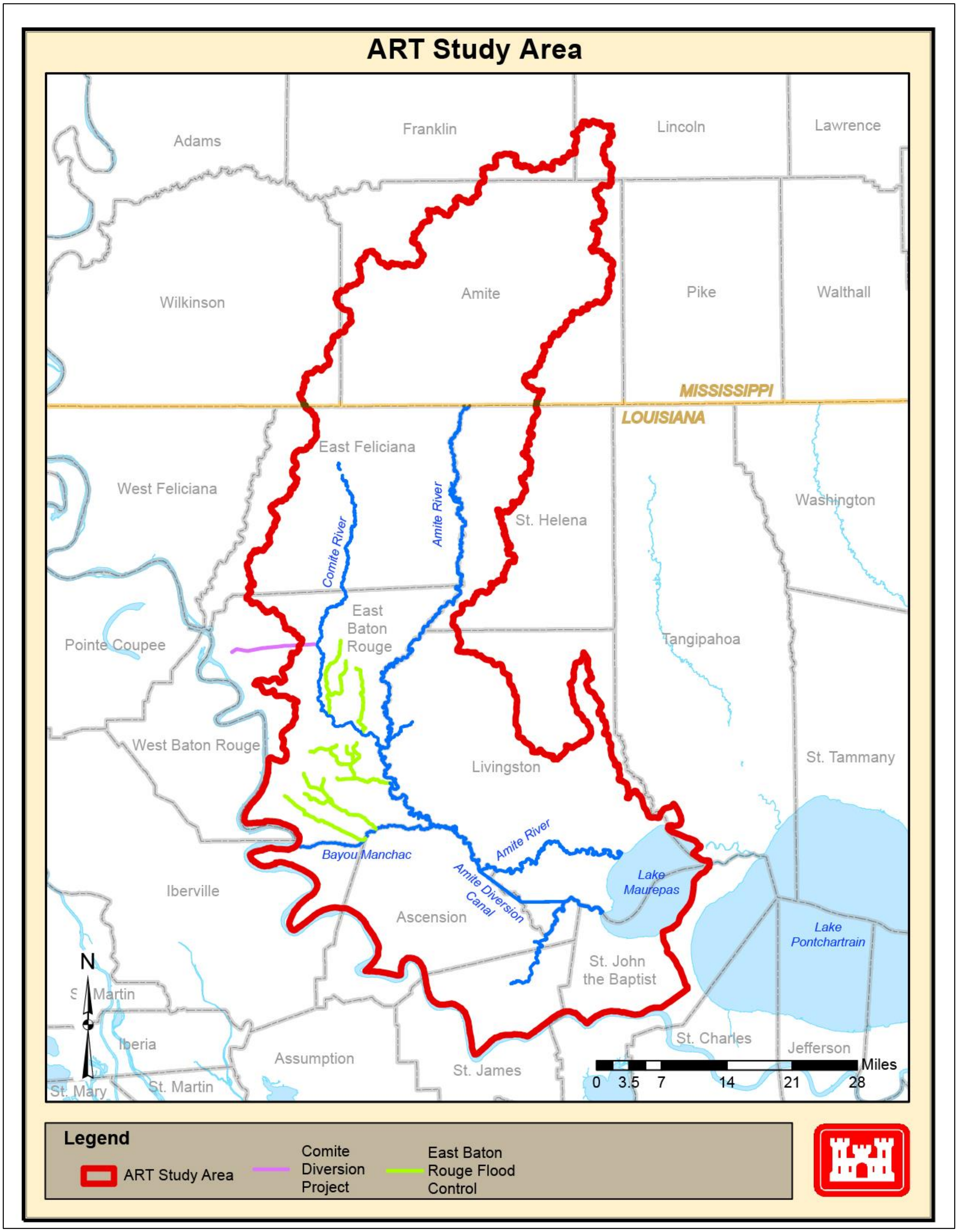


*Figure 1-1. ART Study Area*

## 1.5 PRIOR REPORTS, EXISTING WATER PROJECTS, AND ONGOING PROGRAMS

A number of prior reports and studies by USACE as well as other agencies were reviewed and utilized in writing this report. Information from the documents in Table 1-1a was deemed the most significant to problem identification and plan formulation.

There is one existing FRM USACE constructed project in the study area that was authorized on August 9, 1955 (construction was completed in 1964). Pursuant to the 1955 authorization, the NFSs for that project are responsible for its operation and maintenance (O&M). The 1955 authorization states:

> "Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That improvements in the interest of flood control and drainage be undertaken in the Amite River, Bayou Manchac and the Comite River, such work to be prosecuted under the direction of the Secretary of the Army and the supervision of the Chief of Engineers, substantially in accordance with a survey report entitled "Survey Report of Amite River and Tributaries La.," of the district engineer, Corps of Engineers, New Orleans District, dated June 8, 1955, approved by the division engineer, Corps of Engineers, Lower Mississippi Valley Division, and submitted to the Board of Engineers for Rivers and Harbors on July 5, 1955 at an estimated first cost to the United States of $3,008,000: Provided, That local interest comply with the provisions in the district engineer's recommendations, including the contribution of 24.7 per centum of actual cost in cash or equivalent work as approved by the Chief of Engineers, for Comite River, presently estimated at $67,000." House of Representatives, 1956.

The 1955 authorized constructed features include the following:

- Bayou Manchac-Clearing and snagging on bayou from the mouth to below Ward Creek at mile 7.81
- Comite River-Channel enlargement and realignment on Comite River from its mouth to Cypress Bayou at mile 10
- Blind River-Intermittent Clearing/snagging on Blind River below Lake Maurepas
- Amite River-Enlargement/realignment between Bayou Manchac (mile 35.75) to control weir at (mile 25.3); intermittent clearing/snagging from mouth Comite(mile 54) to Bayou Manchac (mile 35.75)
- Amite Diversion Channel-Construct weir and diversion 19 miles long from mile 25.3 on the Amite to mile 4.8 on the Blind River. Weir orginal design 1,500' at sea level divided into 1,000 & 500' sections and then modified to include 5x20' boat way.

Additionally, two authorized USACE construction projects, which will impact the hydrology of the ARB when construction is completed, are located in or adjacent to the study area: Comite River Diversion and the East Baton Rouge Flood Control.

The State of Louisiana is in the process of developing a statewide, comprehensive Watershed-based Floodplain Management Program. Per the 2018 Phase 1 Investigation Report for the Louisiana Statewide Comprehensive Water Based Floodplain Management Program (LWFMP):

> "Currently, Louisiana various different jurisdictions, including city/parish planning, perform Floodplain Management activities in a largely uncoordinated fashion. Additionally, various jurisdictions, including city/parish planning and zoning departments or public works, regulate or undertake activities that affect floodplains independently, even when they affect the same watersheds. Floodplain issues are managed within political jurisdictions, often without mechanism to consider the effects on other jurisdictions or the watershed on a whole." LWFMP, 2018

Several programs provide funding to the study area for floodplain related activities, as provided in Table 1-1b. Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOSHEP) coordinates funds from grants for Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Pre-Disaster Mitigation Program (PDM). Office of Community of Development (OCD) coordinates funds from the Community Development Block Grant (CDBG). Statewide support (CAPP-SSSE) funds are coordinated by the Analysis Team of LA Watershed Initiative, GOSHEP and LADOTD.

Based on communication with the GOSHEP, LADOTD, and OCD, the current programs and projects with funding that may have an impact on the hydrology of the ARB are presented in Table 1-1c. Additionally, the Louisiana Watershed Resiliency Study is currently ongoing by the Federal Emergency Management Agency (FEMA) and the state has applied to FEMA for a Housing and Urban Development grant.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| 1980 | LA Coastal Resources Program | X | X | X | X | X |
| 1999 | Coast 2050: Toward a Sustainable Coastal LA | X | X | X | X | X |
| 2004 | LA Coastal Area (LCA), LA Ecosystem Restoration Study | X | X | X | X | X |
| 2017 | Louisiana State Master Plan by Coastal Protection and Restoration Authority | X | X | X | X | X |
| 2017 | Louisiana Watershed Resiliency Study: Developed Following the March and August 2016 Floods by Federal Emergency Management Agency, Mitigation Branch, Hazard Performance Analysis Group | X | X | X | X | X |
| 2017 | Characterization of Peak Streamflows and Flood Inundation of Selected Areas in Louisiana from the August 2016 Flood by United States Geological Survey (USGS) for FEMA | X | X | | | X |
| | | | | | | |
| 1888 | Preliminary Examination of Bayou Manchac, Louisiana by USACE | X | | | | |
| 1907 | Pass Manchac, Louisiana House Doc 882, 60th Congress, 1st Session | X | | | | |
| 1912 | Completed Pass Manchac Project by USACE via the River and Harbor Act of 6/24/1910 | X | | | | X |
| 1927 | Amite River and Bayou Manchac, Louisiana Navigation Project was authorized. (7'X60' navigation canal) | X | | | | X |
| 1928 | USACE completes navigation channel improvements in the ARB from Denham Springs to Lake Maurepas. | X | | | | X |
| 1930 | Amite River and Bayou Manchac, Louisiana Feasibility Report by USACE | X | X | | | X |
| 1953-1967 | LA DPW and East Baton Rouge improvements to Wards Creek, Clay Cut Bayou, Jacks Bayou, Bayou Duplantier and White Bayou. | X | | | | |
| 1955 | ARB and Tributaries Flood Control Study by USACE | X | X | X | X | X |
| 1956 | USACE Chief of Engineers Report: Amite River and Tributaries | X | X | X | X | X |
| 1964 | USACE completes channel improvements to upstream portions of Amite River, and to lower portions of Comite River, Blind River, and Bayou Manchac; including construction of the Amite Rover | X | X | X | X | X |

*Table 1-1a. Relevant Prior Reports and Studies*

| Year | Study/Report/Environmental Document Title | Data Source | Consistency | Structural Measures | Non-Structural Measures | FWOP Conditions |
|---|---|---|---|---|---|---|
| | Diversion Canal and weir | | | | | |
| 1971 | Bayou Fountain: Floodplain Information Report for East Baton Rouge Parish by USACE | X | X | | | X |
| 1972 | Amite Rivers and Tributaries: Preliminary Evaluation Report by USACE | X | X | | | X |
| 1972 | Ward Creek and Tribes: Floodplain Information Report for East Baton Rouge Parish by USACE | X | X | | | X |
| 1974 | Clay Cut Bayou, Jones Creek and Tributaries: Flood plain Information Report For East Baton Rouge Parish by USACE | X | X | | | X |
| 1976 | Hurricane Creek, Monte Sano Bayou and Tribes: Floodplain Information Report for East Baton Rouge Parish by USACE | X | X | | | X |
| 1976 | Cypress Bayou and Tributaries: Floodplain Information Report for East Baton Rouge Parish by USACE | X | X | X | X | X |
| 1979 | Bayou Manchac and Amite River Louisiana Feasibility Report by USACE | X | X | X | X | X |
| 1984 | Amite Rivers and Tribes: Flood Control Initial Evaluation Study by USACE | X | X | X | X | X |
| 1989 | Amite River Flood Control Study Report for LADOTD | X | X | X | | X |
| 1990 | Amite River and Tributaries, Louisiana, Comite River Basin Feasibility Study by USACE | X | X | X | X | X |
| 1990 | Land Use and Development Plan (Horizon Plan) for the City of Baton Rouge | X | X | | | X |
| 1991 | Comite River Final EIS by USACE | X | X | | | X |
| 1991 | Amite River And Tributaries Study - Feasibility Report On Comite River Basin by USACE | X | X | X | X | X |
| 1992 | Amite River and Tributaries Darlington Reservoir Feasibility Study by USACE | X | X | X | X | X |
| 1995 | Comite River Design Memorandum No. 1 by USACE | X | X | X | X | X |
| 1995 | Final Environmental Assessment (EA #222) Amite River And Tributaries Louisiana, Comite River Basin, Revision Of Diversion Channel Alignment And Other Changes by USACE | X | X | | | X |
| 1995 | Amite Rivers and Tributaries East Baton Rouge Flood Control | X | X | X | X | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Projects by USACE | | | | | |
| 1995 | Study to Lower Stages along the Amite River (3 Low Impact Dry Dams) by C.E. Matrailer P.E. & Cecil E. Soileau P.E. | X | X | X | | |
| 1995 | ARB Flood Control Program for LADOTD | X | X | X | | |
| 1996 | Post Authorization Change Report for the Comite River Diversion Plan by USACE | X | X | X | X | X |
| 1997 | Livingston Parish Feasibility Study for channel improvement for Flood Control by USACE | X | X | X | X | X |
| 1997 | Darlington Reservoir Re-evaluation Study by USACE | X | | X | | |
| 1998 | ARBC in conjunction with USGS, LADOTD and LOEP and USACE establish a Flood Warning System for the ARB | X | X | | X | X |
| 1999 | Comite River Diversion Construction Authority WRDA August 17, 1999 | X | | | | X |
| 1999 | Amite River Sand & Gravel Mine Reclamation Demonstration Project for LADOTD | X | X | | | |
| 2000 | Amite River and Tributaries Ecosystem Restoration Reconnaissance Study by USACE | X | X | | | |
| 2002 | Environmental Assessment, Lilly Bayou Control Structure, Phase 1 EA# 222-A by USACE | X | X | X | X | X |
| 2005 | City of Baton Rouge and East Baton Rouge Parish Bridge Location Index Map by City of Baton Rouge & East Baton Rouge Parish | X | X | | | X |
| 2005 | Frog Bayou and Alligator Bayou Comprehensive Flood Risk Reduction Plan for the Pontchartrain Levee District | X | X | | | X |
| 2007 | Fluvial Instability and Channel Degradation of Amite River and its Tributaries, Southwest Mississippi and Southeast Louisiana by ERDC Geotechnical and Structures Lab | X | X | X | X | X |
| 2007 | East Baton Rouge Flood Control Project Authority WRDA 2007 | X | | | | X |
| 2011 | Amite River Field Investigation and Geomorphic Assessment by ERDC Coastal & Hydraulics Laboratory | X | X | | X | X |
| 2014 | West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study by USACE | X | X | X | X | X |

*Table 1-1a. Relevant Prior Reports and Studies*

| Year | Study/Report/Environmental Document Title | Data Source | Consistency | Structural Measures | Non-Structural Measures | FWOP Conditions |
|---|---|---|---|---|---|---|
| 2015 | ARB Floodplain Management Plan by Gulf Engineers and Consultants for ARB Drainage and Water Conservation District | X | X | X | X | X |
| 2016 | August 2016 Flood Preliminary Report ARB | X | X | X | X | X |
| 2017 | Hydrologic and Hydraulic Numerical Model of the ARB-Detailed Work Plan, Detailed Cost Estimate and Schedule Proposal | X | X | | | X |
| 2018 | West Shore Lake Pontchartrain Hurricane and Storm Damage Risk Reduction Study by USACE | X | X | X | X | X |
| 2018 | St. James/Ascension Storm Surge Flood Protection Project by The Pontchartrain Levee District | X | X | X | X | X |
| 2018 | Bayou Conway & Panama Canal Drainage Improvement Project by The Pontchartrain Levee District | X | X | X | | X |
| 2018 | Laurel Ridge Levee Extension Project Ascension Parish by The Pontchartrain Levee District | X | X | X | X | X |
| 2019 | Investigation into the Potential Hydraulic Impacts of Dredging the Lower Amite River for LADOTD | X | X | X | | |
| 2019 | ARB Numerical Model Project Report for LADOTD | X | X | | | X |
| 2019 | Investigation into the Impacts of the Darlington Reservoir Concept for LADOTD | X | X | X | | X |

*Table 1-1b. Funding Sources for Floodplain Related Activities within the Study Area*

| Funding Source | Type | Grantor | Funding Range ($ Millions) |
|---|---|---|---|
| Federal Emergency Management Agency (FEMA) Public Assistance (PA) | Post disaster (Non-recurring) | Federal | Varies based on eligible recovery and mitigation scopes of work following a major presidential disaster declaration. |
| HMGP | Post disaster (Non-recurring) | Federal | Varies based on amount of total federal assistance |
| FMA | Non-disaster (recurring) | Federal | Varies based on amount appropriated annually by congress, from the NFIP |
| PDM | Non-disaster (recurring) | Federal | Varies based on amount appropriated annually by congress |
| CDBG | Post-disaster (Non-recurring) | Federal | $65 to $13,400 |
| Gulf of Mexico Energy Security Act (GOMESA) | Recurring | Federal | $0.1 to $8 (previous) $70 predicted |
| Statewide Flood Control Program | Recurring | State | $10 to $20 |

Source: LWFMP, 2018.

*Table 1-1c. Current Funded Programs/Projects within the Study Area*

| Program | Project Title | Parish |
|---|---|---|
| FMA | FMA-PJ-06-LA-2017-024 | East Baton Rouge |
| FMA | EBR Acquisition/Demolition & Elevation | East Baton Rouge |
| FMA | Livingston FMA 2016 Acquisition & Elevation | Livingston Parish Council |
| FMA | FY 17 Flood Mitigation Assistance | Livingston Parish Council |
| HMGP | Livingston Parish 4263 Elevation Project | Livingston Parish Council |
| HMGP | St. Helena Parish Home Acquisition | St. Helena Parish |
| FMA | St. John the Baptist Parish Elevation Project | St. John The Baptist |
| HMGP | Drainage Improvements | St. John The Baptist |

# Section 2
# Problems and Opportunities (Purpose and Need)

## 2.1 SPECIFIC PROBLEMS AND OPPORTUNITIES

The study area has experienced riverine flooding from excessive rainfall events, in addition to flood damages associated with hurricanes and tropical storms. Since 1851, the paths of 51 tropical events have crossed the study area. The paths and intensities of these storms are shown in Figure 2-1. The FEMA flood claims for the most recent events to impact the area are shown in Table 2-1. Table 2-2 shows the flood claims paid between 1978 and September 2018 for all counties and parishes in the study area. The table includes the number of claims, number of paid losses, and the total amount paid in the dollar value at the time of the payment. The table excludes losses that were not covered by flood insurance.

The most recent event to affect the study area was the 2016 Louisiana flood. This event brought catastrophic flooding damage to Baton Rouge and the surrounding areas with both localized flooding and riverine flooding from the Amite and Comite Rivers and their tributaries. In August 2016, the President issued disaster declarations for parishes in the ARB due to impacts from "The Great Flood of 2016." The flood was responsible for 13 deaths http://ldh.la.gov/index.cfm/page/2553 and the rescue of at least 19,000 people https://www.army.mil/article/173589/national_guard_rescues_19000_in_flood_affected_areas. The study area experienced historic flooding to thousands of homes and businesses and impacts to the Nation's critical infrastructure because both the I-10 and I-12 transportation system were shut down for days. Major urban centers in the ARB saw significant flooding, well outside of normal flood stages.

The study will provide FRM alternatives to reduce the risks to public, commercial, and residential property, real estate, infrastructure, and human life; increase the reliability of the Nation's transportation corridor (I-10-I-12); and enhance public education and awareness of flood risks.

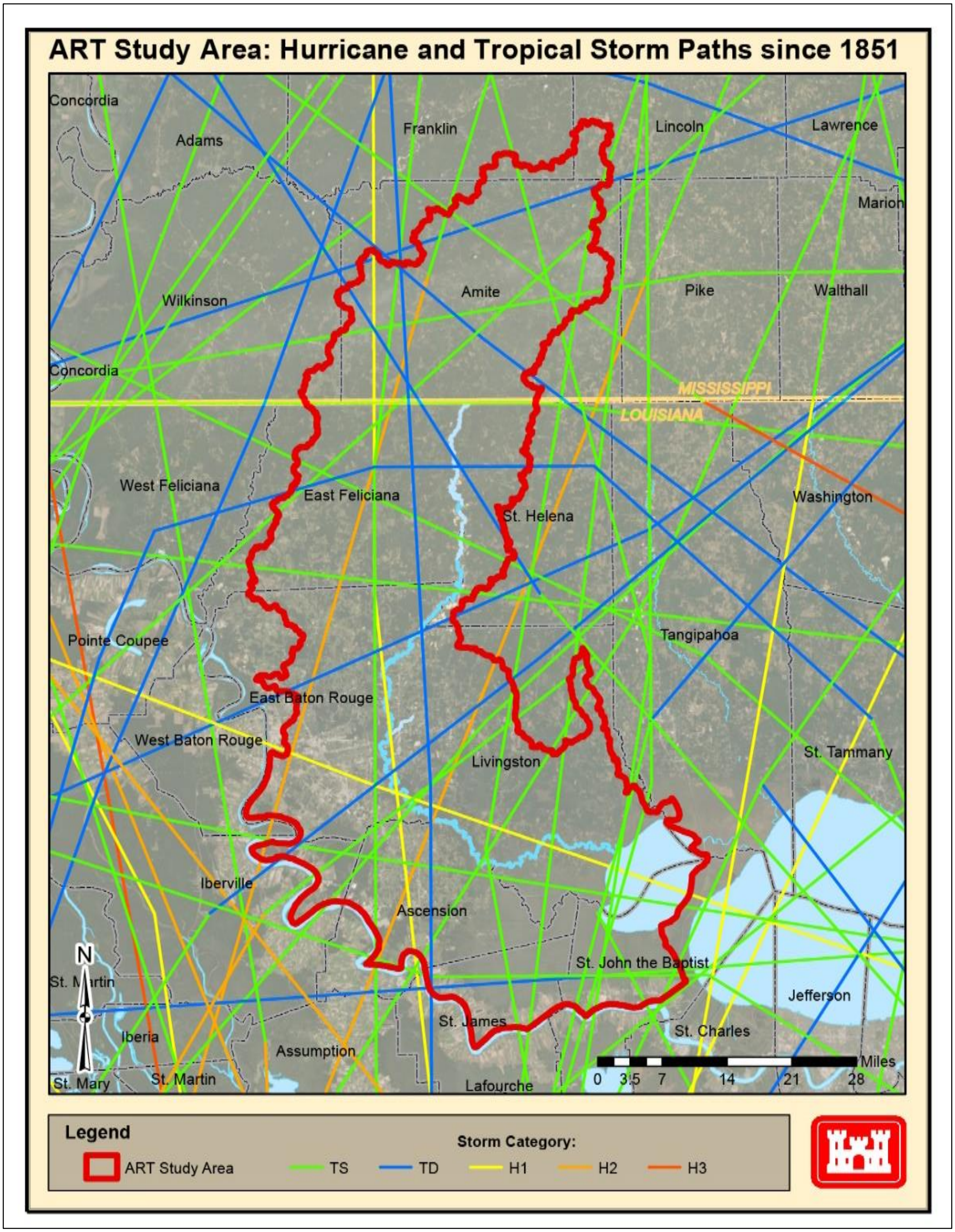


*Figure 2-1. Hurricane and Tropical Storm Paths since 1851*

*Table 2-1.Top Tropical Storms by Amount Paid by FEMA in the Study Area*

| Event | Month & Year | Number of Paid Claims | Total Amount Paid (millions) |
|---|---|---|---|
| 2016 Louisiana Floods | August 2016 | 26,909 | $2,455.7 |
| Tropical Storm Lee | September 2011 | 9,900 | $462.2 |
| Hurricane Ike | September 2008 | 46,684 | $2,700.1 |
| Hurricane Gustav | September 2008 | 4,545 | $112.6 |
| Hurricane Rita | September 2005 | 9,354 | $466.2 |
| Hurricane Andrew | August 1992 | 5,587 | $169.1 |

Source: Federal Emergency Management Agency (FEMA)

Note 1: Total amount paid is at price level at time of the event.
Note 2: Claims and amount paid are for entire event, which may include areas outside of the study area.

*Table 2-2. FEMA Flood Claims in the Study Area by Parish/County from January 1978 through September 2018*

| Parish/County | Total Number of Claims | Number of Paid Claims | Total Payments (millions) |
|---|---|---|---|
| Ascension | 6,606 | 5,658 | $336.8 |
| East Baton Rouge | 19,926 | 17,139 | $1,170.6 |
| East Feliciana | 83 | 72 | $2.8 |
| Iberville | 540 | 453 | $7.8 |
| Livingston | 14,394 | 12,684 | $813.9 |
| St. Helena | 51 | 38 | $2.3 |
| St. James | 249 | 204 | $6.2 |
| St. John the Baptist | 4,942 | 3,996 | $264.2 |
| Amite | 4 | 4 | $0.0 |
| Franklin | 3 | 1 | $0.0 |
| Lincoln | 23 | 16 | $0.1 |
| Wilkinson | 1,883 | 1,603 | $21.0 |
| Total | 48,704 | 41,868 | $2,625.8 |

Source: Federal Emergency Management Agency (FEMA)

### 2.1.1 Problems

The primary problem identified in the study area is the risk of flood damages from the Amite River and its tributaries to industrial, commercial, and agricultural facilities and residential and nonresidential structures. Critical infrastructure throughout the regions includes the I-10 and I-12 transportation corridors, government facilities, and schools. This critical infrastructure is expected to have increased risk of damage from rainfall events.

### 2.1.2 Opportunities

Opportunities to address the identified problems include:

- Risk Reduction to life, land, property, and infrastructure from flooding.
- Work with local communities to manage flood risk by leveraging the following efforts:
    - Enhance public education and awareness of floodplain management;
    - Improve flood warnings for preparation and evacuation;

    - Recommend future modifications to the roadway systems to maintain emergency response vehicles access during hurricane and tropical storm events.
- Increase the resiliency of the vitally important I-10/I-12 transportation corridor
- Prevent degradation to fish and wildlife habitat by:
    - Improving water quality;
    - Increasing habitat or slowing down the trend of habitat quality reduction;
    - Encouraging best management practices for land use management.
- Afford access to recreation (boating, bike trails, camping, swimming, and sightseeing facilities)

### 2.1.3 Purpose and Need

Per the authority referenced in Section 1.2, the ART study's purpose is to evaluate FRM. Without the project, the ART study area would continue to experience damages from rainfall and wind/tide induced flooding. These impacts would be exacerbated in the Lower ARB because of increased risk due to flood events.

## 2.2 PLANNING GOAL AND OBJECTIVES

The primary goal is to develop alternatives to reduce the severity of flood risk and damages and risk to human life along the ART to residents, businesses, and critical infrastructure. The federal objective of water and related land resources project planning is to contribute to National Economic Development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Planning objectives represent desired positive changes to future conditions. All of the objectives focus on alternatives within the study area and within the 50-year period of analysis from 2026 to 2076. The planning objectives are:

- Reduce risk to human life from flooding;
- Reduce flood damages in the ARB to industrial, commercial, and agricultural facilities and residential and nonresidential structures;
- Reduce interruption to the nation's transportation corridors, particularly the I-10/I-12 infrastructure;
- Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.).

## 2.3 PLANNING CONSTRAINTS

A planning constraint is a restriction that limits plan formulation or that formulation must work around. It is a statement of things the alternative plans avoid. One planning constraint was identified in this study:

- Avoid induced development, to the maximum extent practicable, which contributes to increased life safety risk.

Additionally, several planning considerations identified for plan formulation that would not require the removal of an alternative plan, but needs to be assessed as part of the plan formulation process:

- Avoid or minimize negative impacts to:
  - threatened and endangered species and protected species;
  - critical habitat, e.g., threatened and endangered species (T&E);
  - water quality;
  - cultural, historic, and Tribal resources;
  - recreation use in the ARB.
- Recognition/awareness that reaches of the Amite and Comite Rivers are Scenic Rivers, which may require legislative changes in order to implement alternatives.
- Consistency with local floodplain management plans by not inducing flooding in other areas.

## 2.4 PUBLIC SCOPING

Early NEPA coordination with the NFS, stakeholders, Federal and state agencies, and Federally-recognized Tribes (Tribes) was performed prior to the Notice of Intent (NOI) and afterwards through public meetings, social media, and the USACE New Orleans District (CEMVN) website. USACE hosted general scoping meetings within 90 days of the start of the study, per Water Resources Reform and Development Act (WRRDA) 2014. As part of the early coordination, general scoping was initiated prior to the NEPA NOI, in conformity with 40 CFR 1500-1508. A public website page with the study information and request for feedback was established in mid-December 2018.

The collaborative stakeholders associated with this study are USACE, ARB Commission (ARBC), Coastal Protection and Restoration Authority (CPRA), and the following parishes: Livingston, Ascension, St. Helena, East Feliciana, East Baton Rouge, Iberville, St. John the Baptist, and St. James. Resource agencies associated with this study include the US Fish and Wildlife Service (FWS), US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), US Geological Survey (USGS), and the Louisiana Department of Wildlife and Fisheries (LDWF). Additionally, in partial fulfillment of USACE's responsibilities under Executive Order (EO) 13175, early NEPA coordination was initiated with the following Tribes: Alabama-Coushatta Tribe of Texas (ACTT), Chickasaw Nation, Chitimacha Tribe of Louisiana (CTL), Choctaw Nation of Oklahoma (CNO), Coushatta Tribe of Louisiana (CT), Jena Band of Choctaw Indians (JBCI), Mississippi Band of Choctaw Indians (MBCI), Muscogee (Creek) Nation (MCN), Seminole Nation of Oklahoma (SNO), Seminole Tribe of Florida (STF), and Tunica-Biloxi Tribe of Louisiana (TBTL) on December 4, 2018.

A NEPA stakeholder meeting was conducted by USACE on December 3, 2018. A subsequent reconnaissance meeting was conducted with the NFS, and resource agencies; Tribes were invited, but were unable to attend the meeting on December 10, 2018. However, a follow up meeting was held on January 7, 2019, during which the MBCI participated. Additionally, a public scoping meeting was conducted on January 10, 2019, at CEMVN with

Facebook Live Streaming, which requested feedback as well. Feedback from the public scoping meeting resulted in the identification of three additional measures.

In accordance with NEPA, a NOI to prepare an EIS was published in the Federal Register (Volume 84, No. 63) on April 2, 2019. The scoping period ends on July 8, 2019. Three public scoping meetings were conducted within the study area on April 24 and 25, with Facebook Live Streaming. Comments were accepted via written correspondence and emails. Approximately 80 non–USACE people attended the meetings in person and the Facebook Live Streaming had over 6,000 views. Scoping identified four areas of concern: flooding, dredging opportunities, levee opportunities, and nature based engineering. People are concerned about inducement of flooding into other area and proposed further investigation in alternative formulation and specific areas of concern. Feedback from the public scoping meeting resulted in the identification of one additional measure, which was proposed by the Healthy Gulf Collaborative, regarding conversion of sand and gravel mines to bottomland hardwoods habitat for flood control.

Additionally, a meeting was conducted on June 18, 2019 with collaborative stakeholders, the NFS, resource agencies, and Tribes to present the preliminary final array of alternatives and the screening rationale of the alternatives that were screened. As a result, three agencies, (FWS, Louisiana Department of Environmental Quality (LDEQ), and LDWF) requested an evaluation of river restoration, which resulted in the addition of another alternative, restoration of river meanders.

The scoping report is included in the Environmental Appendix C-2, which has copies of all written feedback received. Table 2-3 shows the typical NEPA reporting requirements and where they are located in the report.

*Table 2-3. NEPA Information in this Report*

| EIS Sections | | Location in this Document |
|---|---|---|
| Cover Page | | Cover Page |
| Abstract | | Cover Page |
| Table of Contents | | Table of Contents |
| Purpose of and Need for Action | | Section 2 |
| Alternatives Including Proposed Action | | Section 4 |
| Affected Environment | | Section 3 |
| Environmental Consequences | | Section 5 |
| List of Preparers | | Section 10 |
| Public Involvement | | Section 9 |
| Environmental Laws and Regulations | | Section 8 |
| Mitigation | | Section 7 |
| List of Report Recipients | | Section 9 |
| Index | | Listed in References |
| Appendices | | Listed in the Table of Contents |

# Section 3
# Inventory and Forecast Conditions

## 3.1 ENVIRONMENTAL SETTINGS

### 3.1.1 Land Use

The Pre-Contact settlement of the ARB extends as far back as the Paleoindian period (11,500-8000 B.C.), although few sites of this age have been identified within the study area. However, archaeological evidence supports that during the period from 8000 B.C. to 800 B.C. the region was well inhabited by Native American peoples who often settled along ridges overlooking streams with gravel outcroppings. It is noteworthy to mention that during the subsequent Pre-Contact period, from approximately 800 B.C. and leading up until the time of Native American-European contact, settlement strategies shift away from the uplands of the ARB towards alluvial valleys, giving rise to some of the earliest agricultural-based settlements in the region. Upon the arrival of Europeans to the ARB there were multiple groups of Native Americans occupying the ARB. The effects of contact between these cultures is understudied at the present time and can be refined as additional investigations are conducted in the future. European Settlements from the 1800s in the ARB primarily consisted of farming, fishing, hunting, and trapping communities near the Prairie Terraces and natural levees, often at or near floodplains. More densely populated communities began to form in response to the need for government administration and trade centers, resulting in the slow degradation of nearly 100 percent of the natural forested landscape. Road and rail networks further contributed to urbanization near high-ground water routes, and the establishment of multiple universities, a large petrochemical industry, and the Second World War prompted continuous population growth into the 1900s (GEC, Inc., 2015).

As of 2015, the study area predominantly consisted of undeveloped acreage. About 28 percent of the land was developed for commercial, residential, agricultural, recreation, and industrial purposes. The remaining 72 percent of the land was comprised of wetlands, new-growth forest, barren land, and other undeveloped land. Refer to Appendix C-1, for the land use classification table and map of the study area.

### 3.1.2 Climate, Weather Patterns, and Climate Change

The 2014 USACE Climate and Resiliency Policy Statement states the “USACE shall continue to consider potential climate change impacts when undertaking long-term planning, setting priorities, and making decisions affecting its resources, programs, policies, and operations.” The ART Study evaluates the feasibility of structural and nonstructural flood risk measures from 2026 to 2076. The most significant impact on coastal wetlands resulting from climate change is sea level change.

Climate in the region is humid subtropical, being heavily influenced by the movements of warm moist air off of the Gulf of Mexico. Average monthly temperatures vary from approximately 51.2 °F in January to 82.0 °F in July. Winter nighttime lows below freezing are common, as are summer daytime highs in the mid-90s. See Appendix C1, Table C1-2 for the monthly temperature normals recorded from the Baton Rouge Metro Airport, LA monitoring station by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC).

Normal annual precipitation for the ARB is 60.5 inches, although for the period 1980 through 1991 rainfall averaged 64 inches a year. The ARB experienced drought conditions (-2 or less on the Palmer Drought Severity Index) during the modern era years of 1952, 1963, 1981, 1999, and 2000. Southerly, maritime winds prevail for much of the year, resulting in the potential for highly variable rainfall over the ARB. Daily variations are frequently measured in inches. Even for a 30-year averaging period annual precipitation at various weather stations throughout the ARB ranged from 56 to 67 inches. The wettest month is December with an average monthly normal rainfall of 6.14 inches. October is the driest month, averaging 3.50 inches of rainfall.

High cumulative rainfall events (e.g., 6 inches or more in less than 72 hours) over large areas of the ARB are caused under two typical scenarios: slow moving cold fronts encountering warm moist coastal air in late-winter or early spring; and slow moving tropical storms in summer or early fall. High short-term localized rainfall intensities (e.g., over one inch in an hour) can occur under these two scenarios, and are also experienced in a third scenario—heavy summer-time thunderstorms. Severe riverine flooding in the lower ARB has occurred under extreme examples of all three scenarios, with minor localized flood events typically occurring at least once per year in small, poorly drained catchments. Record floods often result when significant rainfall events occur in the context of above-average seasonal rainfall patterns, which sustain high soil moisture saturation and floodplain water levels. In addition to rainfall-riverine flood events, the lower ARB is also subject to wind-driven coastal flooding associated with slow-moving tropical storms. Prolonged, heavy, southerly winds cause high water levels along the southeastern Louisiana coast (e.g., Breton and Mississippi Sounds), causing back-step rises in Lakes Borgne, Pontchartrain, and Maurepas. Lake Maurepas levels above 3 feet mean sea level (MSL) typically impact the lower ARB at least once per year. Tropical storms have pushed levels above 6 feet MSL. Increasing levels of relative sea level change are also associated with climate change (See Section 3.1.4).

Current projections of storm frequencies from CPRA Coastal Master Plan Report (2017) anticipates increased frequencies for hurricanes and decreased frequencies for tropical storms. See Table 3-1a for the average annual number of North Atlantic Basin tropical storms and major hurricanes (CPRA 2017).

*Table 3-1a. North Atlantic Basin Tropical Storms and Major Hurricanes based on the Plausible Range of Future Tropical Storm Frequency*

| | 1981-2010 Average | Projected Average for 2015-2065 | Range of Frequency change (2015-2065) |
|---|---|---|---|
| All tropical storms | 12.1 | 8.8 to 12.6 | -28% |
| Major Hurricanes | 2.7 | 3.1 to 8.6 | +13% and +83% |

See Appendix C-1, Table C1-2 for the temperature normals from Baton Rouge Metro Airport.

### 3.1.3 Flood Events

The August 2016 Flood Preliminary Report for ARB (Jacobsen, B.J. 2017) provides findings on prior flooding as well as the 2016 Flood Event. See Appendix C-1, Section 1.1.3 for Table C1-3, which presents the top 10 pre-2016 crests based on USGS gauges for the Amite River at Denham Springs and Comite River at Joor Road (with peak stage data as far back as 1921 and 1943, respectively) and the peak discharge for five of the Amite River floods at Denham Springs. Three significant pre-2016 flood events are:

- The April 1983 Flood. A slow moving system produced 6 to 13 inches of rain over a broad portion of the ARB, with high totals in the Upland Hills. This flood established the pre-2016 record flood for the lower Amite River and backwater in associated tributaries in the Middle and Lower Prairie zones. It was the second highest flood recorded on the Comite River at Joor Road. About 5,300 homes and 200 businesses were flooded and an estimated $172 million of damages incurred (1983 dollars). Flood damages in the Comite River Sub-basin were estimated $48 million.
- Hurricane Juan in October 1985. Hurricane Juan became stalled along the Louisiana coast for several days, producing extremely high wind-driven water levels in Lake Maurepas, reportedly above 6 feet NAVD 88, and 6-day rainfall totals of five to eleven inches throughout the ARB. Record flooding occurred in the Coastal Wetlands and Margins. Upstream portions of the ARB were largely unaffected.
- Tropical Storm Allison in June 2001. Tropical Storm Allison stalled over the region, with 7-day measured rainfall totals of 19.66 inches in Baton Rouge; 14.07 inches in Denham Springs; and, 23.29 inches in Ascension Parish. The seven day rainfall totals in parts of the lower ARB were considered a 0.01 AEP precipitation event. Due to a significant drought and very low soil moisture conditions present prior to the event, flood conditions in the upper and middle ARB were not as extreme.

Additional storms that have had damaging impacts in the study area are included in Table 2-1.

The August 2016 flood over Southeast and Southcentral Louisiana was caused by a slow moving low pressure system that had its origins as an Atlantic tropical wave. Beginning on Monday, August 8, 2016, the low traversed east-to-west across northern Florida and lower

Alabama/Mississippi and approached the ARB late on Thursday, August 11th. The low was not considered an area of interest for development by the National Hurricane Center. The US National Weather Service (NWS) issued a flash flood watch for the region on Tuesday, August 9th. Flash flood and river flood warnings were issued beginning on Wednesday, August 10th and continued through the event. The majority of the ARB received in excess of 10 inches, with a large portion of the northern half of the ARB experiencing over 15 inches. Parts of the Middle Prairie zone in northern East Baton Rouge and northeastern Livingston Parishes had over 20 inches of rainfall.

A report commissioned by Louisiana Economic Development (2016) estimates damages under lost economic activity, property damages to residences, autos and businesses, and damage to government infrastructure. Operations at approximately 19,900 Louisiana businesses were disrupted by the flooding event, impacted approximately 278,500 workers (14 percent of the Louisiana workforce). Table 3-1b provides a summary of damages by category.

*Table 3-1b. Summary of Damages by Category*

| Damages Category | Loss in Millions |
|---|---|
| Residential Housing Structures | $3,844.2 |
| Residential Housing Contents | $1,279.8 |
| Automobiles | $378.8 |
| Agriculture | $110.2 |
| Business Structures | $595.6 |
| Business Equipment | $262.8 |
| Business Inventories | $1,425.5 |
| Business Interruption Loss | $836.4 |
| Total $8,733.3 | |

(https://team.usace.army.mil/sites/MVN/PPM/proj/Amite/Plan%20Formulation/Related%20Reports/2016-August-Flood-Economic-Impact-Report_09-01-16.pdf)

### 3.1.4 Sea Level Change

ER 1100-2-8162 (https://www.publications.usace.army.mil/Portals/76/Users/182/86/2486/ER_1100-2-8162.pdf?ver=2019-07-02-124841-933) provides guidance for incorporating direct and indirect physical effects of projected future sea level change across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. Potential relative sea level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence.

Research by climate science experts predict continued or accelerated climate change for the 21st century and possibly beyond, which would cause a continued or accelerated rise in global mean sea level. The resulting local relative sea level change (SLC) will likely impact USACE coastal project and system performance. As a result, managing, planning, engineering, designing, operating, and maintaining for SLC must consider how sensitive and adaptable natural and managed ecosystems and human and engineered systems are to climate change and other related global changes. Planning studies and engineering designs over the project life cycle, for both existing and proposed projects, will consider alternatives that are formulated and evaluated for the entire range of possible future rates of SLC, represented here by three scenarios of “low,” “intermediate,” and “high” SLC. These alternatives will include structural, nonstructural, nature based, or natural solutions, or combinations of these alternatives. In compliance with USACE policy (Engineering Regulation (ER) 1100-2-8162), the performance of all projects under all three SLR scenarios will be analyzed for the final array of alternatives in the final IFR and EIS.

Using USACE-predicted future water levels under the SLR scenarios, those water levels were converted into relative sea level rise (RSLR) rates, incorporating sea level rise effects measured at the gauges and land loss experienced in the extended project area for each project. No operations and maintenance activities were planned for any of the projects in relation to future elevation changes. Long-term sustainability (percent land left at the end of the period of analysis) was used to analyze the impact that different SLR scenarios had on the project areas. Comparison between the long-term sustainability numbers experienced under the intermediate and high SLR scenarios for all of the mitigation projects in the final array supported the choice of the TSP for all habitat types performed the best under the influence of both the intermediate and high SLR scenarios.

## 3.2 RELEVANT RESOURCES

This section contains a description of relevant resources in the study area that could be impacted by the proposed project. The significant resources described are those recognized 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. Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, Tribes, or private groups. Significance based on public recognition means that some segment of the general public recognizes the importance of an environmental resource. Significance based on technical recognition means that the importance of an environmental resource is based on scientific or technical knowledge or judgment of critical resource characteristics. Table 3-2 provides summary information of the institutional, technical, and public importance of these resources.

*Table 3-2. Relevant Resources in the Study Area*

| Resource | Institutionally Important | Technically Important | Publicly Important |
|---|---|---|---|
| Cultural and Historic Resources | National Historic Preservation Act (NHPA), as amended, and Section 106 and 110 of the NHPA; the Native American Graves Protection and Repatriation Act of 1990; the Archeological Resources Protection Act of 1979; and USACE's Tribal Consultation Policy (2012). | Federal, State, and Tribal stakeholders document and protect cultural resources including archaeological sites, districts, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and/or sites of religious and cultural significance based on their association or linkage to past events, to historically important persons, to design and construction values, and for their ability to yield important information about prehistory and history. | Preservation groups and private individuals support protection and enhancement of historical resources. |
| Recreation Resources | Federal Water Project Recreation Act of 1965 as amended and Land and Water Conservation Fund Act of 1965 as amended | Provide high economic value of the local, state, and national economies. | Public makes high demands on recreational areas. There is a high value that the public places on fishing, hunting, and boating, as measured by the large number of fishing and hunting licenses sold in Louisiana; and the large per-capita number of recreational boat registrations in Louisiana. |
| Aesthetics | USACE ER 1105-2-100, and National Environmental Policy Act of 1969, the Coastal Barrier Resources Act of 1990, Louisiana's National and Scenic Rivers Act of 1988, and the National and Local Scenic Byway Program. | Visual accessibility to unique combinations of geological, botanical, and cultural features that may be an asset to a study area. State and Federal agencies recognize the value of beaches and shore dunes. | Environmental organizations and the public support the preservation of natural pleasing vistas. |
| Wetlands | Clean Water Act of 1977, as amended; Executive Order 11990 of 1977, Protection of Wetlands; Coastal Zone Management Act of 1972, as amended; and the Estuary Protection Act of 1968., EO 11988, and Fish and Wildlife Coordination Act. | They provide necessary habitat for various species of plants, fish, and wildlife; they serve as ground water recharge areas; they provide storage areas for storm and flood waters; they serve as natural water filtration areas; they provide protection from wave action, erosion, and storm damage; and they provide various consumptive and non-consumptive recreational opportunities. | The high value the public places on the functions and values that wetlands provide. Environmental organizations and the public support the preservation of marshes. |

| | | | |
|---|---|---|---|
| Uplands | Food Security Act of 1985, as amended; the Farmland Protection Policy Act of 1981; and the Fish and Wildlife Coordination Act of 1958, as amended. | They provide habitat for both open and forest-dwelling wildlife, and the provision or potential for provision of forest products and human and livestock food products. | The high value the public places on their present value or potential for future economic value. |
| Aquatic Resources/ Fisheries | Fish and Wildlife Coordination Act of 1958, as amended; Clean Water Act of 1977, as amended; Coastal Zone Management Act of 1972, as amended; and the Estuary Protection Act of 1968. | They are a critical element of many valuable freshwater and marine habitats; they are an indicator of the health of the various freshwater and marine habitats; and many species are important commercial resources. | The high priority that the public places on their esthetic, recreational, and commercial value. |
| Soils and Water Bottoms | Fish and Wildlife Coordination Act, Marine Protection, Research, and Sanctuaries Act of 1990 | State and Federal agencies recognize the value of water bottoms for the production of benthic organisms. | Environmental organizations and the public support the preservation of water quality and fishery resources. |
| Wildlife | Fish and Wildlife Coordination Act of 1958, as amended and the Migratory Bird Treaty Act of 1918 | They are a critical element of many valuable aquatic and terrestrial habitats; they are an indicator of the health of various aquatic and terrestrial habitats; and many species are important commercial resources. | The high priority that the public places on their esthetic, recreational, and commercial value. |
| Threatened and Endangered Species | The Endangered Species Act of 1973, as amended; the Marine Mammal Protection Act of 1972; and the Bald Eagle Protection Act of 1940. | USACE, FWS, NMFS, NRCS, EPA, LDWF, and LDNR cooperate to protect these species. The status of such species provides an indication of the overall health of an ecosystem. | The public supports the preservation of rare or declining species and their habitats. |
| Prime and Unique Farmland | Farmland Protection Policy Act | State and Federal agencies recognize the value of farmland for the production of food, feed and forage. | Public places a high value on food and feed production. |
| Air Quality | Clean Air Act of 1963, Louisiana Environmental Quality Act of 1983. | State and Federal agencies recognize the status of ambient air quality in relation to the NAAQS. | Virtually all citizens express a desire for clean air. |
| Noise and Vibration | USACE ER 1105-2-100, and National Environmental Policy Act of 1969, Noise Control Act of 1972, Quiet Communities Act of 1978 | Unwanted noise has an adverse effect on human beings and their environment, including land, structures, and domestic animals and can also disturb natural wildlife and ecological systems. | The EPA must promote an environment for all Americans free from noise that jeopardizes their health and welfare. |
| Water Quality | Clean Water Act of 1977, Fish and Wildlife Coordination Act, Coastal Zone Mgt Act of 1972, and Louisiana State & Local Coastal Resources Act of 1978. | USACE, FWS, NMFS, NRCS, EPA, and State DNR and wildlife/fishery offices recognize value of fisheries and good water quality and the national and state standards established to assess water quality. | Environmental organizations and the public support the preservation of water quality and fishery resources and the desire for clean drinking water. |

| Resource | Institutionally Important | Technically Important | Publicly Important |
|---|---|---|---|
| Environmental Justice | Executive Order 12898 of 1994 (E.O. 12898) and the Department of Defense's Strategy on Environmental Justice of 1995 | State and Federal agencies recognize social and economic welfare of minority and low-income populations | 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. |
| Socioeconomics | USACE ER 1105-2-100, and National Environmental Policy Act of 1969 | When an environmental document is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental document will discuss all of these effects on the human environment. | Government programs, policies and projects can cause potentially significant changes in many features of the socioeconomic environment. |

Resources not impacted in this study include Navigation and Essential Fish Habitat.

### 3.2.1 Natural Environment

#### 3.2.1.1 Wetland Resources

Bottomland hardwood forests (BLH) in the study area are dominated by water oak, nuttall oak, green ash, red maple, and pignut hickory. Swamps in the Lower ARB are dominated by bald cypress and water tupelo, which have regenerated following extensive logging of virgin forest more than 70 years ago. The Louisiana swamps generally lack a mature canopy, as was present in the forests before logging occurred, and have lower productivity where isolated from riverine influences (Shaffer et al., 2003). Economically important natural resources associated with these swamps include fisheries of crawfish, blue catfish, and channel catfish, as well as logging. The classification of wetlands habitat from the US Fish and Wildlife National Wetlands Inventory (https://www.fws.gov/wetlands/) is located in Appendix C-1, Section 2.1.

#### 3.2.1.2 Upland Resources

*Forested Wetlands (From LDWF Natural Communities of Louisiana)*

<u>Hardwood Slope Forest</u>

These forests mostly occur on slopes, or sometimes on stream and river terraces that are only rarely subject to flooding. This natural community occurs along slopes rising out of the floodplains in the Upper ARB and is dominated by hardwood trees with a sparse herbaceous layer. The hardwood slope forest community historically occupied approximately 100,000 to 500,000 acres and an estimated 25 to 50 percent of this acreage remains. Habitat conversion to pine plantations or residential uses, invasive and exotic species, construction of roads, utilities and pipelines, and use of off-road vehicles currently threatens the long-term viability of these forests.

Small Stream Forest

Small stream forests are relatively narrow wetland forests occurring along small rivers and large creeks in central, western, southeastern, and northern Louisiana. They are seasonally flooded for brief periods. The percentage of sand, silt, calcareous clay, acidic clay, and organic material in the soil is highly variable (depending on local geology) and has a significant effect on species composition. Soils are typically classified as silt-loams. At times, the community is quite similar in species composition to hardwood slope forests (beech-magnolia forests). These forested wetlands are critical components of the landscape filtering surface and subsurface flows, improving water quality, and storing sediment and nutrients (Rummer 2004). See Appendix C-1, Table C1-6 for vegetative species list for this natural community.

*Nuisance Species (from LDWF Waterbody Management Plan 2017)*

Common salvinia and water hyacinth have been the main source of access and habitat issues and complaints over the past several years. Common salvinia is scattered throughout the ARB and is constantly being restocked by draining swamps and bayous. Within the river system, the desire to own/sell waterfront property has led to the construction of numerous man-made canals over the past 4 decades. These canals are typically 50 to 200 feet wide, dead-end offshoots of the main river channel. The canals are lined with houses, camps, boat slips, docks, and an occasional boat ramp. The canal systems are rarely designed so that river water can flow through unimpeded (i.e. horseshoe in shape, etc.). Consequently, these dead-end canals have no inherent “flushing” mechanism to remove floating vegetation. Invariably, some form of aquatic vegetation makes its way into these canals each year and remains stranded due to the stagnant water conditions, and thrives. When the suspect vegetation in these canals reaches unacceptable levels, shoreline property owners call LDWF to complain.

Estimates of vegetation coverage are:

Problematic Species:

- Common Salvinia (*Salvinia minima)* – 25 acres
- Water Hyacinth (*Eichhornia crassipes)* – 15 acres
- Duckweed (*Lemna spp.)* – 15 acres
- Duck Lettuce (*Ottelia alismoides*) – 50 acres
- Crested Floating Heart (*Nymphoides cristata*) – 6 acres

Beneficial Species:

- Yellow Water Lily (*Nymphaea mexicana)* – 100 acres
- Coontail (*Ceratophyllum demersum)* – 100 acres

#### 3.2.1.3 Aquatic Resources and Fisheries

For a list of fish species in the study area, see Appendix C-1, Table C1-8 (LDWF Waterbody Management Plan).

The Alabama Hickorynut (*Obovaria unicolor*) is an at-risk species, 1.2-2 inch-long freshwater mussel, with round or elliptical shape. The outer shell (periostracum) is smooth and brown to yellow-brown, with rays. This species is a long-term brooder that is gravid from June through August of the following year. Like other freshwater mussels, the Alabama Hickorynut releases its larvae (glochidia) into the water column, where they parasitize a fish (glochial host) in order to transform into a juvenile mussel. Once the glochidia are ready, they release from the host to find a suitable substrate. Suitable glochidial host fishes for this species include the naked sand darter (*Ammocrypta beani*), southern sand darter (*Ammocrypta meridiana*), Johnny darter (*Etheostoma nigrum*), Gulf darter (*Etheostoma swaini*), blackbanded darter (*Percina nigrofasciata*), dusky darter (*Percina sciera*), and redspot darter (*Etheostoma artesiae*).

The Alabama Hickorynut inhabits sand and gravel substrates in moderate currents in large streams. However, the presence of moderate gradient pool and riffle habitats in a variety of stream and river sizes may contain this species. In Louisiana, the Alabama Hickorynut is known to occur in the Pearl and Amite River systems. Habitat modification and destruction due to siltation (i.e. from flooding events) and impoundment threaten this species. It is also negatively affected by the pollution of streams and rivers.

The rare Broadstripe topminnow *(Fundulus euryzonus)* is endemic to the Amite and Tangipahoa River Basins. The Broadstripe topminnow is listed as Vulnerable at the global and national level, and Imperiled at the state level. This fish prefers smaller channel widths, with riparian vegetation canopy; features of upstream reaches of rivers. Current and historical mining operations in the ARB have led to channelization, which changes the upstream reaches of the river to behave more like downstream reaches by widening the channel and increasing water flow; thus, diminishing suitable habitat for the topminnow.

#### 3.2.1.4 Wildlife

The study-area wetland and non-wetland forests provide valuable habitat for a variety of migratory game and non-game birds, mammals, amphibians, and reptiles. For a listing of associated species, see Appendix C-1, Table C1-9 through Table C1-12.

The coastal marshes and forested wetlands of the Lake Pontchartrain Basin have been identified by the North American Waterfowl Management Plan (NAWMP), Gulf Coast Joint Venture (GCJV): Mississippi River Coastal Wetlands Initiative as a key waterfowl wintering area. The Gulf Coast is the terminus of the Central and Mississippi Flyways and is therefore one of the most important waterfowl areas in North America, providing both wintering and migration habitat for significant numbers of the continental duck and goose populations that use both flyways.

The Mississippi River Coastal Wetlands Initiative area is dominated by coastal marsh, forested swamps, and seasonally flooded bottomland hardwoods that provide habitat for several species of wintering waterfowl. Wood ducks are the primary waterfowl species in forested wetlands, while other ducks, and use those forested habitats to a lesser degree. Other game birds are present in or adjacent to the study area including rails (Family: Rallidae). Non-game bird species also utilize the study area marshes including various species of gulls and terns. Birds of prey in the study area include resident and transient hawks. Some neo-tropical migrants, currently experiencing population decline, are dependent on large forested areas to successfully reproduce. Also, present are cuckoos, swifts, hummingbirds, woodpeckers, and the belted kingfisher (*Megaceryle alcyon*). See Appendix C-1, Table C1-9 for a list of bird species in the study area.

*Alligator Snapping Turtle (From FWS Planning Assistance Letter)*

The alligator snapping turtle (*Macrochelys temminckii*) may be found in large rivers, canals, lakes, oxbows, and swamps adjacent to large rivers. It is most common in freshwater lakes and bayous, but also found in coastal marshes and sometimes in brackish waters near river mouths. Typical habitat is mud bottomed waterbodies having some aquatic vegetation. The alligator snapping turtle is slow growing and long lived. Sexual maturity is reached at 11 to 13 year of age (Ernst et al. 1994). Because of this and its low fecundity, loss of breeding females is thought to be the primary threat to the species.

#### 3.2.1.5 Threatened, Endangered, and Protected Species

Factors regarding the existing conditions for threatened and endangered species in the study area principally stem from the alteration, degradation, and loss of habitats; and human disturbance. The continued high rate of commercial development throughout the study area continues to reduce available wetland habitat to threatened and endangered species. This creates increased intra- and interspecific competition for rapidly depleting resources between not only the various threatened and endangered species, but also other more numerous fauna.

On February 26, 2018, CEMVN obtained a planning assistance letter from the FWS that provides lists of threatened and endangered species that may occur in the proposed project location, and/or may be affected by the proposed project (See Appendix C-4 Agency Coordination). Appendix C-1, Table C1-13 provides a summary of these findings including the presence of critical habitat. Descriptions for species with the “May Affect” Impact follow below.

*West Indian Manatee*

Federally listed as a threatened. species, *Trichechus manatus* (West Indian manatees) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals. All contract personnel associated with the project should be informed of the potential presence of manatees and the need to avoid collisions with manatees, which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. All construction personnel are responsible for observing water-related activities for the presence of manatee(s). Temporary signs should be posted prior to and during all construction/dredging activities to remind personnel to be observant for manatees during active construction/dredging operations or within vessel movement zones (i.e., work area), and at least one sign should be placed where it is visible to the vessel operator. Siltation barriers, if used, should be made of material in which manatees could not become entangled, and should be properly secured and monitored. If a manatee is sighted within 100 yards of the active work zone, special operating conditions should be implemented, including: no operation of moving equipment within 50 feet of a manatee; all vessels should operate at no wake/idle speeds within 100 yards of the work area; and siltation barriers, if used, should be re-secured and monitored. Once the manatee has left the 100-yard buffer zone around the work area on its own accord, special operating conditions are no longer necessary, but careful observations would be resumed. Any manatee sighting should be immediately reported to the Service's Lafayette, Louisiana Field Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).

Public data on manatee sightings have provided benefits for conservation efforts, according to Hieb et al. (2017). Ongoing manatee population growth, future climate change, or other large-scale environmental perturbations are likely to continue altering the timing, duration, and location of manatee visits to the northern Gulf of Mexico. Although publicly sourced data and citizen-science efforts have inherent biases, on a decadal time scale these datasets could provide comprehensive information on manatee habitat use than is possible by direct observations.

*Atlantic Sturgeon*

*Acipenser oxyrhynchus desotoi* (the Atlantic sturgeon), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain Basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May).Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than 2 years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the FWS and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the

Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project; however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

USACE is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the FWS' concurrence with that determination. If USACE determines, and the FWS concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the Endangered Species Act (ESA) should be submitted to the FWS. That request should also include USACE's rationale supporting their determination.

*Inflated Heelsplitter Mussel (From Planning Aid Letter, dated 3/13/19)*

Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) was historically found in Louisiana in the Amite, Tangipahoa, and Pearl Rivers. Many life history aspects of the species are poorly understood, but are likely similar to that of other members of the Unionidae family. Although the primary host fish for the species is not certain, investigation by K. Roe et al. (1997) indicates that the freshwater drum (Aplodinotus grunniens) is a suitable glochidial host for the species.

Based on the most recent survey data, the currently known range for the Alabama heelsplitter in Louisiana occurs only in the lower third of the Amite River, along the East Baton Rouge/Livingston Parish line from Spiller's Creek, which is in the vicinity of Denham Springs, downstream to the vicinity of Port Vincent. Because it has not been used widely for past or present gravel mining operations, the lower third of the Amite River (between Louisiana Highway 37 and Louisiana Highway 42) is more typical of a coastal plain river; being characterized by a silt substratum, less channelization, and slower water flow, all of which are characteristic of heelsplitter habitat. This freshwater mussel is typically found in soft, stable substrates such as sand, mud, silt, and sandy gravel, in slow to moderate currents. Heelsplitter mussels are usually found in depositional pools below sand point bars and in shallow pools between sandbars and river banks.

Major threats to this species in Louisiana are the loss of habitat resulting from sand and gravel dredging and channel modifications for flood control, as shown by the apparent removal of the species in the extensively modified upper portions of the Amite River.

*Protected Species*

<u>Bald Eagle</u>

The project-area forested wetlands provide nesting habitat for *Haliaeetus leucocephalus* (the bald eagle), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. There is one active bald eagle nest that is known to exist within the proposed project area; however, other nests may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. They typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy "territories" that they will typically defend against intrusion by other eagles and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The FWS developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at: http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf. Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

Colonial Nesting Birds

In accordance with the Migratory Bird Treaty Act and Planning Aid Letter from FWS (dated March 13, 2019) the study area includes habitats that are commonly inhabited by colonial nesting waterbirds. Recommendations to address compliance with the Migratory Bird Treaty Act is included in Section 6.2.12.

#### 3.2.1.6 Geology, Soils and Water Bottoms, and Prime Farmland

The study area can be roughly divided into three regions with distinctive landforms, topographies, and associated floodplain characteristics. For a map of the geographic and physiographic setting, see Appendix C-1, Figure C1-3.

1. The High Terraces includes the Mississippi counties, East Feliciana Parish and St. Helena Parishes, and northern East Baton Rouge Parish. The area, with sediment dated to the Pleistocene era, consists of narrow floodplains with rolling hills at elevations typically ranging from approximately 80 to 500 feet above mean sea level (MSL).
2. The Intermediate and Prairie Terraces includes most of East Baton Rouge and Livingston Parishes and upland portions of Iberville and Ascension Parishes. This landscape transitions from rural hilly older Plio-Pleistocene Terraces to flatter, mid-elevation (approximately 20 to 80 feet MSL) recent Intermediate and Prairie Pleistocene Terraces.
3. The Recent Alluvial Floodplain includes lower Livingston Parish, the remainder of Iberville and Ascension Parishes, as well as St. James Parish. This area is dominated by expansive, low-lying (approximately 1 to 5 feet MSL), alluvial floodplains filled during the recent Holocene.

*Soils and Water Bottoms*

Soil textures present in the study area are found in Appendix C-1, Section 2.11.

*Prime and Unique Farmland*

The Farmland Protection Policy Act of 1981 (FPPA) was enacted to minimize the extent that Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, would be compatible with state, unit of local government, and private programs and policies to protect farmland.

Under this policy, soil associations are used to classify areas according to their ability to support different types of land uses, including urban development, agriculture, and silviculture. The USDA Natural Resource Conservation Service (NRCS) designates areas with particular soil characteristics as either “Farmland of Unique Importance,” “Prime Farmland,” “Prime Farmland if Irrigated,” or variations on these designations. Prime farmland, as defined by the FPPA, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. Farmland of unique importance is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, drought-prone, and less productive, and cannot be easily cultivated as compared to prime farmland (NRCS 2016).

No unique farmlands are located within the study area, but approximately 503,703 acres of prime farmlands are located in the Louisiana Parishes within the study area. For land classification and acreage of prime and unique farmlands in the study area, see Appendix C-1, Figure C1-5 and Table C1-14.

#### 3.2.1.7 Water Quality

The dominant bodies of water in the ARB are the Amite River, Blind River, and Comite River. Numerous rivers and streams cross through the ARB and its hydrology is greatly affected in the lower basin because the elevation is around sea level, plus or minus a foot.

Water quality in the main channels of the ARB is influenced by non-point source agricultural runoff and by residential and commercial point sources. Water quality in the Upper ARB; however, is often quite different because of hydrological modifications from the sand and gravel mines and berms. Louisiana Department of Environmental Quality has a general permit for the Louisiana Pollutant Discharge Elimination System, which requires that "impoundments of process or mine dewatering wastewater must be surrounded by a levee of sufficient size and construction to prevent a discharge of pollutants into waters of the state." The berms must have a height of 2 feet freeboard.

Nineteen water bodies in the Amite watershed are listed as impaired for one or more designated uses in the 2016 Integrated Report of Water Quality in Louisiana. (See Appendix C-1, Table C1-15 for the 305(b) impaired waterbodies in the study area from the LDEQ Final 2016 Integrated Report of Water Quality in Louisiana).

Most of the segments are impaired for fish and wildlife propagation and swimming. In the Amite watershed, the top five suspected causes of impairment are 1) dissolved oxygen, 2) nitrate/nitrite (nitrite plus nitrate as N), 3) fecal coliform, 4) Phosphorus (Total), and 5) Turbidity.

#### 3.2.1.8 Air Quality

The U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, called “criteria” pollutants. They are carbon monoxide, nitrogen dioxide, ozone, lead, particulates of 10 microns or less in size (PM-10 and PM-2.5), and sulfur dioxide. Ozone is the only parameter not directly emitted into the air but forms in the atmosphere when three atoms of oxygen (03) are combined by a chemical reaction between oxides of nitrogen and volatile organic compounds in the presence of sunlight. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of nitrogen and volatile organic compounds, also known as ozone precursors. Strong sunlight and hot weather can cause ground-level ozone to form in harmful concentrations in the air. The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to State or Federal Implementation

Plans) dictates that a conformity review be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more National Ambient Air Quality Standards. A conformity assessment would require quantifying the direct and indirect emissions of criteria pollutants caused by the Federal action to determine whether the proposed action conforms to Clean Air Act requirements and any State Implementation Plan.

The general conformity rule was designed to ensure that Federal actions do not impede local efforts to control air pollution. It is called a conformity rule because Federal agencies are required to demonstrate that their actions “conform with” (i.e., do not undermine) the approved State Implementation Plan for their geographic area. The purpose of conformity is to (1) ensure Federal activities do not interfere with the air quality budgets in the State Implementation Plans; (2) ensure actions do not cause or contribute to new violations, and (3) ensure attainment and maintenance of the National Ambient Air Quality Standards.

The ART Study Area includes several parishes in Louisiana and several counties in southwest Mississippi. Four of the Louisiana parishes are located in the Baton Rouge metropolitan area, which has been designated by the EPA as a maintenance area for ozone under the 8-hour standard effective December 27, 2016. This classification is the result of area-wide air quality modeling studies, and the information is readily available from the LDEQ, Office of Environmental Assessment and Environmental Services.

Federal activities proposed in the ozone-maintenance area may be subject to the state’s general conformity regulations as stated under LAC 33:III.14.A, Determining Conformity of General Federal Actions to State or Federal Implementation Plans. A general conformity applicability determination is made by estimating the total of direct and indirect volatile organic compound (VOC) and nitrogen oxide (NOX) emissions caused by the construction of the project. Prescribed de minimis levels of 100 tons per year per pollutant are applicable in Ascension Parish. Projects that would result in discharges below the de minimis level are exempt from further consultation and development of mitigation plans for reducing emissions.

#### 3.2.1.9 Noise and Vibration

The Noise and Vibration section characterizes the affected environment for this resource. There have been no studies or new data generated to date that are relevant to the discussion of the affected environment.

### 3.2.2 Human Environment

#### 3.2.2.1 Cultural, Historic, and Tribal Trust Resources

The cultural prehistory and history of Southeast Louisiana and Southwest Mississippi is a rich one that is shared with much of the southeast. The generalized Pre-Contact cultural chronology for the region according to Rees (2010:12) is divided into five primary archaeological components, or “periods,” as follows: Paleoindian (11,500-8000 B.C.), Archaic (8000-800 B.C.), Woodland (800 B.C.-1200 A.D.), Mississippian (1200-1700 A.D.), and Historic (1700 A.D.-present). Regionally, these periods have been further divided into sub-periods based on material culture, settlement patterns, subsistence practices, and sociopolitical organization. Specific sub-periods identified within the study area include: Poverty Point, Tchefuncte, Marksville, Baytown, Troyville, Coles Creek, Plaquemine, and Mississippian. Post-Contact Period (ca. 1650 A.D.-present) cultural affiliations within the study area, follow the thematic approach set forth in the Louisiana Division of Archaeology's (LDOA) State of Louisiana Site Record Form (amended August 29, 2018) and are divided into the following temporal groups: *Historic Exploration* (1541-1803 A.D.), *Antebellum Louisiana* (1803-1860 A.D.), *War and Aftermath* (1860-1890 A.D.), *Industrial and Modern* (1890-1945 A.D.), and *Post-WWII* (1945 A.D.-present).

*Archaeological Sites*

Table 3-3 lists the historic properties within the study area.

Table 3-3. Historic Properties within the Study Area

| County/Parish | Building | Site | Structure | District | NHL | Archaeological Sites |
|---|---|---|---|---|---|---|
| **Mississippi:** | | | | | | |
| Amite | 18 | 1 | — | — | — | 29 |
| Franklin | 3 | — | 2 | — | — | — |
| Lincoln | 14 | — | — | 1 | — | — |
| Wilkinson | 11 | 3 | — | 2 | — | 1 |
| **Louisiana:** | | | | | | |
| Ascension | 17 | 1 | — | 1 | — | 78 |
| East Baton Rouge | 67 | 7 | 2 | 13 | 2 | 20 |
| East Feliciana | 28 | 1 | — | 2 | 1 | 104 |
| Iberville | 21 | — | 1 | 1 | — | 22 |
| Livingston | 13 | — | — | 1 | — | 87 |
| St. Helena | 3 | — | — | — | — | 72 |
| St. James | 19 | — | 1 | 2 | 1 | 41 |
| St. John the Baptist | 14 | 1 | — | 2 | 1 | 14 |

Based on a review of the LDOA, *Louisiana Cultural Resources Map* (web-resource), the Mississippi Department of Archives and History (MDAH) Historic Resources Inventory Map (web-resource), and pertinent site and survey reports regarding previous investigations, CEMVN determined that approximately 468 archaeological sites (Table C1-14) are recorded within the current study area that collectively span the entire spectrum of Pre-Contact and Post-Contact archaeological components referenced above; encompassing some 10,000 years or more. It is also important to stress that many known of the known sites in the study area have occupation spans encompassing more than one of these cultural/temporal periods attesting to the long-ranging cultural importance of the region. Presently, no comprehensive systematic archaeological survey has been conducted throughout the entire study area and the distribution of recorded archaeological sites is largely indicative of project-specific federal and state compliance activities (e.g., linear surveys of roads, pipelines, and power line right-of-ways). Therefore, in addition to considering the known sites within the region, project areas must also be further assessed for archaeological site potential.

*Archaeological Site Potential*

It is estimated that several hundred archaeological sites exist within the proposed study area that cover the range of human occupation from the Paleo-Indian through to historic occupation. It is anticipated that project measures and/or alternative measures will impact these sites. In lieu of additional survey data, Louisiana's Comprehensive Archaeological Plan (Girard, et al. 2018) and research conducted by Earth Search, Inc. (Lee et al. 2009) for the *Proposed Amite River and Tributaries, Bayou Manchac Water Shed Feasibility Study, Ascension, East Baton Rouge & Iberville Parishes, Louisiana*, can be used for baseline planning purposes. To a great extent, the unique geomorphology and ecology of the study area has influenced site type and location. To examine how the physical landscape impacts the archaeological record, the LDOA divides the study area into a series of regions that follow the ecoregions classification of the Western Ecology Division of the U.S. Environmental Protection Agency (https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6#pane-16). There are six Regions at Level III, three of which fall within the present study area (Southern Coastal Plain, Mississippi Valley Loess Plain and Mississippi Alluvial Plain). All three Level III Regions are then further divided into sub-regions (Level IV: Southern Rolling Plains, Baton Rouge Terrace, Gulf Coast Flatwoods, Inland Swamps, and Southern Holocene Meander Belts). Girard, et al. (2018: 24-31) define how the unique environmental, biological, and physiological characteristics of each region influenced cultural development in order to provide context to the distribution of where sites are likely or unlikely to occur. Complimentary to Girard, et al.'s (2018) ecosystem-based model (above), Lee et al. recommend:

> It is essential that investigations be conducted in the fullest consideration and effective integration of available knowledge of landscape dynamics. In doing so, surveys can be designed to provide adequate assessment of all areas, but with greater attention and effort focused on areas that would have been relatively more favorable for prehistoric occupation. Of greater importance, it avoids the expenditure of resources in areas where existing knowledge of geomorphic processes and landscape evolution indicates with confidence that prehistoric activities were precluded or where subsequent natural processes have destroyed the evidence…Geomorphologic data, previous archaeological investigations, and previously recorded sites will constitute the primary data sets utilized in the predictive model. Landform type, elevation, and soils will also be utilized to construct the predictive model. These data will be integrated

> to determine high probability areas within the riverine and upland portions of the project area. Lee et al. (2009:132)

Geospatial modeling of cultural landscapes for predictive scientific research is an important emerging approach in contemporary archaeology. Depending on the scale of the final array of project alternatives, it may be advantageous to develop a geospatial predictive model based upon the work of Girard, et al. (2018) and Lee et al. (2009) that incorporates the accumulated environmental and archaeological information specified above as a means to forecast the probability of significant archaeological sites occurring in any particular location that can be used to guide efficient identification and evaluation strategies.

*U.S. Civil War*

The study area is also the setting of at least 11 terrestrial and naval Civil War battles ranging from small skirmishes to major decisive battles. The NPS's American Battlefield Protection Program (ABPP; 54 U.S.C. 380101-380103), Civil War Sites Advisory Commission (Public Law 101-628), has assigned Preservation Priorities (https://www.nps.gov/abpp/battles/bystate.htm) to five individual battlefields located within the study area: Magnolia Cemetery (East Baton Rouge: Priority IV.1), Donaldsonville 1862 (Ascension Parish; Priority IV.2), Donaldsonville 1863 (Ascension Parish; Priority IV.2), Cox's Plantation (Ascension Parish; Priority IV.1), and Port Hudson (East Baton Rouge Parish and East Feliciana Parish: Priority I.1).

*Louisiana Scenic Rivers Act*

The Louisiana Department of Wildlife and Fisheries is the lead state agency in the State Scenic River Program. Archaeological resources within scenic river corridors are protected by law under the Louisiana Scenic Rivers Act of 1988 (LSRA). The current study area includes the following Louisiana Natural and Scenic Rivers: the Amite River, Comite River, Blind River, and Bayou Manchac. In addition to the extra protections afforded to cultural resources under the LSRA, Bayou Manchac from the Amite River to the Mississippi River is designated as a “Historic and Scenic River,” which requires that “full consideration shall be given to the detrimental effect of any proposed action upon the historic and scenic character thereof, as well as the benefits of the prosed use.”

#### 3.2.2.2 Aesthetics

The majority of the study area is within the ARB, which constitutes a mosaic of forest, pine plantations, pasture, and cropland. The primary land-use in the area is agriculture. The Amite River flows South from the Mississippi Valley Loess Plains Ecoregion and into the Mississippi Alluvial Ecoregion. The dominant natural vegetation in the northeast consists of upland forests dominated by oak, hickory, and both loblolly and shortleaf pine. The dominant natural vegetation in the northwest consists of forests characterized by beech, southern magnolia, and American holly. The dominant natural vegetation in the south consists of inland swamps and ridges (according to the State of Louisiana Eco-Region Map, ref. "Louisiana Speaks" and “USGS Eco-Region Map,” Daigle, J.J., Griffith, G.E. Omernik, J.M., Faulker, P.L., McCulloh, R.P., Handley, L.R., Smith, L.M., and Chapman, S.S., 2006, Ecoregions of Louisiana color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,000,00).”

From an aesthetic perspective, the inland swamps in the south have a fairly dense canopy constituted by bald cypress and water tupelo trees. The majority of the bald cypress are rarely the mature and majestic specimens as they once were due to logging operations in the early 1900s. The heavily shaded swamp understory is composed primarily of red maple and green ash. The ground is hard bottom. The tranquil swamps are perennially wet and the water is clear. These swamp areas are often difficult to access and are generally viewed into from roadway edges, waterways, and natural ridges. The ridges are small rises in the inland swamp and are typically occupied by Water Oak, Diamond Oak, Sweetgum, Ash, Wax Myrtle, Black Willow, Chinese Tallow, and Privet. The ridges provide a dryer and slightly more accessible setting in contrast to the surrounding darkness and wetness of the inland swamps for hunters, nature observers, bird watchers, and ecologists.

Numerous efforts have been made to protect and promote visual resources within the ARB that are known for their unique culture and natural identity. One of these efforts, made by the Louisiana Department of Culture, Recreation & Tourism, is for marketing scenic byways thru rural landscape and culturally significant communities. There is a Scenic Byway bordering the study area on the south and east which includes the Great River Road. This is but one segment to an overall scenic byway that stretches on multiple thoroughfares from Canada to the Gulf of Mexico. It is state and federally designated and has an “All American Road” status, making it significant in culture, history, recreation, archeology, aesthetics, and tourism.

In 1970, the Louisiana Legislature created the Louisiana Natural and Scenic Rivers System. The System was developed for the purpose of preserving, protecting, developing, reclaiming, and enhancing the wilderness qualities, scenic beauties, and ecological regimes of certain free-flowing Louisiana streams. These rivers, streams and bayous, and segments thereof, are located throughout the state and offer a unique opportunity for individuals and communities to become involved in the protection, conservation and preservation of two of Louisiana's greatest natural resources; its wilderness and its water. Within the study area, there are four designated Louisiana Natural and Scenic Rivers (RS 56:1857). The Amite River from the Louisiana-Mississippi state line to La. Hwy. 37 in East Feliciana Parish; the Blind River from its origin in St. James Parish to its entrance into Lake Maurepas; the Comite River from the Wilson-Clinton Hwy. in East Feliciana Parish to the entrance of White Bayou in East Baton Rouge Parish; and Bayou Manchac from the Amite River to the Mississippi River is designated as a Louisiana Historic and Scenic River (RS 56:1856).

“The general purpose of the Louisiana Scenic Rivers Act as it applies to the Amite River is to protect this section of river from channel modifications, protect water quality and habitats, and preserve recreational and scenic aspects of this river. Many of the Amite River reaches upstream and downstream of Grangeville have experienced significant mining activity and are neither natural nor scenic.” (Hood, Patrick, Corcoran, Fluvial Instability and Channel Degradation of Amite River and its Tributaries, Southwest Mississippi and Southeast Louisiana, ERDC/GSL TR-07-26, Page 12, September 2007)

#### 3.2.2.3 Recreation

Both consumptive and non-consumptive recreation activities in the study area are centered on natural resources. Consumptive recreation includes hunting, fishing for freshwater and saltwater species, and trapping alligators and nutria. Non-consumptive recreation includes wildlife viewing, sightseeing, boating, camping, and environmental education/interpretation. Opportunities for the activities listed are widespread via the waterways within and comprising the boundaries of the study area.

The following public areas, both within and in close proximity to the study area, have been set aside and provide high quality recreation opportunities: Homochito National Forest, Caston Creek Wildlife Management Area (WMA), Maurepas Swamp WMA, Waddill Outdoor Education Center, and multiple county-wide park and recreation systems. Table 3-4 highlights the extensive network of recreation resources within the study area currently established at the public level.

*Table 3.4. Recreational Resources within the Study Area*

| Public Area | Size (acres) | Parish / County | Managing Agency | Recreation Consumptive | Recreation Non-consumptive | Boat Launch | Recreational Highlights |
|---|---|---|---|---|---|---|---|
| **National Forest** | | | | | | | |
| Homochito National Forest | 191,839 | Amite, Franklin, Lincoln, Wilkinson | United States Department of Agriculture Forest Service | fishing, hunting | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping, shooting range | Yes | This National Forest is just outside the project area border to the northwest and includes 5.5 mile Bushy Creek Horse Trail, Clear Springs Recreation Area, Okhissa Lake Recreation Area with boat ramps, Woodman Springs Shooting Range |
| **State Wildlife Refuge** | | | | | | | |
| Caston Creek WMA | 28,286 | Amite, Franklin | Mississippi Department of Wildlife, Fisheries& Parks | Fishing, hunting | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping | No | This WMA is just outside the project area border to the northwest and within Homochito National Forest. It offers scenic horseback trails as well as various hiking and biking trails for the avid outdoorsmen or the novice adventurer. |
| Maurepas Swamp WMA | 124,567 | Ascension, Livingston, St. James, St. John the Baptist | Louisiana Department of Wildlife and Fisheries | fishing, hunting, trapping | Boating, camping, birding, wildlife viewing | No | Bald eagles and osprey nest in and around the WMA. Numerous species of neotropical migrant birds use this coastal forest habitat during fall and spring migrations. Resident birds, including wood ducks, black-bellied whistling ducks, egrets, and herons can be found on the WMA year-round. |
| Waddill Outdoor Education Center | 237 | East Baton Rouge | Louisiana Department of Wildlife and Fisheries | fishing, | Nature trails, birding, shooting range, archery range, picnic facilities | No | Accessible via North Flannery Road or by boat from the Comite River. LDWF initiated a Summer Day Camp for children ages 12 to 16 in the summer of 2011. The camp is free and open for 5 days allowing participants to receive official boater and hunter education certifications. The camp also offers a fish identification class, fishing and canoeing, skeet shooting, and other outdoor related activities. |
| **Parish/County Park System** | | | | | | | |
| Ascension Parish Parks | N/A | Ascension | Ascension | N/A | Ballfields, courts, playgrounds, leisure paths, swimming pools, picnic areas | Yes | The parish has 13 parks within the study area in communities including St. Amant, Gonzales, Prairieville, and Geismer |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Recreation and Park Commission for the Parish of East Baton Rouge (BREC) | N/A | East Baton Rouge | BREC | N/A | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping, shooting range | Yes | BREC has more than 180 parks including a unique mix of facilities, which mirror the history and rich natural resources in the region; including a state-of-the-art observatory, a swamp nature center and conservation areas, a performing arts theatre, an equestrian park, an art gallery, an arboretum, an accredited zoo, seven golf courses and an extreme sports park with a 30,000-foot concrete skate park, rock-climbing wall, BMX track, and velodrome. |
| Livingston Parish Parks | N/A | Livingston | Livingston | N/A | Ball field, courts, pools, leisure paths, picnic areas | No | The parish has parks within the study area in communities including Greenwell Springs, Walker, Parks and Recreation of Denham Springs (PARDS), and Livingston Parks and Recreation (LPR). |
| St. James Parish Parks | N/A | St. James | St. James Parish Parks and Recreation | N/A | Ball fields, courts, playgrounds, leisure paths, swimming pools | No | The parish has 4 parks within the study area including Gramercy Park, Lutcher Park, Paulina Park, and Romeville Park, |
| St. John Parish Parks | N/A | St. John the Baptist | St. John the Baptist | N/A | Ball fields, courts, playgrounds, leisure paths, swimming pools, picnic areas | No | The parish has 8 parks within the study area: Ezekiel Jackson, Regala, Belle Pointe, Emily C. Watkins, Greenwood, Cambridge, Stephanie Wilking, and Hwy. 51 Park |

According to the United States Department of the Interior National Park Service Land & Water Conservation Fund (LWCF), nearly 100 recreation projects within the study area have been supported between 1965 and 2011. Section 6(f)(3) of the L&WCF Act assures that once an area has been funded with L&WCF assistance, it is continually maintained in public recreation use unless National Park Service (NPS) approves substitution property of reasonably equivalent usefulness and location and of at least equal fair market value. Table 3-5 illustrates funding from the LWCF within the study area.

*Table 3-5. LWCF Grant Funding within the Project Area*

| Grants | Parish/County | Amount |
|---|---|---|
| 19 | Ascension | $1,249,286.86 |
| 58 | East Baton Rouge | $3,729,989.60 |
| 16 | Livingston | $1,538,956.14 |
| 5 | St. James | $539,740.17 |
| 1 | St. John the Baptist | $128,026.56 |
| **99** | **Total** | **$7,185,999.33** |

#### 3.2.2.4 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 the Federal action, in this case, the proposed flood risk-reduction system alternatives: Darlington Dry Dam, the Sandy Creek Dry Dam, and the Non-Structural plan. The EJ assessment identifies environmental and demographic indicators for the project alternatives, using the EPA tool, EJSCREEN. If the alternative 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 or mitigation are then required. The following subsections provide information on the low-income and minority population in Ascension, East Baton Rouge, East Feliciana, Iberville, Livingston, St. Helena, St. James, and St. John the Baptist Parishes in Louisiana and the Mississippi Counties of Amite, Franklin, Lincoln, and Wilkinson. .

*Methodology*

EJ is institutionally significant because of Executive Order 12898 of 1994 (E.O. 12898) and the Department of Defense's Strategy on Environmental Justice of 1995, which direct Federal agencies to identify and address any disproportionately high adverse human health or environmental effects of Federal actions to minority and/or low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, 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.

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 EPA's EJSCREEN tool. At this time, although public scoping meetings have taken place, specific EJ outreach has not been conducted and may have to be performed during the Pre-Construction, Engineering and Design (PED) phase of 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.

*Existing Conditions*

Five of the 12 parishes or counties in the study area including East Baton Rouge, Iberville, St. James, and St. John the Baptist Parishes as well as Wilkinson County, Mississippi, 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. Most of the minority population identifies as Black/African American. The 2017 ACS total population of the 12 parish area is approximately 895,000. Hispanic population represents the largest ethnicity of the parishes and counties and is between 0.2 percent and 5.8 percent of total population. For more information on minority populations, refer to Appendix C-1, Section 3.8.

Four of the 12 parishes/counties in the study area, including St. Helena Parish in Louisiana and Amite, Lincoln, and Wilkinson Counties in Mississippi have 20 percent or more of individuals living below poverty, which in 2017 is $25,094 for a family of four. Less than 20 percent of the population lives below poverty level in the other eight areas. For more information on low-income populations, refer to Appendix C-1, Section 3.8.

The EJSCREEN uses environmental and demographic indicators to help identify EJ communities. The EJ Environmental Indexes, presented in Table C1-22 of the Environmental Appendix C-1, Section 3.8 are all below the 80th percentile in the state or USA, which is according to the EPA, the percentile where one would expect EJ concerns.The Environmental Indicators do not highlight EJ concerns. However, the demographic indicator, Minority Population, shows the area well over 50 percent minority, both for communities within the Darlington Dam footprint and communities in the 0.04 AEP floodplain.



Mitigation measures should be developed specifically to address potential disproportionately high and adverse effects to minority and/or low-income communities. When identifying and developing potential mitigation measures to address environmental justice concerns, members of the affected communities would be consulted. Enhanced public participation efforts would also be conducted to ensure that effective mitigation measures are identified and that the effects of any potential mitigation measures are fully analyzed and compared. Mitigation measures may include a variety of approaches for addressing potential effects and balancing the needs and concerns of the affected community with the requirements of the action or activity. If necessary, additional EJ details would be provided in future NEPA documents including:

- Outreach and public involvement details
- Details of acquisition alternatives
- Relocation assistance

#### 3.2.2.5 Socioeconomics

Table 3-6, 3-7, and 3-8 display the population, number of households, and the employment (number of jobs) for each of the parishes and counties for the years 2000, 2010, and 2017 as well as projections for the years 2025 and 2045. The 2000 and 2010 population, number of households, and employment is based on estimates from the 2010 U.S. Census and the projections were developed by Moody's Analytics (ECCA) Forecast, which has projections to the year 2045.

*Table 3-6 Historical and Projected Population by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 76,627 | 107,215 | 122,948 | 136,988 | 161,973 |
| East Baton Rouge | 412,852 | 440,171 | 446,268 | 441,495 | 415,720 |
| East Feliciana | 21,360 | 20,267 | 19,412 | 18,140 | 15,910 |
| Iberville | 33,320 | 33,387 | 33,027 | 31,166 | 27,428 |
| Livingston | 91,814 | 128,026 | 138,228 | 150,306 | 166,260 |
| St. Helena | 10,525 | 11,203 | 10,363 | 9,681 | 8,592 |
| St. James | 21,201 | 22,006 | 21,790 | 22,599 | 23,727 |
| St. John the Baptist | 43,248 | 45,621 | 44,078 | 45,713 | 47,995 |
| Amite | 13,599 | 13,131 | 12,447 | 11,992 | 11,680 |
| Franklin | 8,448 | 8,118 | 7,765 | 7,517 | 7,476 |
| Lincoln | 33,166 | 34,869 | 34,347 | 35,400 | 36,479 |
| Wilkinson | 10,312 | 9,878 | 8,804 | 8,335 | 7,823 |
| Total | 776,472 | 873,893 | 899,477 | 919,332 | 931,063 |

Sources: 2000, 2010, 2017 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics (ECCA) Forecast

*Table 3-7. Projected Households by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 26,995 | 38,050 | 44,890 | 51,815 | 66,244 |
| East Baton Rouge | 156,740 | 172,440 | 179,910 | 184,008 | 186,082 |
| East Feliciana | 6,694 | 6,996 | 6,922 | 6,752 | 6,411 |
| Iberville | 10,697 | 11,075 | 11,229 | 11,137 | 10,643 |
| Livingston | 32,997 | 46,297 | 52,184 | 57,891 | 69,149 |
| St. Helena | 3,890 | 4,323 | 4,116 | 3,995 | 3,810 |
| St. James | 7,002 | 7,691 | 7,945 | 8,561 | 9,727 |
| St. John the Baptist | 14,381 | 15,875 | 16,005 | 17,249 | 19,602 |
| Amite | 5,261 | 5,349 | 5,213 | 5,149 | 5,252 |
| Franklin | 3,205 | 3,214 | 3,118 | 3,138 | 3,272 |
| Lincoln | 12,563 | 13,313 | 13,682 | 14,272 | 15,446 |
| Wilkinson | 3,584 | 3,452 | 3,236 | 3,097 | 3,065 |
| Total | 284,008 | 328,074 | 348,450 | 367,063 | 398,703 |

Sources: 2000, 2010 from U.S. Census Bureau; 2017, 2025, 2045 from Moody's Analytics (ECCA) Forecast

*Table 3-8.Projected Employment by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 36,431 | 49,414 | 59,670 | 65,803 | 82,614 |
| East Baton Rouge | 197,789 | 205,112 | 227,301 | 222,833 | 222,810 |
| East Feliciana | 7,811 | 7,427 | 7,866 | 7,321 | 6,820 |
| Iberville | 11,745 | 12,622 | 13,661 | 12,892 | 12,054 |
| Livingston | 42,326 | 56,675 | 66,010 | 70,000 | 82,219 |
| St. Helena | 3,830 | 4,097 | 4,171 | 3,868 | 3,649 |
| St. James | 8,102 | 8,949 | 8,940 | 9,257 | 10,448 |
| St. John the Baptist | 18,702 | 19,252 | 18,794 | 19,479 | 21,968 |
| Amite | 5,274 | 4,385 | 4,206 | 4,023 | 4,082 |
| Franklin | 3,234 | 2,866 | 2,721 | 2,650 | 2,747 |
| Lincoln | 13,981 | 12,940 | 13,614 | 13,749 | 14,784 |
| Wilkinson | 3,239 | 2,968 | 2,610 | 2,404 | 2,343 |
| Total | 352,463 | 386,704 | 429,564 | 434,280 | 466,538 |

Sources: 2000, 2010 from U.S. Bureau of Labor Statistics; 2017, 2025, 2045 from Moody's Analytics (ECCA) Forecast

Table 3-9 shows the per capita personal income levels for the 12 parishes and counties for the years 2000, 2010, 2017, and 2025, with projections provided by Moody's Analytics Forecast.

*Table 3-9***.** *Per Capita Income ($) by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 |
|---|---|---|---|---|
| Ascension | 24,052 | 39,416 | 47,628 | 60,180 |
| East Baton Rouge | 27,228 | 39,651 | 48,120 | 60,048 |
| East Feliciana | 20,049 | 33,122 | 39,908 | 53,331 |
| Iberville | 18,681 | 32,342 | 38,960 | 50,288 |
| Livingston | 21,521 | 32,621 | 39,883 | 51,341 |
| St. Helena | 16,821 | 34,136 | 41,273 | 55,046 |
| St. James | 18,722 | 38,421 | 45,219 | 60,576 |
| St. John the Baptist | 20,002 | 33,894 | 41,505 | 57,423 |
| Amite | 17,923 | 25,620 | 32,225 | 41,711 |
| Franklin | 15,844 | 27,175 | 33,133 | 42,441 |
| Lincoln | 20,257 | 30,468 | 36,895 | 44,607 |
| Wilkinson | 14,667 | 24,322 | 28,745 | 37,916 |

Sources: 2000, 2010 from U.S. Census Bureau; 2017, 2025 from Moody's Analytics (ECCA) Forecast

## 3.3 FUTURE WITHOUT PROJECT CONDITIONS

NEPA requires that in analyzing alternatives to a proposed action, a federal agency must consider an alternative of "No Action." The Future without Project (FWOP) conditions apply to when the proposed action would not be implemented and the predicted additional environmental gains (e.g. flood risk reduction) would not be achieved. The FWOP conditions would include lower tax revenues as property values decline due to higher risk of damage from flooding events over time. Higher risk of damage from flooding could manifest itself in higher premiums for flood insurance under FEMA's National Flood Insurance Program: higher premiums are expected to increase the cost of property ownership and result in correspondingly lower market values.

Without implementation of the proposed action, other federal, state, local, and private restoration efforts may still occur within or near the proposed project area. Section 1.5 of this report discusses ongoing programs and potential projects in the study area for floodplain related activities. None of the proposed projects are currently in construction and if they were implemented would have only localized flood risk reduction within the study area. The projects/programs would have the potential to reduce the number of eligible structures for the nonstructural portion of the TSP.

Two authorized USACE construction projects, Comite River Diversion and the East Baton Rouge Flood Control, were included in the baseline conditions of the study; therefore, they are not anticipated to impact the benefits from the economic analysis of this study.

The Comite River Diversion, which is currently under construction, will be located approximately 20 river miles upstream of the confluence of the Comite and Amite Rivers (Figure 4-1). The project will divert water from the Comite River west to the Mississippi River, between the cities of Zachary and Baker, providing urban flood damage reduction. The East Baton Rouge Flood Risk Reduction Project reduces flooding along five sub-basins throughout the parish, including Jones Creek, Ward Creek, Bayou Fountain, Blackwater Bayou, and Beaver Bayou. This project consists of improvements to 66 miles of channels, including clearing and snagging, widening, concrete lining, and improvements to existing culverts and bridges to reduce headwater flooding/backwater overflow in the ARB.

# Section 4
# Formulate Alternative Plans

Plan formulation supports the USACE water resources development mission. A systematic and repeatable planning approach is used to ensure that sound decisions are made. The Principles and Guidelines describe the process for Federal water resource studies. It requires formulating alternative plans that contribute to Federal objectives. Alternative plans are a set of one or more management measures functioning together to address one or more planning objectives. 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 initial plan formulation strategy was to focus on regional solutions (e.g., dams, detention basin, and diversion) followed by formulation based on economics damage centers (e.g., where the greatest consequences are) minimizing life loss, and/or more local protection. These measures/alternatives were developed based on previous reports and studies, NFS information, stakeholder/public input, new hydrology and hydraulics, geotechnical assessments, and professional judgment. This section also describes the plan formulation process to identify the TSP, which includes development of cost estimates and economic analysis.

The plan formulation process utilized the best available information at this phase of the study to identify a TSP. However, during the final phase of this feasibility study, additional analyses will be completed to refine the design and cost estimates of the features included in the TSP. The revised design and costs will be incorporated into the numerical modeling (Hydraulics and Economics) in order to develop an accurate assessment of the performance and cost-effectiveness of the plan which will be included in the Final IFR & EIS.

## 4.1 MANAGEMENT MEASURES AND SCREENING

The ARB primarily has flooding from two different sources. The upper basin flooding is caused from headwater flooding from rainfall events. The lower basin flooding is caused by a combination of drainage from headwaters and backwater flooding from tides and wind setup. Thirty-four nonstructural and structural management measures of a variety of scales were identified for evaluation to reduce the risk of flood damages within the ARB (Table 4-1). The measures were evaluated by the screening process based on the planning objectives, constraints, as well as the opportunities and problems of the study/project area.

Nineteen measures were carried forward to develop the alternative plans. Section 2 of Appendix E provides a description of the evaluation.

| | |
|---|---|
| | |
| RW-1 | Dredging of Outfall @ Amite River |
| RW-2 | Dredging of Lower Amite River |
| RW-3 | Dredging of Upper Amite River |
| RW-4 | Dredging of Bayou Manchac |
| RW-5 | Bridge Restrictions/ Improvements for I-12 |
| RW-6 | Amite River Channel Bank Gapping |
| RW-7 | Storage Area at Spanish Lake, Ascension/Iberville Parish |
| RW-8 | Hwy 22 and Port Vincent Bridge Drainage Improvements |
| RW-9 | Upper Amite Bridge Restrictions/ Improvements |
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| | |
| RW-12 | Diversion Pump Station (Manchac) |
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| | |
| HW-1 | 0.01 AEP Dry Dams-Upper Amite Tributaries |
| HW-2 | Small Dry Dams on Amite River -Upper Amite |
| HW-3 | Reservoirs along Bayou Manchac |
| | |
| | |
| | |
| HW-7 | University Lakes as Reservoir |
| UL-1 | Large Scale Dam -Upper Amite (i.e. Darlington 0.04 AEP) |
| NS-1 | Flood warning/Monitoring systems |
| UL-2 | Dredging of Amite River Tributaries |
| NS-2 | Nonstructural Improvements for high frequency events |
| FS-1 | Ring Levees around Critical Facilities |

Note: Shaded cells are measures that were not carried forward during the screening process.

## 4.2 DEVELOPMENT OF INITIAL ARRAY OF ALTERNATIVE AND SCREENING

Fifteen alternatives were assembled through the plan formulation process, which include alternatives for No Action and Nonstructural (Table 4-2). The alternative plans were initially identified using one or more of the nineteen management measures that were carried forward after the screening evaluation. Two additional alternatives were identified through public scoping, as discussed in Section 2.4.

The alternatives comprised of the FRM concepts are:

- Remove Water (RW) = Removing water more quickly out of the ARB
- Hold Water (HW) = During heavy rainfall events water would be held back from flowing down the ARB until water levels drop to reduce the flood risk.
- Nonstructural (NS)= does not modify or restrict the natural flood
- Upper and Lower Basin (UL) = Alternative that likely results in reduced flood risk for the entire ARB.
- FS = Focused Structural measures to protect critical Facilities.

Most alternatives assessed had very little reduction in flood risk and limited benefits. Topographic relief features in the geomorphology of the ARB have significant influence over flooding in the upper and lower basins. In the upper basin water flows to the south and in the central/lower basin the geomorphology is very flat, which limited the effectiveness of alternatives. Additionally, many of the alternatives were located where there were not many structures, so there were limited benefits. The parishes in the study area have a combined population of about 900,000 with more than half of the population living in East Baton Rouge Parish. The study area has over 260,000 structures and of those, about 80 percent are in the central portion of the ARB north of Bayou Manchac. Many of the alternatives were located where there were not many structures, so there were limited benefits. The remaining alternatives that were not screened, were those that provided storage of water to attenuate flooding downstream in heavily developed areas. Those alternatives are the focused array of alternatives. Appendix E provides a description of the evaluation as well as list of each of the alternatives evaluated. Appendix G provides details of the Hydraulics and Hydrology (H&H) analysis completed.

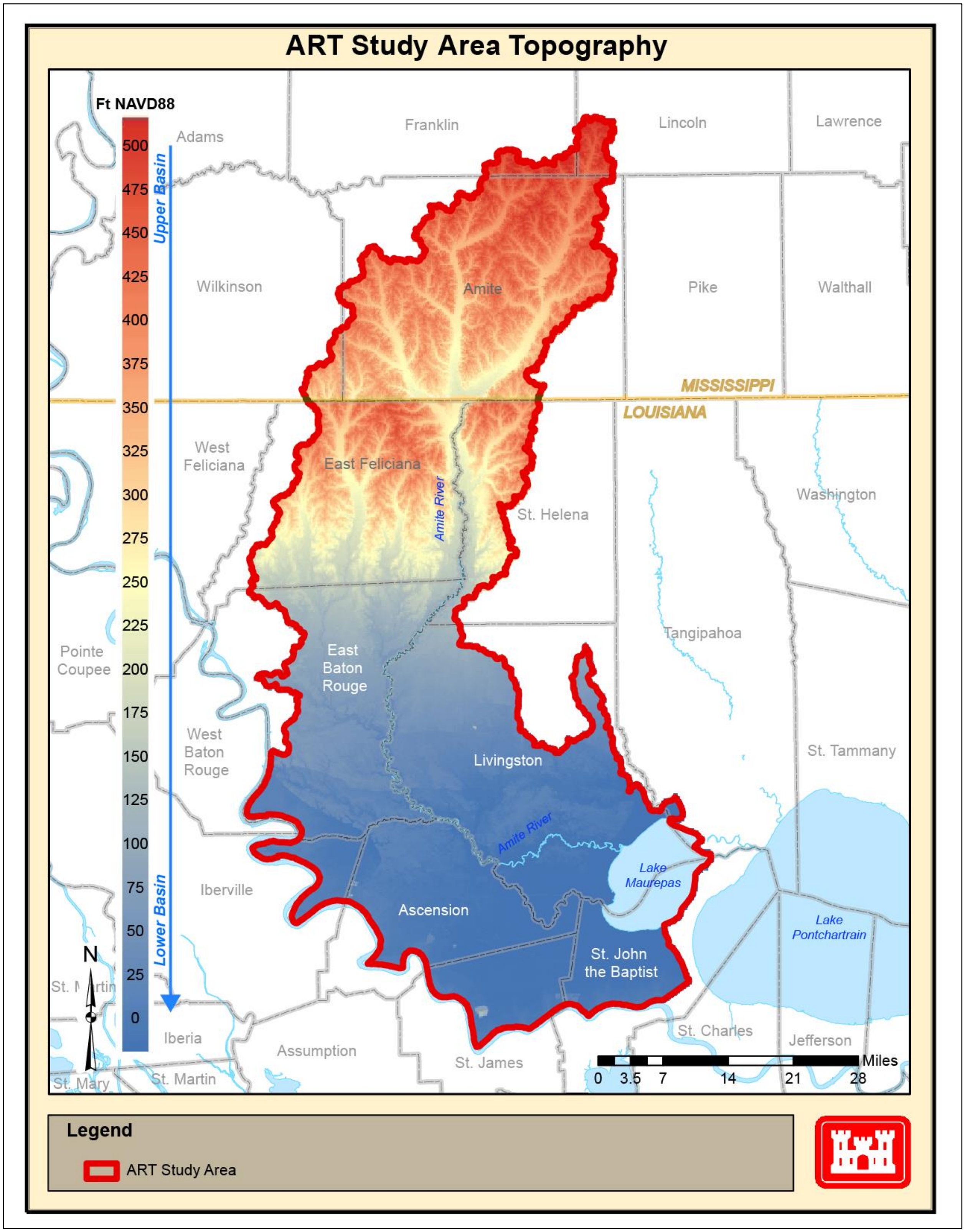


*Figure 4-1. ARB Topographic Digital Elevation Model (Source: Louisiana Oil Spill Coordinators Office 2001)*

*Table 4-2. Alternatives*

| Alt ID | Measures Included | Alternative Description |
|---|---|---|
| Alt 1 | No Action | No action would be taken under this plan. Damages would continue into the future. |
| Alt 2 | RW-1+RW-2 | Dredging of the Amite River outfall (RW-1) and in the lower reaches of the Amite River (RW-2) |
| Alt 3 | RW-6 | Lower Amite River Channel Bank Gapping (RW-6) |
| Alt 4 | RW-8 | Hwy 22 and Port Vincent Bridge drainage improvements (RW-8) |
| Alt 5 | HW-3+ RW-4 | Dredging (RW-4) and storage along Bayou Manchac in multiple small reservoirs (HW-3) |
| Alt 6 | RW-7+NS-2+FS-1 | Flood gate at Airline Hwy, Pump to MS River, open flood gates at Turtle and Alligator Bayous (RW-7) with the addition of nonstructural measures (NS-2) and ring levees for residential communities and critical infrastructure (FS-1) |
| Alt 7 | RW-5+RW-9 | Reduction of flow restrictions from bridges at I-12 (RW-5) and above I-12 (RW-9) |
| Alt 8 | RW-3 | Dredging of the Upper and Central Amite Basin, above I-12 (RW-3) |
| Alt 9 | HW-7 | University Lakes as reservoirs (HW-7) |
| Alt 10 | HW-1 | 0.01 AEP Dry Dams along tributaries (HW-1) |
| Alt 11 | HW-2 | Small dry dams on the Amite River (HW-2) |
| Alt 12 | UL-1 | Large scale 0.04 AEP dam (UL-1) |
| Alt 13 | NS-1+ NS-2 | Nonstructural (NS-1 and NS-2) |
| Alt 14 | None | Conversion of sand and gravel mines in the Amite Riverine to bottomland hardwood forest and swamp forest |
| Alt 15 | None | Restoration of River Meanders |

Note: Shaded cells are alternatives that were not carried forward during the screening process.

## 4.3 FOCUSED ARRAY OF ALTERNATIVES

The focused array of alternatives carried forward for consideration are presented in Table 4-3 and the locations of the structural alternatives are presented on Figure 4-2. Engineering Appendix A provides design and details of the structural alternatives.

*Table 4-3. Focused Array of Alternatives*

| Alt ID | Management Measures | Alternative Description |
|---|---|---|
| Alt 1 | No Action | No action would be taken under this plan. Damages would continue into the future. |
| Alt 10 | HW-1 | 0.01 AEP Dry Dams along tributaries (HW-1) |
| Alt 12 | UL-1 | Large scale 0.04 AEP dam (UL-1) |
| Alt 13 | NS-1+ NS-2 | Nonstructural (NS-1 and NS-2) |

### 4.3.1 No Action

Under the No Action Alternative, no risk reduction would occur. The area would continue experience damages from rainfall and wind/tide induced flooding. This would be exacerbated in the Lower ARB due to relative sea level rise.

### 4.3.2 Dry Dams along Tributaries

A 0.01 AEP dam design was chosen.to try to capture the most benefits by lowering the peak stage height along the Amite River by holding water back along larger tributaries in the upper basin. The alternative for dry dams along tributaries was divided further into two different alternatives after the initial assessment in order to ensure incremental justification of the dry dams. The alternative was broken into H&H analysis runs for one dam along Sandy Creek and the other run which combined there smaller dams along Darlington, Lilley, and Bluff Creeks. Limited data was available; therefore, many assumptions were made such as the geology of the area, the dam theoretical section, the outlet and spillway structure design, borrow material, and quantities, as discussed in Appendix A.

#### 4.3.2.1 Dry Dam on Sandy Creek

The Dry Dam on Sandy Creek alternative consists of an earthen dam on Sandy Creek, a tributary of the Amite River and a summary of the design is presented in Table 4-4.

*Table 4-4. Dry Dam on Sandy Creek Design Summary*

| Dry Dam Site | Storage Required for 0.01 AEP (acre-ft) | Maximum Elevation (ft) (NGVD29) | Max Elevation Acreage | Max Elevation Pool Volume (acre-ft) | Dry Dam Height (ft) | Length (ft) |
|---|---|---|---|---|---|---|
| Little Sandy Creek | 26,000 | 160 | 3,550 | 56,250 | 30 | 7,720 |

#### 4.3.2.2 Dry Dams on Darlington, Lilley, and Bluff Creeks

The dry dam for the Darlington, Lilley, and Bluff Creek alternative consists of three earthen dams on Darlington Creek, Lilley Creek, and Bluff Creek, all tributaries of the Amite River. A summary of the design is presented in Table 4-5.

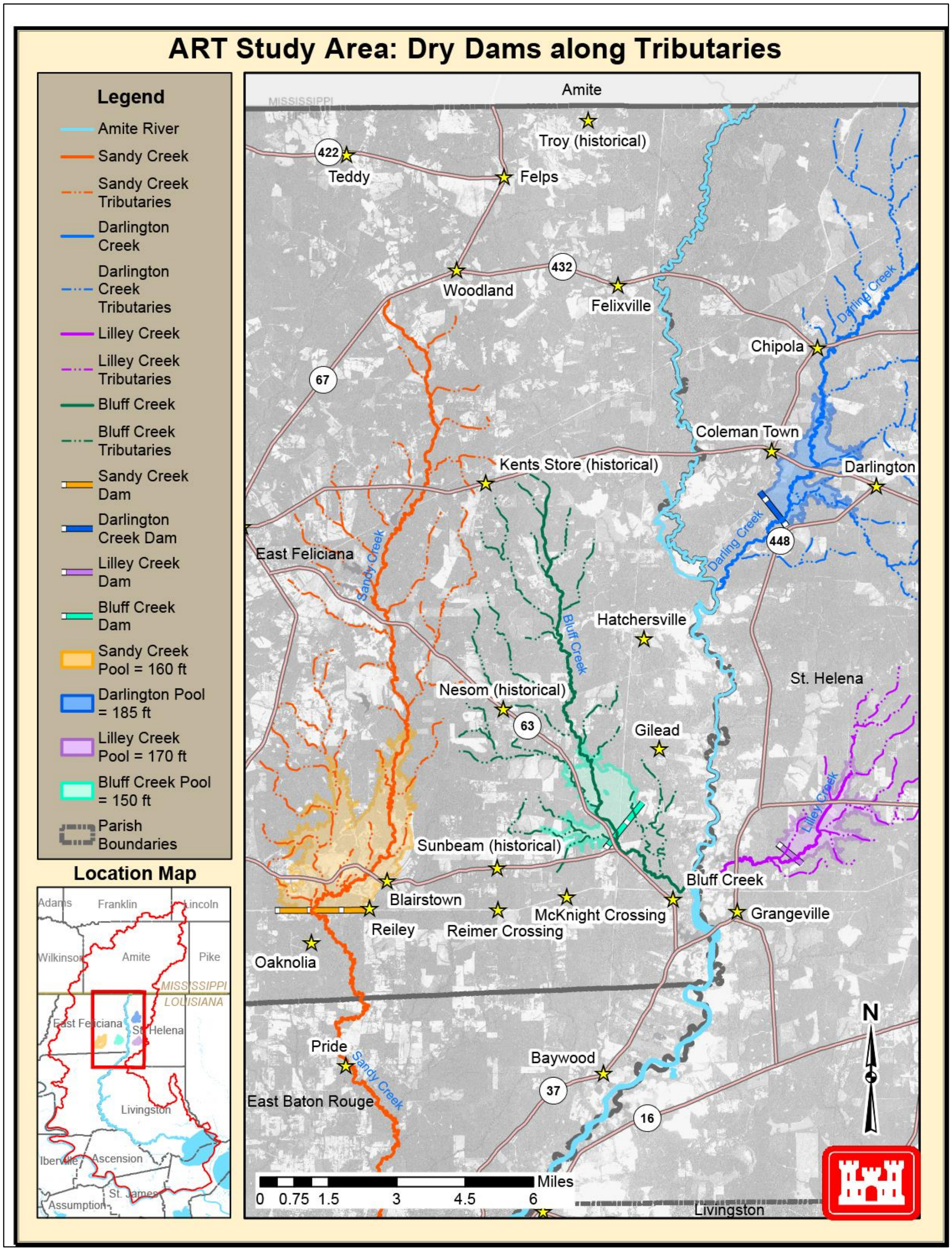


*Figure 4-2. Location of Dry Dams along Tributaries and Large Scale Darlington Dam*

*Table 4-5. Dry Dams on Darlington, Lilley, and Bluff Creeks Design Summary*

| Dry Dam Site | Storage Required for 0.01 AEP (acre-ft) | Maximum Elevation (ft) (NGVD29) | Max Elevation Acreage | Max Elevation Pool Volume (acre-ft) | Dry Dam Height (ft) | Length (ft) |
|---|---|---|---|---|---|---|
| Darlington Creek | 6,700 | 185 | 1,400 | 13,300 | 20 | 3,980 |
| Bluff Creek | 3,300 | 150 | 1,220 | 9,772 | 20 | 4,980 |
| Lilley Creek | 7,300 | 170 | 1,040 | 14,240 | 35 | 2,780 |

### 4.3.3 Large Scale 0.04 AEP Dam (Darlington Dam)

The large scale 0.04 AEP Darlington Dam alternative consists of an earthen dam on the Amite River with the option of being a wet or dry dam. Because this alternative was previously studied, data for analyzing it was available in the “Amite River and Tributaries, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope),” dated September 1997. The 1997 report recommended Dry and Reduced-wet Darlington Dam alternatives were analyzed using the same design section (Figure 4-3 and Appendix A). A wet dam would consist of a permanently flooded reservoir/conservation pool, while the reservoir for a dry dam would be used only during flood events to accommodate outflow and thus minimize inundation to the surrounding area. The dry dam would have a crown elevation 1 foot lower than the reduced-wet (Table 4-6).

The dam consists of a clay core with a random fill outer layer and a 70 foot deep slurry trench. The dry dam design section consists of a reservoir with a 24 foot wide crown at elevation 201.0 (NGVD 29), side slopes of 1 vertical on 3 horizontal from the crown to elevation 171.0 (NGVD) (Figure 4-4). Below elevation 171.0 (NGVD 29) on the flood side, the slope is 1 vertical on 6 horizontal to elevation 150.0 (NGVD 29). The flatter slope is to reduce the chances of sudden drawdown failures that tend to occur in this zone. Below elevation 150.0 (NGVD 29), the slope is 1 vertical on 4 horizontal down to the existing ground. On the protected side, from elevation 171.0 to elevation 150.0 (NGVD 29), the slope is 1 vertical on 5 horizontal. The flatter slope in this area will increase stability and will resist seepage forces that may concentrate in the lower portion of the dam. Below elevation 150.0 (NGVD 29), the slope is 1 vertical on 3 horizontal. The low-level outlet structure consists of 3 - 10’ x 10’ concrete box culverts and will be located approximately 1000 feet to the east of the Amite River. A 1000 foot long emergency spillway will be placed at elevation 171.0 (NGVD 29).

The design section developed using slope stability analyses in the 1997 study was designed with a top width of 24 feet. The top width of the dam does not meet EM 1110-2-2300 (General Design and Construction Considerations for Earth and Rock-Fill Dams), Article 4-3, which requires a minimum top width between 25 and 40 feet based on the dam height. However, EM 1110-2-2300 also states that the top width has little effect on stability and is governed by the functional purpose the top of the dam must serve. The design will be refined for the final IFR and EIS.

*Table 4-6. Darlington Dam Design Summary*

| | **0.04 AEP Dry Dam** | **0.04 AEP Wet Dam** |
|---|---|---|
| **Dam Elevation NGVD** | 201 | 202.8 |
| **Flood Control Pool** | NA | 39,000 |
| **Flood Control Pool Elevation** | 171 | 172.8 |
| **Flood Control Pool Storage acre-ft** | 213,000 | 198,000 |
| **Surcharge Pool Storage acre-ft** | 399,000 | 421,000 |
| **Total Peak Storage acre-ft** | 612,000 | 658,000 |
| **Max Outflow cfs** | 437,000 | 432,000 |

### 4.3.4 Nonstructural

A nonstructural assessment (Appendix F) was completed that looked at the effectiveness of implementing physical nonstructural measures (NS-2) such as structure elevations, acquisitions, and floodproofing.  For evaluation purposes, the nonphysical measures (NS-1) which consists of flood warning system/evacuation plans were not included in the evaluation since there are no economic benefits that can be derived, but these measures are intended to reduce incremental risk at low cost, and will be included in the tentatively selected plan.

An inventory of residential and non-residential structures was developed using the National Structure Inventory (NSI) version 2.0 for the portions of the study area impacted by flooding from rainfall and sea-level rise associated with the future without project condition. An assessment of all structures located in the 0.04 and 0.02 AEP floodplains was performed and the results are presented below.

The nonstructural alternatives will be further refined based on analyses of effectiveness and cost. Further refinement will include a new analysis to combine nonstructural measures with structural alternatives, revisiting of groupings to address areas of potential life safety concerns and/or geographic groupings, as well as additional surveys conducted to be applied to the structure inventory.

The second nonstructural alternative that was evaluated included acquisition and relocation for all structures located in the 0.04 aggregated floodplain and can also be found in Appendix F. In this alternative, the costs of acquisitions, with relocation assistance to displaced persons, were compared with the expected annual damages reduced by the demolition of structures from the floodplain. For the analysis of the Nonstructural Alternative as a standalone alternative, acquisitions were not carried forward because the cost of the alternative exceeded the damages reduced (benefits).

#### 4.3.4.1 0.04 AEP Floodplain

Measured every structure receiving a flood stage at or above the first floor elevation during the base year 0.04 AEP event.

- 4,291 residential structures could be raised to the future 0.01 AEP stage up to 13 feet.
- 387 nonresidential structures could be floodproofed up to 3 feet.

#### 4.3.4.2 0.02 AEP Floodplain

Measure to every structure receiving a flood stage at or above the first floor elevation during the base year 0.02 AEP event.

- 6,774 residential structures could be raised to the future 0.01 AEP stage up to 13 feet.
- 670 nonresidential structures could be floodproofed up to 3 feet.

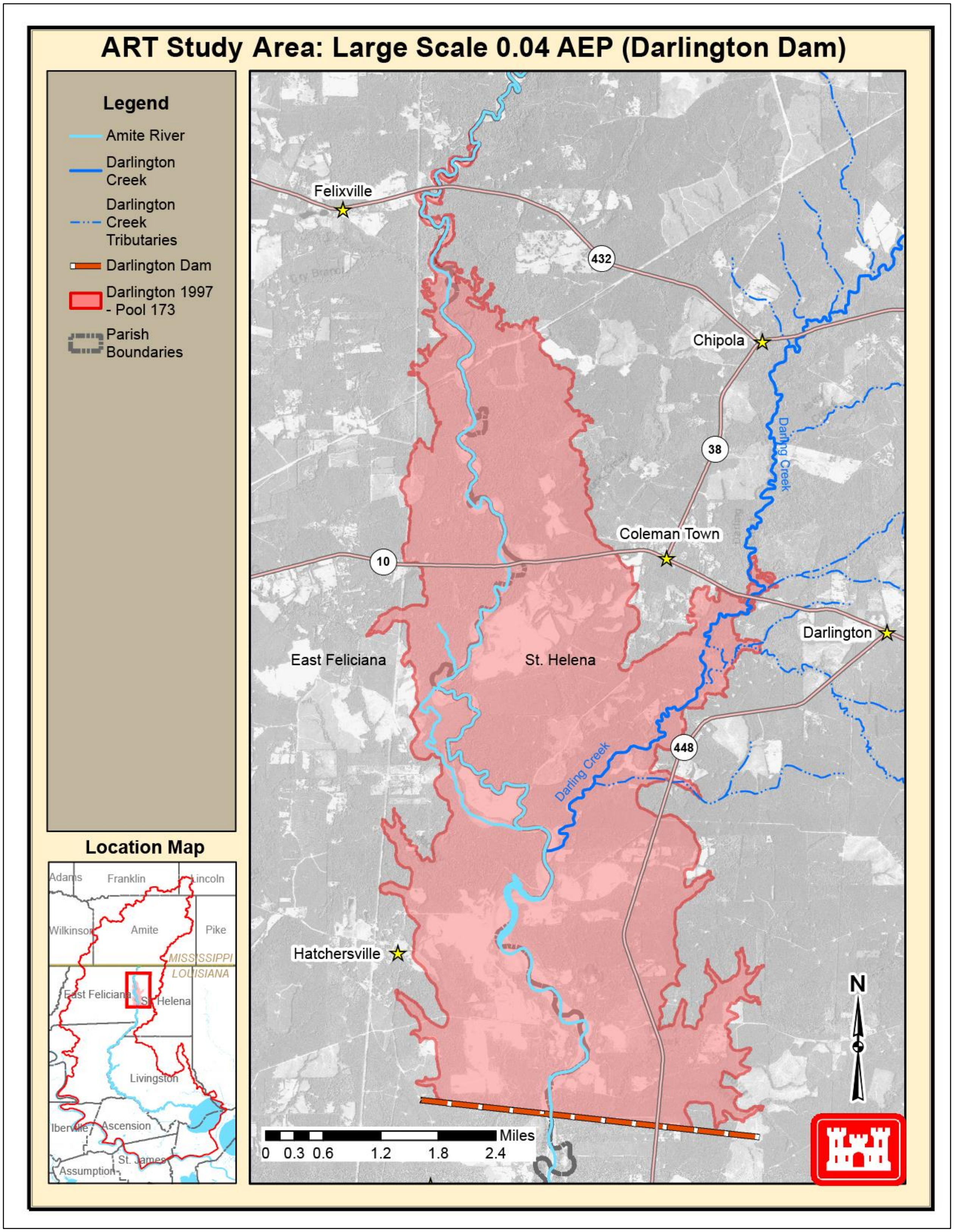


*Figure 4-3. Close up of Large Scale 0.04 AEP Dam (Darlington Dam)*

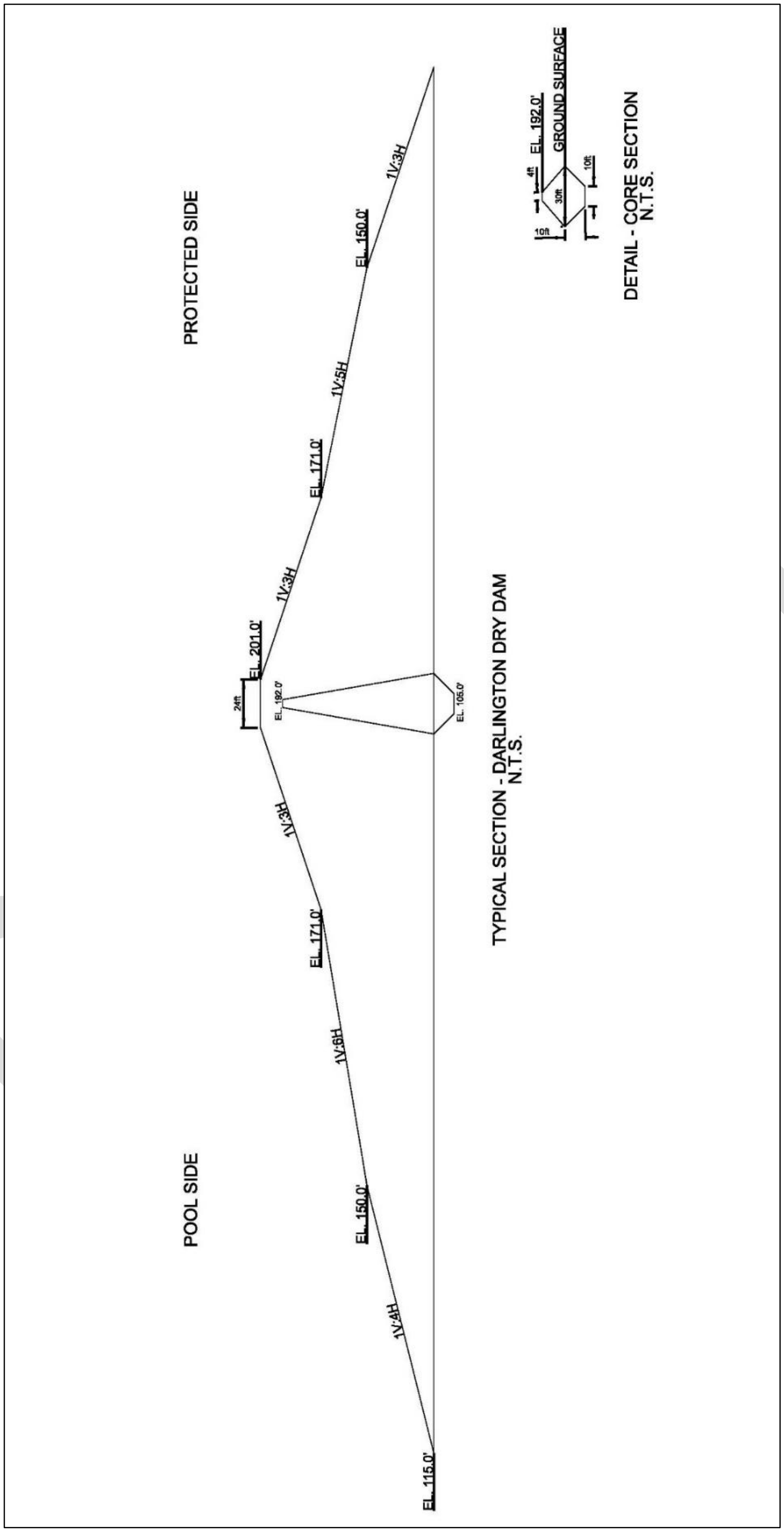


*Figure4-4. Typical Section-Darlington Dry Dam*

The plan formulation process utilized the best available information at this phase of the study to identify a TSP. However, during the final phase of this feasibility study, additional analyses will be completed to refine the design and cost estimates of the features included in the TSP. The revised design and costs will be incorporated into the numerical modeling (Hydraulics and Economics) in order to develop an accurate assessment of the performance and cost-effectiveness of the plan which will be included in the Final IFR & EIS.

## 4.4 FOCUSED ARRAY OF ALTERNATIVES COST ESTIMATES

Cost estimates of the focused array were developed and compared to help identify the TSP based on efficiency.

### 4.4.1 Structural Alternatives

The costs estimates for structural alternatives were developed utilizing Parametric costs, historical costs or the Micro-Computer Aided Cost Estimating System, 2nd Generation (MCACES MII) cost estimating software and is presented in Appendix B. These cost estimates developed First Costs or Construction Costs and include Real Estate costs, Relocation costs, Environmental and Cultural Resources costs, Planning, Engineering and Design costs and Construction Supervision and Administration costs. To cover unknowns, uncertainties, and unanticipated conditions that could not be evaluated at this time an appropriate amount of contingencies were included in each first cost depending on the level of investigative data and design detail available. Separate from first costs, Operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs were developed and later included as part of Total Project Costs.

The first costs for the 0.04 AEP Darlington Dam alternative for the wet reservoir ($1.8 Billion) and dry reservoir ($1.3 Billion) costs were very similar with the exception for the Fish & Wildlife feature that covers BLH habitat and inflated heelsplitter mussel mitigation. Due to the permanently wet flood control pool, the habitat mitigation costs for a wet dam would be approximately $400 million more than for a dry dam. The first cost for the earthen dry dams along tributaries was $270 million for the dry dam on Sandy Creek and $350 million for three dams on Darlington Creek, Lilley Creek, and Bluff Creek.

### 4.4.2 Nonstructural Alternative

The physical nonstructural alternative was evaluated through two measures. The first looked at the cost of elevating residential structures and floodproofing non-residential structures located in the 0.04 and 0.02 AEP floodplains. The second measure looked at the cost of acquiring structures located in the same aggregated floodplains, including relocation assistance to displaced persons. The measure with the higher net benefits was used to determine the nonstructural feature cost, which happened to be the elevation and floodproofing measure. Relative Sea Level Rise (RSLR) impacts the number of structures to be raised in the lower basin near Lake Maurepas, resulting in uncertainty as to how many structures would have to be raised by any given date. A cost estimate of the 0.04 ($1.3 Billion) and 0.02 AEP ($2.2 Billion) nonstructural features was developed based on the cost of reducing risk to structures in the year 2026 respective flood plains and is presented in Appendix F.

## 4.5 FOCUSED ARRAY ECONOMIC ANALYSIS

H&H model outputs and the economics functions were fed into the HEC-FDA, the USACE hydrologic modeling software for flood damage reduction analysis (https://www.hec.usace.army.mil/software/hec-fda/) and those results were tabulated and compared. More detailed costs were estimated based on construction, preconstruction engineering and design, construction management, real estate, and environmental and cultural mitigation, including all contingencies. Annualized costs and benefits were calculated and the Benefit Cost Ratio (BCR) for each alternative was estimated. Each of the alternatives should have benefits long into the future but guidance limits it to the 50-year period of analysis from 2026 to 2076. The economic results for each alternative are summarized in Table 4-7. The economic analysis yielded several alternatives that are in the Federal interest and from which a TSP can be identified. Three alternatives were screened due to negative net benefits, which included the nonstructural plan for a 0.02 AEP floodplain, large scale 0.04 AEP wet Darlington Dam, and the three 0.01 AEP dry dams on the Darlington, Lilley, and Bluff Creeks.

*Table 4-7. Summary of Costs and Benefits for Focused Array of Alternatives*

| Alternative | Non-structural 0.04 AEP | Non-structural 0.02 AEP | Darlington Wet Dam 0.04 AEP | Darlington Dry Dam 0.04 AEP | Sandy Creek Dry Dam 0.01 AEP | 3 Tributary Dry Dams 0.01 AEP |
|---|---|---|---|---|---|---|
| **Total Project Costs** | | | | | | |
| **First Cost** | $1,335,282 | $2,160,836 | $1,788,531 | $1,278,523 | $270,977 | $349,981 |
| **Interest During Construction** | $4,536 | $7,34 | $100,590 | $71,907 | $7,477 | $9,658 |
| **Total Investment Cost** | $1,339,818 | $2,168,176 | $1,889,121 | $1,350,430 | $278,455 | $359,638 |
| **Estimated Annual Costs** | | | | | | |
| **Annualized Project Costs** | $49,628 | $80,311 | $69,975 | $50,021 | $10,314 | $13,321 |
| **Annual OMRR&R** | $0 | $0 | $658 | $439 | $220 | $659 |
| **Total Annual Costs** | $49,628 | $80,311 | $70,633 | $50,461 | $10,534 | $13,980 |
| **Average Annual Benefits** | | | | | | |
| **Total Annual Benefits** | $53,547 | $63,542 | $65,066 | $65,066 | $13,649 | $6,131 |
| **Net Annual Benefits** | $3,919 | -$16,769 | -$5,567 | $14,605 | $3,115 | -$7,849 |
| **Benefit to Cost Ratio** | 1.08 | 0.79 | 0.92 | 1.29 | 1.30 | 0.44 |

FY19 Price Level, $ 1,000s



## 4.6 FINAL ARRAY OF ALTERNATIVES

The remaining alternatives are presented in Table 4-8 as the final array of alternatives, which were further evaluated to identify the TSP. The final array of alternatives were compared based on a variety of factors including economics, H&H impacts, NFS coordination, and tribal coordination. As was done with the initial screening, the four evaluation criteria were also used to evaluate and compare alternative plans:

- Completeness – Does the alternative plan account for all necessary investments/actions to realize the planning objectives?
- Effectiveness – Does the alternative plan contribute to achieving the planning objectives?
- Efficiency – Is the alternative plan cost effective and efficient (benefits exceed costs)?
- Acceptability – Is the alternative plan feasible from technical, environmental, economic, financial, political, legal, institutional, and social perspectives? Does the alternative plan satisfy government entities and the public?

*Table 4-8. Final Array of Alternatives*

| Alternative |
|---|
| No Action (FWOP) |
| 0.01 AEP Dry Dam along tributary: Sandy Creek Dry Dam |
| Large scale dam: Darlington Dry Dam |
| Nonstructural: 0.04 AEP Floodplain (NS-1 and NS-2) |

### 4.6.1 System of Accounts

To facilitate alternatives evaluation and comparison of the alternatives, the 1983 Principles and Guidelines lay out four Federal Accounts that are used to assess the effects of the final array of alternatives. The accounts are NED, Environmental Quality (EQ), Other Social Effects (OSE), and Regional Economic Development (RED).

- The intent of comparing alternative flood risk reduction plans in terms of NED account was to identify the beneficial and adverse effects that the plans may have on the national economy. Beneficial effects were considered to be increases in the economic value of the national output of goods and services attributable to a plan. Increases in NED were expressed as the plans' economic benefits, and the adverse NED effects were the investment opportunities lost by committing funds to the implementation of a plan.
- The EQ account was another means of evaluating the plans to assist in making recommendations. The EQ account was intended to display the long-term effects that the alternative plans may have on significant environmental resources. The Water Resources Council defined significant environmental resources as those components of the ecological, cultural and aesthetic environments that, if affected by the alternative plans, could have a material bearing on the decision-making process.
- The RED account was intended to illustrate the effects that the proposed plans would have on regional economic activity, specifically, regional income and regional employment.
- The OSE account typically includes long-term community impacts in the areas of public facilities and services, recreational opportunities, transportation and traffic and man-made and natural resources. Table 4-9 describes the compared by completeness and effectiveness by alternative of the four accounts NED, EQ, RED, and OSE.

*Table 4-9. Evaluation of the Four Accounts*

| Four Accounts | Nonstructural 0.04 AEP Floodplain | Darlington Dry Dam 0.04 AEP | Darlington Dry Dam with Nonstructural | Sandy Creek Dry Dam 0.01 AEP |
|---|---|---|---|---|

| | | | 0.04 AEP | |
|---|---|---|---|---|
| National Economic Development (NED) | Avg. Annual Benefits- $53.5M<br>Avg. Annual Costs- $49.6M<br>$3.9M in net benefits. 1.07 BCR Ranked 4th | Avg. Annual Benefits- $65M<br>Avg. Annual Costs- $50.5M<br>$14.6M in net benefits. 1.29 BCR Ranked 2nd | Avg. Annual Benefits- $109M<br>Avg. Annual Costs- $88.1M<br>$20.5M in net benefits. 1.23 BCR Ranked 1st | Avg. Annual Benefits- $13.6M<br>Avg. Annual Costs- $10.5M<br>$3.1M in net benefits. 1.30 BCR Ranked 3rd |
| Environmental Quality (EQ) | Negligible footprint for this plan. Ranked 1st | Construction footprint is the largest and therefore a large environmental impact. Ranked 3rd (tie) | Construction footprint is the largest and therefore a large environmental impact. Ranked 3rd (tie) | Construction footprint is the smallest of the three structural plans and therefore little environmental impact. Ranked 2nd |
| Regional Economic Development (RED) | The project cost supports a large amount of regional employment from construction of the project. Ranked 3rd | The project cost supports a large amount of regional employment from construction of the project. Ranked 2nd | The project cost supports the largest amount of regional employment from construction of the project. Ranked 1st | The project cost supports a moderate amount of regional employment from construction of the project. Ranked 4th |
| Other Social Effects (OSE) | Effects to OSE would be minimized as the 0.04 AEP aggregation treats all structures in the floodplain as equals and does not rank individual structures on BCRs. Structure elevation or acquisitions are possible. A human impact to EJ resources is expected. Ranked 2nd | Effects to OSE would increase, as the dam footprint would require acquisition and relocation assistance to low income residents. Ranked 3rd | Effects to OSE would increase, as the dam footprint would require acquisition and relocation assistance to low income residents. Structure elevation or acquisitions related to the Nonstructural plan are possible. Human impacts to EJ resources is expected. Ranked 4th | Effects to OSE would increase, as the dam footprint would require acquisition and relocation assistance to low income residents. Ranked 1st |

### 4.6.2 Other Evaluation

Based on analysis of H&H, the 0.01 AEP dry dam on Sandy Creek was screened because the Darlington Dam has a much larger benefit region; therefore, larger net annual benefits. The large scale 0.04 AEP dry Darlington Dam and the Sandy Creek Dam both have benefit areas that are primarily on the main stem of the Amite River. The Darlington Dam and the Sandy Creek Dam both have benefit areas that are primarily on the main stem of the Amite River. The Darlington Dam provides benefits to structures that could have potentially seen benefits from Sandy Creek Dam. Once the benefits are captured by the Darlington Dam, there are no longer enough potential benefits available for Sandy Creek Dam to be justified. The same would be true in reverse: Sandy Creek Dam provides benefits to some of the structures that could have seen benefits from Darlington Dam. Once those benefits are captured by Sandy Creek, there are less benefits available for Darlington Dam to capture. Due to this overlapping of benefit regions, the alternative of combining Darlington Dam and Sandy Creek cannot simply add the individual benefits of the two dams.

Based on the economic analysis of the focused array (Table 4-7) the NED plan is the Darlington Dry Dam. The flood risk that remains in the floodplain after the proposed alternative is implemented is known as the residual flood risk. Nonstructural measures can be used to reduce the residual risk associated with the TSP. The residential and nonresidential structures, damaged under the with project conditions in year 2026 that incurred flood damages by the stage associated with the 0.04 AEP event, were considered eligible for acquisition, elevation, and floodproofing based upon these criteria.

- Elevating residential structures up to 13 feet and floodproofing non-residential structures up to 3 feet located in the 0.04 AEP floodplain and outside the FEMA regulatory floodway. Residential structures will be elevated to the 0.01 AEP base flood elevation (BFE) predicted to occur in the year 2076.
- If a structure would require elevating greater than 13 feet to meet the future year 0.01 AEP BFE, the structure may instead be acquired and removed from the floodplain. The 13 feet height is based on guidance provided in the FEMA publication P-550.
- Following detailed design, it may become necessary to acquire structures for permanent evacuation of the FEMA regulatory floodway. Such determination would be based on risk and performance.

During further refinement, should the Life Safety Risk Analysis indicate the need for acquisitions for permanent evacuation of the FEMA regulatory floodway or any other areas of critical concern, then eminent domain would be retained as a method of accomplishing acquisitions required of the NFS, consistent with USACE Planning Bulletins 2016-01 and 2019-03.  A preliminary analysis found a total of 3,252 residential structures and an additional 314 non-residential structures in the 0.04 AEP floodplain. The nonstructural measures will be refined by assessing the Darlington Dam as the new base condition for the hydrology which will include assessment of residual flood risk. Table 4-10 shows the expected annual net benefits for the TSP of Darlington Dry Dam with elevation and floodproofing in the 0.04 AEP floodplain to address residual risk. As plans are refined, the costs and benefits of acquisitions within the floodplain will be developed and addressed in the Final IFR and EIS.

*Table 4-10. Summary of Costs and Benefits of the TSP*

| Darlington Dry Dam with 0.04 AEP Nonstructural Measures<br>Total Expected Annual Net Benefits<br>(FY19, $1,000's, 2.75% Discount Rate) | |
|---|---|
| **Item** | **Expected Annual Benefits and Costs** |
| Damage Category | |
| Structure, Contents, Vehicles, and Debris Removal | $109,066 |
| Total Benefits | $109,066 |
| | |
| Structural First Costs | $1,278,524 |
| Nonstructural First Costs* | $1,024,198 |
| Total First Costs | $2,302,722 |
| Interest During Construction | $78,887 |
| Annual Operation & Maintenance Costs | $439 |
| Total Annual Costs | $90,817 |
| *Not including acquisitions and related costs | |
| B/C Ratio | 1.20 |
| Expected Annual Net Benefits | $18,249 |

## 4.7 IDENTIFYING THE TSP

Per USACE Guidance, the tentatively selected plan for flood risk management projects should be the plan that maximizes net benefits which is also called the NED Plan. In order to determine which alternative is the NED Plan, the costs and benefits for the Focused Array of Alternatives were compared. The alternative with the greatest net benefits is the apparent NED Plan, and thus the TSP.

The TSP identified from the final array is the Dry Darlington Dam combined with nonstructural measures.

The Dry Darlington Dam is an earth embankment dam consisting of a clay core with a random fill outer layer. The constructed dam has a footprint of approximately 205 acres and a flood pool of approximately 12,600 acres, located north of the dam between St. Helena and East Feliciana Parishes. The outlet would consist of three 10x10 feet concrete box culverts with sluice gates that would be closed to prevent flow and allow for water to pool behind the dam prior to release. An emergency spillway would be placed at the flood control pool max elevation. Approximately 1,000 acres of suitable borrow material would be required for construction of the dam, consisting of approximately 10,710,000 cubic yards of random fill and 856,000 cubic yards of clay fill. The Dry Darlington Dam scale will be optimized during the feasibility study design. Final determination for abutment requirements, control tower, sedimentation basin, diversion channel dimensions, outlet channel dimensions to existing Amite River, and spillway location and size (currently evaluating different sizes in an effort of optimization) will need to be determined, along with the staging area(s) for construction. Access road paving and/or surfacing including the crest of the dam and shops needed to maintain the dam will also need to be determined. The evaluation of potential borrow sites and staging areas will also consider environmental impacts and will identify compensatory mitigation requirements for unavoidable impacts.

The nonstructural measures include physical and nonphysical elements. The nonphysical nonstructural measures are to reduce incremental risk with the Darlington Dam in place. An Emergency Action Plan and flood warning system, for the dam and downstream flows, will be established for future with project. Also, each parish impacted by the Darlington Dam will need to revise and/or develop their Floodplain Management Plans to include emergency response, preparedness and recovery actions necessary to manage existing and future risks. The Floodplain Management Plans are a responsibility of local governments.

As noted in Section 4.6.2, the physical nonstructural measures of the TSP may include acquisitions with relocation assistance to displaced persons, elevations of residential structures, and floodproofing of non-residential structures. The nonstructural plan will be refined by assessing the Darlington Dam as the new base condition for the hydrology, which will likely include structures in geographical regions that are not getting direct benefits from the Darlington Dam such as the Lower Reach of the ARB.

# Section 5
# Evaluate Alternative Plans

## 5.1 ENVIRONMENTAL CONSEQUENCES

In accordance with NEPA, this chapter includes the scientific and analytic basis for comparison of the considered alternatives identified in Section 4 – Formulate Alternative Plans. The discussion includes the environmental impacts of the considered alternatives, any adverse environmental effects which cannot be avoided, direct, indirect and cumulative effects of proposed actions, the relationship between short-term uses and long-term productivity, and any irreversible or irretrievable commitments of resources involved in the proposed actions should one be implemented.

This chapter assesses the project's potential environmental impact on those resources identified in Section 3, Inventory and Forecast Conditions.

## 5.2 CUMULATIVE EFFECTS ANALYSIS

The Council on Environmental Quality (CEQ) Regulations define cumulative impacts 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 other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR §1508.7).

Cumulative effects 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. The role of the analyst is to narrow the focus of the cumulative effects analysis to important issues of national, regional and local significance (CEQ, 1997).

The Council of Environmental Quality (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 effects analysis concentrates 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.

For a description of the geographic boundaries and timeframe of the cumulative impact analysis, refer to Appendix C-1, Section 5.2

## 5.3 SUMMARY OF ENVIRONMENTAL CONSEQUENCES BY EACH ALTERNATIVE

This chapter describes the environmental consequences associated with implementing the final array of alternatives, including the TSP of the Darlington Dam and Nonstructural measures. Impacts for borrow sources and staging areas for Alternatives 2, 3, and 5 are currently unknown,but will be considered in the final EIS.

This chapter compares the effects of the proposed alternatives:

- Alternative 1: No Action Alternative
- Alternative 2: 0.01 AEP Dry Dam along tributary: Sandy Creek Dry Dam
- Alternative 3: Large-Scale 0.04 AEP .04 (Darlington Dam)
- Alternative 4: Nonstructural: 0.04 AEP Floodplain (Nonstructural)
- TSP: Combined Darlington Dam and Nonstructural

### 5.3.1 Relevant Resources Affected

This section describes the direct, indirect, and cumulative effects of the No Action Alternative and the Proposed Action (TSP).

A wide selection of resources were initially considered and several were determined not to be affected by the project—mainly due to the remote and uninhabited nature of the project area and general lack of significant populated areas in the vicinity. Navigation, aquatic resources/fisheries, and essential fish habitat would not be affected by the proposed project. Table 5-1 provides a list of resources in the project area and anticipated impact(s) from implementation of the proposed action.

*Table 5-1. Relevant Resources Impacts in and near the Project Area*

| Relevant Resource | Negative Impact | Positive Impact | Not Impacted |
|---|---|---|---|
| Wetland Resources | Temporary and permanent for structural measure and No Action (structural) | | Nonstructural measure (nonstructural) |
| Upland Resources | Temporary and permanent for structural and No Action | | Nonstructural |
| Aquatic Resources/Fisheries | Temporary and permanent for structural | | No Action Alternative and nonstructural |
| Wildlife | Temporary for structural | Potential for structural | No Action Alternative and nonstructural |
| Threatened, Endangered, and Protected Species | Potential adverse for structural if present | | *With contractor guidance; not likely to adversely affect.<br>None for No Action Alternative |
| Geology, Soils, and Prime and Unique Farmland | Potential for Prime and Unique Farmland for structural (*soil borrow and placement) | | No Action Alternative and Nonstructural |
| Water Quality | | Potential for permanent | No Action Alternative and Nonstructural |
| Air Quality | Temporary for Structural | | None for No Action Alternative and Nonstructural |
| Cultural | Potential adverse for structural | | No Action Alternative and Nonstructural |
| Recreation | Temporary for structural | potential | No Action Alternative and Nonstructural |
| Aesthetics | Temporary for structural | potential for Nonstructural | No Action Alternative and Nonstructural |
| Socioeconomic Resources | | Potential for Nonstructural with Acquisitions | |
| Environmental Justice | Adverse Impact for No Action; Potential adverse disproportionate for structural and nonstructural measure (acquisition) | Permanent for reduced flood risk for structural and nonstructural measures | |
| HTRW | | | No Action Alternative; structural and nonstructural measures |

While there may be marginal effects to land-use from each of the alternatives, no major changes to land-use are expected from any of the projects being considered. For the structural alternatives, impacts will be further analyzed for the dam footprint, staging area, and borrow sites.

#### 5.3.1.1 Wetland Resources

A preliminary assessment of existing vegetation was completed on the entire final array of alternatives using existing USGS land classifications. Right of entry (ROE) was not available for all portions of the project sites at the time the impacts to the forested communities were estimated based on flood tolerances of tree species present. An assumption was made that all forested habitat was bottomland hardwoods, however a follow-up windshield survey was conducted that identified additional forested habitat types (See Section 5.3.1.2). Final site visits would refine the types of forested habitats impacted. Once ROE is obtained, site-specific WVAs would be run for the Dry Dams and Darlington Dam structural alternatives. As design proceeds, final WVAs would be completed on these alternatives to determine the most probable impacts to the habitat value.

During preliminary WVA's, impacts to forested habitat were estimated to be approximately 1,300 average annual habitat units (AAHUs) for the Darlington Dry Dam using data from projects with similar existing conditions. Figure 5-1 shows the National Wetlands Inventory dataset within the Darlington conservation pool.

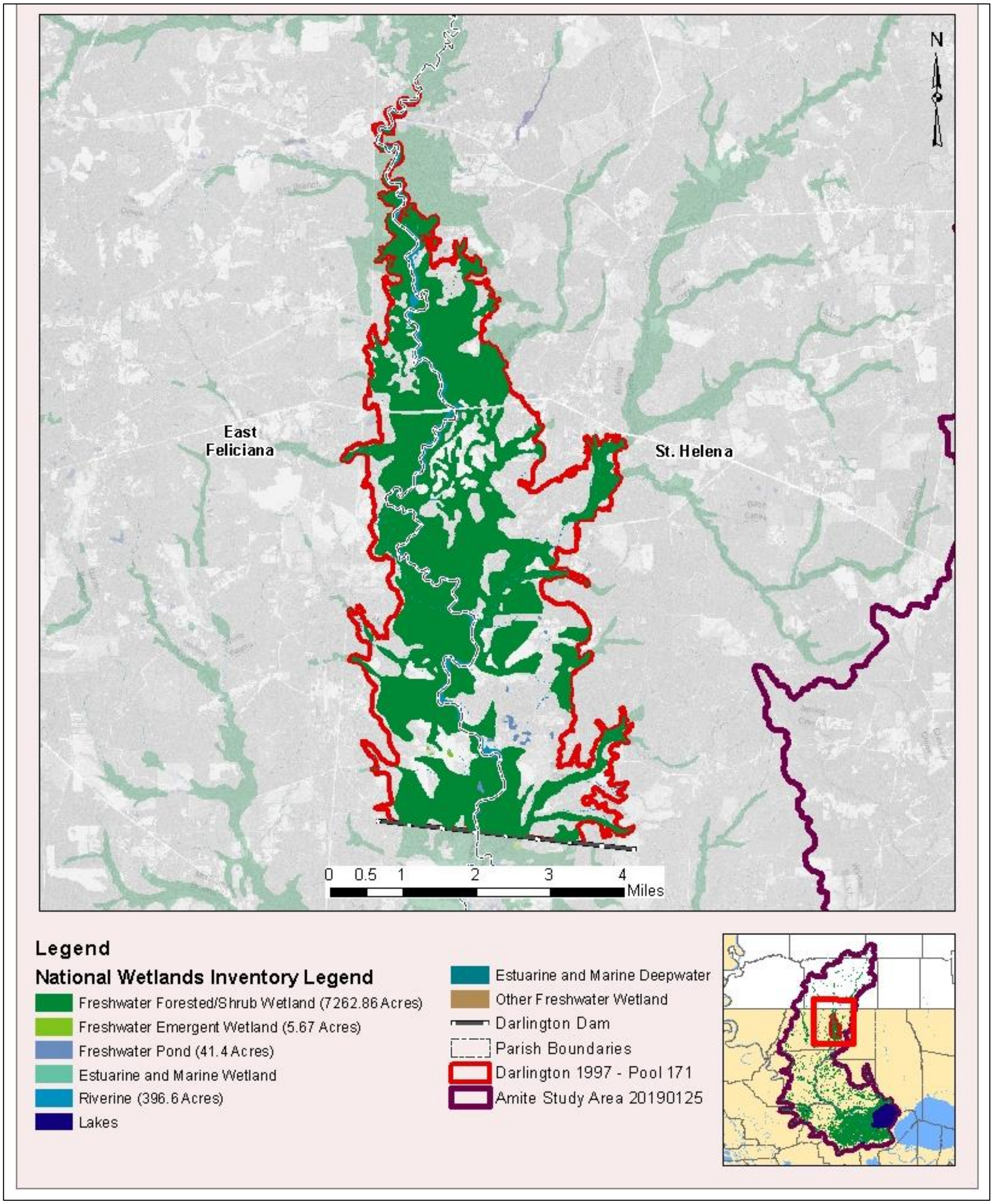


*Figure 5-1. Wetland Impacts in the Darlington Dry Dam Conservation Pool*
Source: FWS National Wetlands Inventory, https://www.fws.gov/wetlands/

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: Without implementation of the proposed action, wetland resources would not be impacted from construction of a dry dam and associated features. Forested wetlands in the project area would continue to be directly and indirectly impacted by the present natural and anthropogenic factors (e.g. commercial development, sand and gravel mining). Erosional forces from major flood events would continue to permanently adversely impact these communities in the Lower ARB, while the Upper ARB would continue to experience less of an impact. Loss of small stream forest and to the Upper ARB from sand and gravel operations would continue.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: The Sandy Creek Dry Dam would be constructed in a manner that allows for drainage following flood events. Complete mortality of flood-sensitive species within those forests is not anticipated as the dry reservoirs would be constructed and operated in a manner that allows them to thoroughly drain following flood events. Some mortality could result with a transition to the more flood-tolerant species over time. Based on the 1997 mitigation estimate for dry reservoirs, approximately half to one-third of the species would experience mortality. USACE would mitigate for impacts to forested habitat and avoid impacts to natural forested habitat within borrow areas, to the extent practicable.

*Alternative 3: 0.04 AEP Large-Scale Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: The Darlington Dam would be constructed in a manner that allows for drainage following flood events. Complete mortality of flood-sensitive species within those forests is not anticipated as the dry reservoirs would be constructed and operated in a manner that allows them to thoroughly drain following flood events. Some mortality could result with a transition to the more flood-tolerant species over time. Based on the 1997 mitigation estimate for dry reservoirs, approximately half to one-third of the species would experience mortality. USACE would mitigate for impacts to forested habitat and avoid impacts to natural forested habitat within borrow areas, to the extent practicable.

Cumulative impacts to this resource would be the additive combination of impacts by this and other Federal, state, local, and private flood risk reduction efforts, including, but not limited to the Comite River Diversion and the East Baton Rouge Flood Control Project.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Implementation of Alternative 4 would have no impact to aquatic species within the ARB.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.2 Upland Resources

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: Without implementation of the proposed action, vegetative resources would not be impacted from construction of a dry dam and associated features. Forested wetlands in the project area would continue to be directly and indirectly impacted by the present natural and anthropogenic factors (e.g. commercial development, sand and gravel mining). Erosional forces from major flood events would continue to permanently adversely impact these communities in the Lower ARB, while the Upper ARB would continue to experience less an impact. Loss of small stream forest and to the Upper ARB from sand and gravel operations would continue.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: The Sandy Creek Dry Dam would be constructed in a manner that allows for drainage following flood events. Complete mortality of flood-sensitive species within those forests is not anticipated as the dry reservoirs would be constructed and operated in a manner that allows them to thoroughly drain following flood events. Some mortality could result with a transition to the more flood-tolerant species over time. Based on the 1997 mitigation estimate for dry reservoirs, approximately half to one-third of the species would experience mortality. USACE would mitigate for impacts to forested habitat and avoid impacts to natural forested habitat within borrow areas, to the extent practicable.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: The Darlington Dam would be constructed in a manner that allows for drainage following flood events. Complete mortality of flood-sensitive species within those forests is not anticipated as the dry reservoirs would be constructed and operated in a manner that allows them to thoroughly drain following flood events. Some mortality could result with a transition to the more flood-tolerant species over time. Based on the 1997 mitigation estimate for dry reservoirs, approximately half to one-third of the species would experience mortality. USACE would mitigate for impacts to forested habitat and avoid impacts to natural forested habitat within borrow areas

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Elevating homes would not directly impact vegetationin any surrounding areas, although the shading could potentially result in shifting plant communities. In cases where a home or land acquisition may take place, this could indirectly impact visual resources by removing a viewer from a given area. In areas where there is public access from a street or roadway, these nonstructural elements would not change the view shed. Houses being raised are currently present, their elevation would change, but the site is still occupied either way. In the case of a home acquisition, if a home is removed and open land is created, this could be considered as a benefit to drivers looking for natural scenery or a loss to an established neighborhood.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.3 Aquatic Resources and Fisheries

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: Without implementation of the proposed action, aquatic resources and fisheries in the project area would continue to be directly and indirectly impacted by the present natural and anthropogenic factors (e.g. commercial development, sand and gravel mining).

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: Implementation of Alternative 2 would be similar to Alternative 3 although lesser in impact.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: Implementation of Alternative 3 would have potentially adverse direct impacts to migration and spawning aquatic species from dam structure. Any aquatic species downstream of the dry dam could potentially by indirectly affected by having limited access to the upstream portion of Sandy Creek.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Implementation of Alternative 4 would have no impact to aquatic species within the ARB.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.4 Wildlife

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: Without implementation of the Proposed Action (TSP), habitat loss would likely continue at the present rate resulting in a reduction of habitat diversity and availability for resident terrestrial wildlife (See Appendix C-1).

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: Habitat loss impacts breeding habitat, nesting, and forage for wildlife species (See Appendix C-1). Impacts from this alternative would be similar to the TSP, except there would be a lesser loss of wildlife habitat.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: Implementation of the TSP would directly result in the loss of forested habitat for wildlife species, with the potential for species mortality and displacement of non-mobile species present during construction. The common inhabitants of this area are bird species that are fully equipped to relocate to nearby freshwater emergent marsh. It is anticipated that displaced wildlife would return to similar habitat in the study area once construction is complete. Migration of terrestrial wildlife would also be restricted by the dry dam and the spillways would also impede movement of partially aquatic wildlife species that navigate in the Upper Amite River (e.g. otters, nutria, amphibians, and alligators.) Traffic from proposed access roads would also directly impact wildlife species that are present during construction activities, resulting in further mortality and displacement.

Any disturbance-tolerant wildlife species outside the project may indirectly benefit from having the converted upland habitat of the dam as additional territory for foraging and mating opportunities.

Cumulatively, this project would prevent an overall loss in the ARBBarataria of habitat necessary for many wildlife species. This project, when added to other past, present, and reasonably foreseeable future ecosystem restoration and mitigation projects in the basin, would help reduce the loss of wetlands and overall decline of wildlife species within the basin and would be beneficial to preserving species biodiversity.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Elevating structures in the floodplain could potentially provide shelter to wildlife species from predators; however, given the limited number of structures elevated, this impact would be low to neglible in extent.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.5 Threatened, Endangered, and Protected Species

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: With the No Action alternative, no direct impacts to endangered species or their critical habitat would occur. Existing conditions would persist and listed threatened, endangered, or protected species would likely continue to be subject to institutional recognition and further regulations and federal management. Other listed species could also be adversely impacted by the continued habitat loss and degradation including the inflated heelsplitter mussel.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: This alternative would have impacts similar in impacts to Alternative 3, but lesser in extent.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: Although threatened or endangered species may occur within the study area, most of their presence within the project area is highly unlikely. The project area does not contain critical habitat for federally-listed species, and the forested areas surrounding the project area would allow them to easily avoid the project activities. Therefore, the proposed action is unlikely to cause adverse direct or indirect impacts to (i.e., not likely to adversely affect) most federally-listed threatened or endangered species, or their critical habitat, under the jurisdiction of FWS, except for the Alabama Heelsplitter Mussel. Additionally, CEMVN has concluded that no critical habitat for any threatened, endangered, or candidate species under the purview of FWS has been designated within the project area, and that there would be no adverse impacts (i.e., not likely to adversely affect, NLAA) to any of the state-listed species that could potentially occur within the project area.

With coordination from FWS and NMFS, it was found that both the Atlantic sturgeon is not in the project area. The NLAA determination for the West Indian manatee includes Standard Manatee Conditions for In-Water Activities (see Section 8).

*Table 5-1. Threatened (T), Endangered (E), & Protected (P) Species in Study Area*

| Scientific name | Common name and status (T, E, or P) | Listing | Found in Study Area | Found in Project Area | Determination of Effects |
|---|---|---|---|---|---|
| *Potamilus inflatus* | Alabama Heelsplitter Mussel (T) | Federal | Yes | Yes | May effect |
| *Acipenser oxyrhynchus desotoi* | Atlantic Sturgeon (T) | Federal | Yes | No | NLAA |
| *Trichechus manatus* | West Indian Manatee (TT) | Federal | Yes | No | NLAA |
| *Haliaeetus leucocephalus* | Bald Eagle (P) | State | Yes | Yes | NLAA |

West Indian manatees and Atlantic Sturgeon are not present in the project area and would not be impacted by the dry dam. Bald eagles could potentially be adversely impacted by loss of nesting habitat. During nesting season, construction must take place outside of FWS/LDWF buffer zones. A USACE Biologist and a FWS Biologist would survey for nesting birds. This would be done prior to the start of construction.

*Alternative 4: Nonstructural*

<u>Direct, Indirect, and Cumulative Impacts</u>: This alternative would not result in impacts to threatened, endangered, and protected species.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.6 Geology, Soils and Water Bottoms, and Prime Farmland

**<u>Impacts of Considered Alternatives</u>**

*Alternative 1: No Action Alternative*

<u>Direct, Indirect, and Cumulative Impacts</u>: This alternative would not have an effect on prime farmland. Soil and water bottoms could continue to experience both anthropogenic and natural impacts within the ARB, including the sand and gravel operations and erosional forces that alter the river channel.

Cumulatively, the soils and water bottoms would continue to experience periodic shifts during rainfall events.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: This alternative would have the same impacts as Alternative 3, but to a lesser extent. There are potential impacts to prime farmland in Louisiana from obtaining borrow material.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: This alternative would affect prime farmland. Soils and prime farmland would be directly adversely impacted by this alternative in areas for obtaining borrow fill material for the dam as well as the constructed dam and reservoir. Soils within the reservoir footprint and other associated features would also be lost.

The borrow source lands will be acquired by the NFS.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Structures elevated or purchased in the floodplain could contain but not affect prime farmland, soils, or water bottoms.

*TSP: Combined Darlington Dam and Nonstructural*

When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.7 Water Quality

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: Without implementation of the Proposed Action, no direct impacts to water quality would occur. Indirect impacts as a result of not implementing the proposed action would be the continued degradation of water quality as the area continues to erode as a result of flood events and human development in the ARB.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: This alternative would be similar in impacts to Alternative 3, but would influence a smaller extent of the ARB.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts:

The Darlington Dry Dam extends between St. Helena and East Feliciana Parishes. It would be built to a 201 feet (NVGD) design elevation. The USACE would apply for a Water Quality Certification (WQC) from LDEQ to determine whether the construction of these proposed features will impact established site specific water quality standards. The construction contractor would be required to comply with any applicable conditions and requirements included as part of the issued WQC. The construction contractor would be required to comply with any special conditions pertaining to protection of water quality contained in LDNR's final determination for the proposed project. Additionally, to help avoid and minimize the proposed project's impacts to water quality, the construction contractor would be required to prepare a Stormwater Pollution Prevention Plan (SWPPP) for review and approval by the USACE. The construction contractor would then be required to apply for and obtain a Stormwater General Permit (i.e., Louisiana Pollutant Discharge Elimination System General Permit) from the LDEQ. The construction contractor would further be required to comply with all applicable conditions and requirements set forth in the issued permit. The required permits and actions above are designed to lessen construction impacts on receiving waterbodies.

Because LDEQ has currently classified the receiving waterbodies (i.e., LDEQ subsegments) as "not supporting designated use" for some of its use categories (see Water Quality Section 1.2.7), which indicates that water quality is currently not meeting applicable water quality standards, the temporary direct effects to water quality from the proposed construction activity would be expected to adversely affect the existing conditions.

There are no permanent cumulative effects to water quality anticipated by implementing the TSP when added to other past, present, and reasonably foreseeable future ecosystem restoration and mitigation projects in the basin. As discussed previously, there would be construction-related water quality degradation that would have a temporary cumulative effect.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: This alternative would not directly impact water quality. When combined with other past, present, and reasonably foreseeable future projects in the ARB, this alternative would not impact water quality.

*TSP: Combined Darlington Dam and Nonstructural*

Direct, Indirect, and Cumulative impacts: When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.8 Air Quality

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: East Feliciana and St. Helena are currently in attainment for all Federal NAAQS pollutants. In the future, without the implementation of the Proposed Action, it is likely that the quality of ambient air would not be adversely affected.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: Construction of this alternative would have impacts similar to Alternative 3, but lesser in extent.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: During construction of this project, an increase in air emissions could be expected. These emissions could include exhaust emissions from operations of various types of ground-moving construction equipment such as bulldozers. Fugitive dust emissions are not anticipated during construction.

Any site-specific construction effects to air quality would be temporary, and air quality would return to pre-construction conditions shortly after the completion of construction activities. Because the project area is in a parish in attainment of NAAQS, a conformity analysis is not required.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative impacts: Construction of this alternative would have no impact on air quality.

*TSP: Combined Darlington Dam and Nonstructural*

Direct, Indirect, and Cumulative impacts: When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.9 Noise and Vibration

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: The No Action Alternative would not have any impact on Noise and Vibration.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: This alternative would have impacts similar to Alternative 3, but lesser in extent.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: No rock outcrops are anticipated with construction of the Darlington Dam. Construction activities would consist of heavy compaction equipment associated with compaction activities during dam construction and would include pile drivers and vibratory steel-wheel rollers (EM 1110-2-1911 on compaction equipment). Overall noise and vibration impacts are anticipated to remain low to moderate during construction and within the staging area, as it may temporarily disturb wildlife and residences, but be less than significant. Some noise and vibration impacts may be potentially reduced by the use of electricity for the construction equipment and the diversion structure.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: This alternative would not have an impact on noise and vibration.

*TSP: Combined Darlington Dam and Nonstructural*

Direct, Indirect, and Cumulative impacts: When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.9 Cultural, Historic, and Tribal Trust Resources

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative impacts: Impacts to cultural and historic resources within the study area have resulted from both natural processes (e.g., erosion) and human activities (e.g., land development, timber harvesting, gravel mining, agriculture, and vandalism). Riverine environments are dynamic, and impacts to cultural and historic resources in the area would continue at the current trend because of natural processes including anthropogenic modifications of the landscape as well as human alterations.

*Alternative 2: Dry Dam on Sandy Creek*

Direct, Indirect, and Cumulative impacts: The impacts to cultural resources for the considered action would be proportionally similar to the impacts described for Alternative 3.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Background: In 1984, a preliminary engineering study was completed on the behalf of LA DOTD for proposed flood-control measures within the ARB (Brown and Butler 1984). The selected plan utilized, as its principal flood-control measure, a single dam and reservoir in approximately the same location as the presently considered action (Alternative 3). As part of the 1984 study, Espey, Huston & Associates, Inc. (EH&A 1989) conducted a Cultural Resource Assessment and sample Cultural Resources Survey of lands within the proposed Darlington damD site and reservoir. The former study area encompassed approximately 21,500 acres of land, of which about 1,400 acres of the proposed reservoir area were subjected to pedestrian survey focused towards re-locating previously recorded resources. A sample area of approximately 70-percent (350 acres) of the 500-acre area that the proposed dam site encompassed was also subjected to an Intensive Cultural Resources Survey (i.e., comparable to LA Division of Archaeology Phase I standards: https://www.crt.state.la.us/cultural-development/archaeology/CRM/section-106/field-standards/phase-i-surveys/indexhttps://www.crt.state.la.us/cultural-development/archaeology/CRM/section-106/field-standards/phase-i-surveys/index). As a result of the aforementioned investigations, a total of 30 archaeological sites were identified within the proposed footprint of the dam. The resources identified within the 350-acre sample area are primarily attributed to the Pre-contact period (e.g., mounds and artifact concentrations). The reservoir footprint (flood pool) also included other types of Pre-contact and historic sites (e.g., extraction locales, cemeteries, farmsteads, residences, other standing structures). Based upon the available information, EH&A (1989) concluded that “at least 365 cultural resource sites are projected to occur within the flood pool and dam site.”

Direct Impacts: This alternative includes ground disturbing activities involving access, staging, demolition, construction of structural features (i.e., dam, spillways, and an on-site batch plant); borrow fill, habitat mitigation, and other required ancillary areas; and, relocation and hardening of infrastructure and/or other direct effects to above-ground historic properties (i.e., demolition). These activities may directly impact both known and undocumented cultural resources listed or eligible for the National Register of Historic Places (NRHP) not limited to: archeological sites; historic structures; cemeteries or other sites that may contain human remains, funerary objects, sacred objects, or objects of cultural patrimony; and Traditional Cultural Properties that exist both within the project footprint and associated areas in a way that will diminish the integrity of these property’s location, design, setting, materials, workmanship, feeling, or association.

Initial dam and reservoir construction will require the removal of above-ground or built-environment cultural resources (e.g., historic architecture). Thereafter, continued direct impacts to archaeological deposits within the reservoir footprint are anticipated as a result of storm water fluctuations. Because inundation removes vegetation, archaeological sites will become more susceptible to deflation resulting from the removal of the archeological soils; leaving heavier items and artifacts behind and altering their contextual relationship within the site. Water running over un-vegetated slopes also causes erosion. The movement of artifacts and site features within or away from an archaeological site decreases its scientific integrity and value because it becomes difficult to reconstruct the site's original features and artifact contexts. Archaeological deposits within the reservoir footprint would also be subjected to repeated cycles of wetting and drying, which causes deterioration of organic deposits (e.g., bone or wood) and other artifact types (e.g., ceramics and metal). Drawdown of flood waters can also cause slumping or landslides of slopes in or above the reservoir as water rapidly vacates the pores between soil particles, causing the soil to lose cohesion. Furthermore, the regular operation of spillways and release of floodwaters also has the potential to induce additional direct effects to cultural resources beyond the dam and reservoir footprint that may require avoidance and minimization measures.

Indirect Impacts

A review of Alternative 3 indicates that the considered action includes the introduction of new visual elements (i.e., flood control structures and infrastructure) to the project area’s viewshed that have the potential to indirectly impact known and previously undocumented cultural resources that may be listed or eligible for the NRHP by introducing an element that is inconsistent with its historic or cultural character in a way that may diminish the visual integrity of the property’s setting, feeling, or association and/or cause changes to the integrity of feeling or character associated with a historic or Traditional Cultural Property (TCP). For example, an increase in nearby recreational uses might adversely affect a TCP (e.g., Native American ritual site) by increasing sights and sounds incompatible with ritual use.

Furthermore, changes in land use within the project area as a result of the creation of the dry reservoir area (e.g., conversion of private to public land) may have additional indirect adverse impacts to archaeological resources. For instance, the recreational attractiveness of the reservoir is likely to lead to an increased number of visitors. The loss of protective vegetation and deflation of archeological sites in the flood pool make them more visible to the public. When more people are present and archeological sites are more visible there is a greater likelihood of vandalism and artifact theft. Archeological sites in the de-vegetated zone are also more susceptible to disturbance, artifact displacement, and erosion from increased pedestrian, vehicle, or livestock traffic. Because of the large size of the reservoir area, it is not possible to patrol all known sites to prevent vandalism and theft. Cumulative impact analysis of operational effects must therefore also consider land management actions. Conversely, positive impacts may include increased public accessibility and interpretation value of archaeological sites.

<u>Cumulative Impacts</u>

A review of Alternative 3 indicates that the Cumulative impacts to cultural resources would be the additive combination of impacts by this and other federal, state, local, and private flood risk reduction efforts including authorized USACE construction projects adjacent to the study area (i.e., Comite River Diversion (CRD) and the East Baton Rouge (EBR) flood control projects) and other projects that will alter the hydrology of the ARB (see: Section 1.5).

A reduction in the frequency of downstream flooding from Alternative 3 in conjunction with the CRD, EBR, and other flood control projects may have a long-term positive net impact to cultural resources within the ARB and surrounding communities; potentially including resources and districts at all levels of significance (Table C1-17, Historic Properties within the Study Area). Conversely, potential negative cumulative impacts may include incremental damage to, or destruction of, archaeological resources significant at the state, local, and national level that may be listed or eligible for the NRHP and/or of significance to Tribes. Incremental effects would result from repeated water table fluctuations within the reservoir as well as from releases during major flood events in conjunction with discharge from other flood control projects adjacent to the study area (CRD and EBR). Rapid fluctuations in water levels can cause river bank slumping in downstream river reaches that destroys cultural resources in an accelerated manner. When combined with the erosion of cultural resources at the reservoir itself, the cumulative effect is significantly adverse, placing a relatively high percentage of the ARB’s cultural resources in jeopardy. The overall effect would be the destruction of a large percentage of the cultural sites and scientific resources from the river basin.

**<u>Alternative 4: Nonstructural</u>**

<u>Direct Impacts</u>

A review of Alternative 4 indicates that the proposed action includes the introduction of new visual elements and/or modifications to built-environment resources (i.e., elevation, flood proofing, or acquisition (demolition)) that may directly affect known and undocumented above-ground historic properties (e.g., standing structures and historic districts; see: Table C1-2), in a manner that may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association and ground disturbing activities (e.g., access, staging, foundation work, utility relocations and hardening, demolition) within the project footprint that may directly affect known and undocumented archeological resources in a manner that may diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Indirect Impacts

A review of Alternative 4 indicates that the considered action includes elevation, flood proofing, and acquisition (demolition) measures that may indirectly result in the potential successive introduction of new visual elements and/or modifications to the viewshed and overall visual landscape of known and previously undocumented cultural resources that may be listed or eligible for the NRHP, potentially including historic structures, National Register Historic Districts (NRHD), National Historic Landmarks (NHL), other built-environment resources (Table C1-2), and/or TCPs by introducing elements that are inconsistent with the historic or cultural character of these resources in a way that may diminish the visual integrity of the property's setting, feeling, or association and/or cause changes to the integrity of feeling or character associated with a historic or TCP.

Cumulative Impacts

A review of Alternative 4 indicates that that the cumulative impacts to cultural resources would be the additive combination of impacts by this and other federal, state, local, and private flood risk nonstructural efforts including authorized USACE construction projects adjacent to the study area (see: Section 1.5). In addition to those direct and indirect impacts described above, successive additions and/or modifications to the visual landscape may result in cumulative adverse effects to cultural resources (Table C1-17) by introducing elements that are inconsistent with their historic or cultural character. In conjunction with similar repetitive impacts from other large-scale nonstructural projects in the region (e.g., Table 1-1c), this could lead to the loss of connection to place; causing a net loss of cultural diversity within the ARB and its surrounding communities.

*TSP: Combined Darlington Dam and Nonstructural*

Direct Impacts

Direct impacts for Alternative 5 would be the combination of those direct impacts described in Alternatives 3 and 4.

Indirect Impacts

Indirect impacts for Alternative 5 would be the combination of those indirect impacts described in Alternatives 3 and 4.

Cumulative Impacts

A review of Alternative 5 indicates that the cumulative impacts to cultural resources for the proposed alternative would be the additive combination of impacts of Alternatives 3 and 4 and other federal, state, local, and private flood risk reduction efforts including authorized USACE construction projects adjacent to the study area (i.e., CRD and EBR flood control projects) and other projects that will alter the hydrology of the ARB (see: Section 1.5). Activities associated with these projects have the potential to cumulatively impact existing and previously undocumented cultural resources within the project footprints, surrounding viewsheds, and communities they occur in. However, no determination of effect under the NHPA has been made at this time.

Potential negative cumulative impacts may include direct damage to, or destruction of, archaeological and built-environment resources, as well as the potential successive introduction of new visual elements and/or modifications to the viewshed and overall visual landscape of known and previously undocumented cultural resources significant at the state, local, and national level and/or of significance to Tribes that may be listed or eligible for the NRHP; including archaeological sites, historic structures, NRHDs, NHLs, other built-environment resources (Table C1-2) and/or TCPs. Conversely, in conjunction with the CRD and EBR flood control projects, a reduction in the frequency of downstream flooding may have long-term positive net impacts to cultural resources within the ARB and surrounding communities; potentially including resources at all levels of significance (Table C1-2). Furthermore, CEMVN acknowledges that non-structural elevation and/or flood-proofing measures may result in modifications to historic buildings or other built-environment resources potentially not meeting the Secretary of the Interior's Standards (48 FR 44716-42, September 29, 1983). However, the overarching goal of this effort is to reduce risk from future flood events while still preserving the physical integrity and historic character of built-environment resources in relation to other resources within a historic district, thus; protecting the architectural qualities of historic districts as a whole. Therefore, the proposed action may also have positive cumulative impacts towards preserving at-risk unique architectural and design characteristics that many of Louisiana communities and historic districts strive to maintain and enhance. Otherwise, damage to, or widespread loss of, cultural resources within the present study area in conjunction with similar repetitive impacts from other large-scale flood risk and coastal storm surge risk reduction projects in the region could lead to the loss of connection to place; causing a net loss of cultural diversity within the ARB and its surrounding communities. This is important because the cultural resources along many portions of the basin are understudied and/or not duplicated or replaced at other locations. Because most cultural resources are nonrenewable this would constitute a significant cumulative impact.

CEMVN would follow its Section 106 procedures, described in Appendix C-1 (Section 3 NHPA and Tribal Coordination) if the proposed action is carried forward to develop a Programmatic Agreement (PA), in consultation with the NFS, LA SHPO, Advisory Council on Historic Preservation (ACHP), federally-recognized Tribes, and other interested parties, that outlines the steps required to identify and evaluate cultural resources and make determinations of effects. If direct, indirect, and/or cumulative adverse effects to cultural resources are identified and cannot be avoided or minimized, such effects would be mitigated through the procedures outlined in the PA. The PA would then govern the

CEMVN's subsequent NHPA compliance efforts and any additional conditions or requirements will be documented at that time.

#### 5.3.1.10 Aesthetics

*Alternative 1: No Action Alternative*

Direct and Indirect Impacts: The harmonious natural landscape combination of rivers and creeks slowly meandering southward is contrasted by unnaturally straight roadways and spoil banks, cutting through the mosaic of forest, pine plantations, pasture, and cropland. Visual resources would continue to evolve from existing conditions as a result of both land use trends and natural processes over the course of time. Waterways would continue to swell to capacity and overflow into nearby areas seasonally. Communities near these waterways would continue to experience high water events seasonally due to stormwater inputs from development adding to, and at times exceeding, the pre-development capacity.

Cumulative Impacts: Cumulative impacts to visual resources would be the additive combination of impacts by this and other Federal, state, local, and private flood risk reduction efforts, including but not limited to the Comite River Diversion and the East Baton Rouge Flood Control Project.

*Alternative 2: Sandy Creek Dry Dam*

Direct Impacts: The Dry Dam on Sandy Creek Alternative consists of an earthen dam on Sandy Creek. Impacts to aesthetics would be minimal as the site is remote and public access is limited. The earthen dam would not directly impact any visual resources such as unique geological, botanical, and cultural features, such as parks, museums, refuges, etc. The earthen dam will be in proximity to and parallel with the existing clear cut utility corridor which may be visible from nearby Louisiana Highway 409 and Parish Road 5-104 / Percy Dreher. The earthen dam could create an elevated vantage point of the surrounding landscape offering a new and unique view shed.

Indirect Impacts: Indirect impacts to visual resources would be similar to those listed for the dry dam on Darlington, but to a lesser degree.

Cumulative Impacts: Cumulative impacts to visual resources would be the additive combination of impacts by this and other Federal, state, local, and private flood risk reduction efforts, including, but not limited to the Comite River Diversion and the East Baton Rouge Flood Control Project.

*Alternative 3: Large Scale 0.04 AEP Dam (Darlington Dam)*

Direct Impacts: The large scale 0.04 AEP Darlington Dam Alternative consists of an earthen dam on the Amite River. This earthen dam would directly impact visual resources with regard to the Louisiana Scenic Rivers Act and the Amite River from the Mississippi River/Louisiana state line to the Louisiana Highway 37 crossing. "The general purpose of the Louisiana Scenic Rivers Act as it applies to the Amite River is to protect this section of river from channel modifications, protect water quality and habitats, and preserve recreational and scenic aspects of this river. Many of the Amite River reaches upstream and downstream of Grangeville have experienced significant mining activity and are neither natural nor scenic." (Hood, Patrick, Corcoran, Fluvial Instability and Channel Degradation of Amite River and its Tributaries, Southwest Mississippi and Southeast Louisiana, ERDC/GSL TR-07-26, Page 12, September 2007) The Amite River would have an earthen dam crossing perpendicular to the river's southward-flow.

The earthen dam would be visible from the Amite River channel at the site itself and the man-made structure may be obtrusive. The earthen dam may be visible from nearby Louisiana Highway 448 and Parish Highway 960. The earthen dam could create an elevated vantage point of the surrounding landscape offering a new and unique view shed.

Indirect Impacts: During construction, visual resources could be temporarily impacted by construction activities related to implementing the earthen dam and by transport activities needed to move equipment and materials to and from the site. However, this temporary impact would most likely affect visual resources only from the immediate roadways.

Cumulative Impacts: Cumulative impacts to visual resources would be similar to those listed for the dry dam on Sandy Creek.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: Elevating and floodproofing homes would not impact view sheds into any surrounding areas. In cases where a home or land acquisition may take place, this could indirectly impact visual resources by removing a viewer from a given area. In areas where there is public access from a street or roadway, these nonstructural elements would not change the view shed. Houses being raised are currently present, their elevation would change, but the site is still occupied either way. In the case of a home acquisition, if a home is removed and open land is created, this could be considered a benefit to drivers looking for natural scenery or a loss to an established neighborhood**.**

*TSP: Combined Darlington Dam and Nonstructural*

Direct Impacts: The impacts to this resource would be the same as Alternative 3's impacts.

The nonstructural component of the TSP may include acquisition and relocation assistance to displaced persons, elevation and floodproofing. Such actions would not directly impact view sheds into any surrounding areas. In areas where there is public access from a street or roadway, these nonstructural elements would not change the view shed. Houses being raised are currently present, their elevation would change, but the site is still occupied either way.

Indirect Impacts: Indirect impacts to visual resources for the 0.04 AEP Darlington Dam component of the TSP would be similar to those listed for the dry dam on Sandy Creek. These temporary impacts would most likely affect visual resources from the Amite River channel and the immediate roadways.

The nonstructural component of the TSP, where a home or land acquisition may take place, could indirectly impact visual resources by removing a viewer from a given area. In the case of a home acquisition, if a home is removed and open land is created, this could be considered a benefit to drivers looking for natural scenery or a loss to an established neighborhood**.**

Cumulative Impacts: Cumulative impacts to visual resources of the TSP would be similar to those listed for the dry dam on Sandy Creek.

#### 5.3.1.11 Recreation

*Alternative 1: No Action (Future without project)*

Direct, Indirect, and Cumulative Impacts: Without intervention, communities within the study area would continue to be at risk from high water events induced by stormwater inputs. Recreational resources would continue to be influenced by existing conditions as a result of both land use trends and natural processes over the course of time.

*Alternative 2: Dry Dam on Sandy Creek*

Direct Impacts: The Dry Dam on Sandy Creek alternative consists of an earthen dam on Sandy Creek which could have a direct impact to recreational resources. The earthen dam may be built in wildlife habitats and displace animals using the area. Consumptive recreational resources associated with hunting and fishing in these habitats may be directly impacted. Productivity to habitat upstream and downstream of the earthen dam could temporarily impact recreational resources. Sandy Creek, north of the earthen dam, may swell on a more frequent basis and in a controlled setting for temporary periods of time. Sandy Creek south of the earthen dam may be cut off from its northern water supply and swell on a less frequent basis for temporary periods of time, all of which could decrease activities such as trapping and wildlife seeing.

Indirect Impacts: During construction, there could be short-term, indirect impacts to recreational resources along the immediate earthen dam. Mobile species associated with hunting and fishing may attempt to move from the area of influence. Non-consumptive recreation resources relating to sports and leisure could be impacted by noise and/or dust associated with construction activity. Traffic associated with construction may indirectly impact recreation near access roads.

Cumulative Impacts: Cumulative impacts to recreational resources would be the additive combination of impacts by this and other Federal, state, local, and private flood risk reduction efforts.

*Alternative 3: Large Scale .04 AEP Dam (Darlington Dam)*

Direct, Indirect, and Cumulative Impacts: The large scale 0.04 AEP Darlington Dam alternative consists of an earthen dam on the Amite River. This earthen dam would directly impact recreational resources with regard to the Louisiana Scenic Rivers Act and the Amite

River from the Mississippi River/Louisiana state line to the Louisiana Highway 37 crossing. Impacts to recreational resources will be similar to those for the Dry Dam on Sandy Creek, but on a larger scale.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: The nonstructural features could have no impact to recreational resources, depending on the methods used.

*TSP: Combined Darlington Dam and Nonstructural*

Direct, Indirect, and Cumulative Impacts: When combining the Darlington Dam and nonstructural measures, there would be no additional impacts to this resource.

#### 5.3.1.12 Environmental Justice

**Impacts of Considered Alternatives**

*Alternative 1: No Action Alternative*

Direct, Indirect, and Cumulative Impacts: The No Action Alternative would not provide flood risk reduction to the residents living within the study area. There would be no direct impact on minority and/or low-income population groups under this alternative. However, because this alternative fails to provide flood risk reduction, the actual and perceived risks to minority and/or low-income population groups under this alternative would be higher than under the 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 flood protection.

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 flood risks as well as continued financial and emotional strain placed on these groups as they prepare for and recover from flood events. Other Federal, state, local, and private flood risk reduction efforts, including but not limited to the Comite River Diversion and the East Baton Rouge Flood Control Project, would also influence these populations.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: The direct, indirect and cumulative impacts to EJ resources in the Sandy Creek Dam area would be similar to the impacts described for the Darlington Dam project, but to a much lesser extent because fewer homeowners would be displaced. Additionally, an EJ community is identified by the low-income criteria, with 21 percent of households having incomes below poverty.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dam)*

Direct Impacts: There is the potential for high, adverse, disproportionate, direct impacts to EJ communities from construction of the Darlington Dam. All structures within the footprint of the proposed dam would be acquired, with relocation assistance provided to displaced persons per the Uniform Relocation Assistance Act (URA). According to the U.S. Census Bureau data, housing considered for the acquisition plan is located in census block groups that have a majority (73 percent) of population identifying as minority. For more information on the Demographic Indicators, refer to Appendix C, Table C1-20. Additionally, 23 percent of the households in the census block groups that comprise the dam have incomes below the poverty level (Table C1-21). Both the minority and low-income criteria used to identify EJ communities are met. Housing located within the proposed footprint and within the FEMA floodway would be purchased and thus removed from the floodplain and homeowners would receive market value for the acquired property and relocation assistance as per the Uniform Relocation Assistance Act (URA). For more information on URA, see the Real Estate Section 6.2.1.

The high, adverse impact of relocation is potentially disproportionate to minority or low-income homeowners if they comprise a vast majority of homes being purchased. According to Census data, it is likely that the vast majority of housing within the dam footprint is minority-owned. The community would likely relocate to housing in an area outside of a floodplain. A disproportionately high and adverse effect means 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 considering offsetting benefits.

Mitigation of the high, adverse and potentially disproportionate EJ impact of relocation includes the provision of market value for the acquired property and relocation assistance, as per URA. Market value is the price paid for a house if sold today, often based upon comparable sales and appraisals. If necessary, additional EJ details would be provided in future NEPA documents including:

- Outreach and public involvement details
- Details of acquisition alternatives
- Relocation assistance

Indirect impacts: Indirect impacts include a decrease in risk of damage from 0.04, 0.02 and 0.01 AEP storm events for minority and/or low-income populations in the study area. Population groups residing or working near the construction site itself may experience minor, adverse indirect impacts due to the added traffic congestion and construction noise and dust. The environmental indicator, “Traffic Proximity and Volume”, Appendix C, shows the area to be at the 13$^{th}$ percentile in the state, which indicates 87 percent of the state has higher traffic volume and is not, compared to the state, an existing environmental risk (Table C1-22). Truck traffic and noise along roads, highways and streets during project construction would cease following completion of construction activities. There may also be a degradation of the transportation infrastructure, primarily local roads and highways, as a result of the wear and tear from transporting construction materials. Indirect impacts related to construction activities are expected to be short-term and minor. Best management practices will be utilized to avoid, reduce, and contain temporary impacts to human health and safety.

Cumulative Impacts: Positive cumulative impacts to minority and/or low-income populations, including lower flood risk, are expected to occur as a result of the Amite, East Baton Rouge and Comite River projects. If these projects and other federal, state and local projects encourage regional economic growth, any additional jobs created may benefit minority and/or low-income groups living within the study/proposed project area.

Adverse cumulative impacts to EJ communities occur when impacted communities are relocated, having to find comparable housing, which may or may not be available in a desired location outside of the floodplain.

Short-term cumulative impacts associated with construction of various flood risk reduction measures will cause inconveniences to those residents in the vicinity of construction activities.

*Alternative 4: Nonstructural*

Direct Impacts: The voluntary nonstructural plan involving structure elevation may directly impact EJ communities and these impacts are not disproportionate. All residents regardless of race and income will have the choice of elevation. Direct impacts include temporary disruption of use of homes during elevation. At this time, there are 4,291 structures within the 0.04 AEP floodplain and it is uncertain who may participate in the non-structural plan. All structures within the 0.04 AEP flood zone are located in economically justified reaches and would be flood-proofed, elevated, or acquired; therefore, all residents within the reaches, irrespective of race, ethnicity, or income, would be able to choose to participate in the plan.

The nonstructural measures may provide those choosing home elevation in this low density area of minority and low-income populations with hurricane and storm damage, risk reduction equivalent to structural measures, which are not economically justifiable due to the sparse populations scattered over a large area. Acquisition of property may potentially affect the economic base found within these communities by removing portions of the population that contribute to the local economy. This may contribute to changes in community cohesion and to potential collapse of the entire local community if there are large numbers of acquisitions. Despite existing base floor elevations differing among individual structures, elevations would provide the same level of risk reduction benefits per structure at year 2076 (end of the period of analysis). Homeowners would be responsible for costs associated with repairs to ensure a structurally-sound home prior to elevation and would be responsible for temporary relocation costs during elevation. All other costs of elevating structures, including the cost to elevate the structure, would not be borne by any single individual or the community; rather, these costs would be part of the proposed project costs.

Indirect Impacts: Indirect impacts to EJ resources will be similar to those described for the Darlington Dam alternative.

Cumulative Impacts: Positive cumulative impacts to minority and/or low-income populations associated with providing risk reduction are expected to occur as a result of the lower flood risk in the area under this alternative. Additionally, other federal, state and local flood risk reduction projects will provide positive cumulative impacts by reducing flood risk to low-income and minority communities. Housing within floodplains that are elevated will no longer be susceptible to 0.04 AEP and greater storm events. For those living in structures in the 0.04 AEP floodplain that choose not to elevate, flood risk from future storm events, 0.04 AEP and greater, will continue (unless new H&H modeling, which is still being determined, shows flooding is greatly reduced once a dam is built).

*TSP: Combined Darlington Dam and Nonstructural*

Direct Impacts: Direct impacts to EJ communities are expected to be similar to those described for the Darlington Dam Alternative and similar to but less than for the Nonstructural Alternative. EJ direct impacts include the potential acquisition of structures within the proposed dam footprint and the FEMA floodway and the potential for high, adverse disproportionate impacts and temporary inconveniences during elevation of residential structures in the 0.04 AEP floodplain. However, the number of structures affected by the TSP nonstructural measure could be less than the number of structures impacted under the Nonstructural Alternative since the dam would be in place and residual flood risk may be lower resulting in fewer structures having to be relocated.

Indirect Impacts: Indirect impacts would be similar to those described for Darlington Dam Alternative and similar but less than indirect impacts described for Nonstructural plan.

Cumulative Impacts: Cumulative impacts of the TSP to EJ resources would be similar to those described for the Darlington Dam and Nonstructural Alternatives.

#### 5.3.1.13 Socioeconomics

*Alternative 1: No Action*

Direct, Indirect, and Cumulative Impacts: The No Action alternative would maintain the current without-project condition of the study area. There are no expected cumulative impacts due to the Comite River Diversion and East Baton Rouge Flood Control projects or other Federal, state, local, or private flood risk reduction efforts. Cumulative impacts to socioeconomic resources would be the additive combination of impacts by this study and other studies, including, but not limited to the two aforementioned projects.

*Alternative 2: Sandy Creek Dry Dam*

Direct, Indirect, and Cumulative Impacts: In the short-term, the Sandy Creek Dry Dam may have some minor negative socioeconomic consequences such as displacement of low-income residents (21 percent of households have incomes below the poverty level in the region, according to U.S. Census Bureau data) from acquisitions necessary to complete construction of the dam. In the long-term, remaining residents would enjoy a decreased risk of flooding which would benefit the residents of the area. There are no expected cumulative socioeconomic impacts due to this alternative; anticipated socioeconomic impacts due to this alternative are independent of the socioeconomic impacts of the Comite River Diversion and East Baton Rouge Flood Control projects or other Federal, state, local, or private flood risk reduction efforts.

*Alternative 3: Large-Scale 0.04 AEP Dam (Darlington Dry Dam)*

Direct, Indirect, and Cumulative Impacts: Socioeconomic consequences of the Darlington Dry Dam are similar to those of the Sandy Creek Dry Dam, but on a larger scale. 73 percent of the population with homes considered for acquisitions under this plan identify as minority, according to U.S. Census Bureau data. Additionally, households with incomes below the poverty level comprise 23 percent of the census block. While these individuals may be subjected to displacement under this alternative, the remaining residents would enjoy a decreased risk of flooding. There are no expected cumulative socioeconomic impacts due to this alternative; anticipated socioeconomic impacts due to this alternative are independent of the socioeconomic impacts of the Comite River Diversion and East Baton Rouge Flood Control projects or other Federal, state, local, or private flood risk reduction efforts.

*Alternative 4: Nonstructural*

Direct, Indirect, and Cumulative Impacts: The non-structural alternative would rely upon the voluntary participation of residents of the 4,291 structures within the 0.04 AEP floodplain to have their structures flood-proofed, elevated, or acquired where applicable. The voluntary nature of this alternative makes it impossible to determine which residents would participate without surveys. Because all residents of the floodplain would be given this opportunity, there is no expected socioeconomic impact from this alternative. There are no expected cumulative socioeconomic impacts due to this alternative; socioeconomic impacts due to this alternative are independent of the socioeconomic impacts of the Comite River Diversion and East Baton Rouge Flood Control projects or other Federal, state, local, or private flood risk reduction efforts.

*Alternative 5: Combined Darlington Dam and Nonstructural (TSP)*

Direct, Indirect, and Cumulative Impacts: Socioeconomic impacts are expected to be similar to those described for the Darlington Dam alternative and the Non-Structural alternative. Regardless of their decision, residents given the option to participate in non-structural measures will enjoy a decreased risk of flooding from the Darlington Dam. This may result in fewer residents electing to participate in the Non-Structural alternative, but again, because all residents will be given this opportunity, there is no expected socioeconomic impact. There are no expected cumulative socioeconomic impacts due to this alternative; anticipated socioeconomic impacts due to this alternative are independent of the socioeconomic impacts of the Comite River Diversion and East Baton Rouge Flood Control projects or other Federal, state, local, or private flood risk reduction efforts.

# Section 6
# Tentatively Selected Plan

Based on the cost and benefit analysis of the final array of alternatives, the TSP is the NED Plan of the Dry Darlington Dam combined with nonstructural measures. The Dry Darlington Dam scale will be optimized during the feasibility study design. Additionally, the nonstructural plan will be refined by assessing the Darlington Dam as the new base condition for the hydrology, which will likely include structures in geographical regions that are not getting direct benefits from the Darlington Dam, such as the Lower Reach of the ARB.

This plan is estimated to produce $109 million in average annual benefits at an average annual cost of $90.8 million (total project cost of 2. Billion), for a BCR of 1.2 at the current Federal Discount Rate (FDR) of 2.75 percent.

## 6.1 NATIONAL SIGNIFICANCE OF THE PROJECT

The intent of comparing alternative flood risk reduction plans in terms of NED is to identify the beneficial and adverse effects that the plans may have on the national economy. Beneficial effects were considered to be increases in the economic value of the national output of goods and services attributable to a plan. Increases in NED were expressed as the plans' economic benefits, and the adverse NED effects were the investment opportunities lost by committing funds to the implementation of a plan. The NED costs and benefits for the final array are described in Table 4-7. The Dry Darlington Dam combined with nonstructural measures has the greatest net benefits (Table 4-10).

## 6.2 IMPLEMENTING THE PLAN

Subject to project authorization, appropriation and availability of funding, full environmental compliance, and execution of a binding agreement with the NFS, construction is currently scheduled to begin in 2022. The schedule assumes a complete risk reduction system in place by year 2026. The project requires construction authorization and the appropriation of construction funds. A continuous funding stream is needed to complete this project within the anticipated timeline, which requires continuing appropriations from Congress and the State of Louisiana in order to fund the detailed design phase and fully fund construction contracts.

Once construction funds are appropriated for this project, the LADOTD, as the NFS, and the Department of the Army will enter into a Project Partnership Agreement (PPA). After the signing of a PPA, the NFS will acquire the necessary land, easements and rights of way to construct the project. Because project features cannot be advertised for construction until the appropriate real estate interests have been acquired, obtaining the necessary real estate in a timely fashion is critical to meeting the project schedule. At the completion of construction, or functional portions thereof, the NFS would be fully responsible for OMRR&R, as the functional portions of the project are completed.

### 6.2.1 Real Estate

The TSP for the project includes a structural component (the Darlington Dam) and a nonstructural component that may include acquisitions, residential elevations and nonresidential flood proofing. The Darlington Dam component will require 15,860 acres to be acquired in Fee, Excluding Minerals and 10,309 acres in Flowage Easements. The Darlington Dam footprint is estimated to impact approximately 700 landowners. Using preliminary information, there appear to be approximately 365 structures within the footprint that would need to be acquired. Relocation assistance to displaced persons would need to be provided for these acquisitions and an estimated cost has been included in the cost estimate. These costs do not include acquisitions downstream, if applicable, due to potential life safety concerns associated implementation of the Darlington Dam. Additionally, there are administrative costs associated with relocating a cemetery, which is within the footprint. Mitigation will be required for unavoidable impacts and it is not determined at this time if compensatory mitigation will involve the purchase of credits from approved mitigation banks or USACE constructed mitigation sites. If USACE constructed sites are needed, these sites will be acquired in Fee, Excluding Minerals. Costs for acquiring mitigation sites are not included for the estimate, but if Corps constructed mitigation sites are necessary, then the Total Real Estate Costs for the Structural portion of the TSP are $223,167,000. This cost is not only land costs, but also improvements cost, relocations assistance to displaced persons, acquisition costs, cemetery relocation administrative costs, mitigation costs, and contingencies.

The Nonstructural portion of the TSP consists of implementing nonstructural measures to reduce the risk of damages from flooding to residential and non-residential structures that have first floor elevations at or below the 0.04 AEP flood plain. This may involve acquisitions, elevations of residential structures and flood proofing of nonresidential structures. An economics assessment of at-risk properties has currently identified a total of 3,566 structures (3,252 residential and 314 non-residential) that appear to meet the preliminary eligibility criteria for participation in the project. Total Real Estate Costs for this portion of the TSP are $74,567,000. This cost includes relocation assistance for tenants, administrative costs (Flood Proofing Agreement, Title verification, etc.), and contingencies. As the plans are refined, the cost of acquisitions and relocation assistance to such displaced persons will be developed and addressed in the Final IFR & EIS.

### 6.2.2 Darlington Dam 0.04 AEP Dry Design

Based on the review of ART, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope)," dated September 1997, it was determined that the limited analyses performed are considered adequate for cost estimating purposes of the Darlington Reservoir alternative.

### 6.2.3 Construction Method for the Structural Component of the TSP

A comprehensive construction sequence has not been completed, but a general construction method would begin with foundation preparation. This includes clearing, grubbing, stripping (approximately 5 feet), and scarifying the footprint of the dam. A diversion channel would need to be created to divert the river away from the current course to allow seepage cutoff and outlet construction. Once diverted, the slurry trench would be constructed from one abutment through the existing river alignment. The construction of the outlet conduits and control tower would commence. Outlets would include trash racks and debris booms. The embankment construction would commence from the same abutment the slurry trench began. Once the conduit has adequate cover, the river would be returned to its original path and route through the new conduit construction. A sedimentation basin would be designed and possibly placed near the diversion channel. Final placement and size is to be determined. Slurry trench would continue from the end point beyond the original termination and extend through the other abutment. Embankment construction would follow the slurry trench construction. Embankment construction would also include filter blanket as determined by future design. The construction of embankment to full section would be completed except the spillway. Spillway construction would include walls, anchors, and exit control. A new channel would be placed between the spillway and the downstream segment of the river. Final dressing would require armoring at the dam features as needed. Embankment would be fertilized and seeded. Final determination for access road paving and or surfacing including the crest of the dam will need to be determined. Final determination will also be made for storage facilities and shops needed to maintain the dam. Final construction duration cannot be made until specific details and acquisition strategy is determined. First cut of construction duration is 4 years. It is recommended to enhance construction sequencing in accordance with EM 1110-2-2300 and EM 1110-2-1911.

### 6.2.4 Operations, Maintenance, Repair, Rehabilitation, and Replacement

OMRR&R is currently under development.

### 6.2.5 Cost Sharing Requirements

A NFS must support all phases of the project. Feasibility study costs are typically shared 50 percent Federal and 50 percent non-Federal, but this one is 100 percent federally funded for up to $3,000,000. Design and implementation phases are cost-shared, with the NFS providing a minimum 25 percent and maximum 50 percent of the total project costs. Additionally, the NFS must provide all the LERRDs. While the sponsor may receive credit toward this cost-share for work-in-kind and LERRDs, a minimum cash contribution of 5 percent is required. Once a project has been implemented, OMRR&R of the project is a 100 percent non-Federal responsibility.

### 6.2.6 Federal Responsibilities for the Selected Plan

The Federal government will be responsible for PED and construction of the project in accordance with the applicable provisions of Public Law 99-662 (WRDA of 1986), as amended. The Government, subject to Congressional authorization, the availability of funds, and the execution of a binding agreement with the NFS in accordance with Section 221 of the Flood Control Act of 1970, as amended, and using those funds provided by the NFS, shall expeditiously construct the project, applying those procedures usually applied to Federal projects, pursuant to Federal laws, regulations, and policies.

### 6.2.7 Non-Federal Responsibilities for the Selected Plan

Federal implementation of the project would be subject to the NFS agreeing in a binding written agreement to comply with applicable Federal laws and policies, and to perform the following non-Federal obligations, including, but not limited, to:

a. Provide minimum 25 percent and maximum 50 percent of total project costs as further specified below:
    1. Provide the required non-Federal share of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
    3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct 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, maintenance, repair, rehabilitation and replacement of the project;
    4. Provide, during construction, any additional funds necessary to make its total contribution equal to the NFS share of total project costs;
b. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project;
c. Not less than once each year, inform affected interests of the extent of protection afforded by the project;
d. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;
e. 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 partnership agreement, and to implement such plan not later than one year after completion of construction of the project;
f. 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 project;
g. 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 project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
h. 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;

i. For so long as the project remains authorized, OMRR&R 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; provided, however, that the NFS shall have no obligation to address loss of risk reduction due to relative sea level rise through the repair, rehabilitation or replacement of localized storm surge risk reduction components associated with the construction of large ring berms around groups of residential structures, nor shall the NFS be obligated to OMRR&R those flood proofing measures that constitute elevation of individual residential structures or construction of small ring berms around individual non-residential or light industry/warehouse structures.
j. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the NFS owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
k. 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;
l. 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;
m. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; 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.);
n. 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 the 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, including those lands, structures and interests necessary for the implementation of all of the localized storm surge risk reduction components of the Project as described in this Report. 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 NFS with prior specific written direction, in which case the NFS shall perform such investigations in accordance with such written direction;

o. Assume, as between the Federal government and the NFS, 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, including those lands, structures and interests necessary for the implementation of all of the localized storm surge risk reduction components of the Project as described in this Report;
p. Agree, as between the Federal government and the NFS, that the NFS 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
q. 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.
r. Shall not use any project features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;
s. Pay all costs due to any project betterments or any additional work requested by the sponsor, subject to the sponsor's identification and request that the Government accomplish such betterments or additional work, and acknowledgement that if the Government in its sole discretion elects to accomplish the requested betterments or additional work, or any portion thereof, the Government shall so notify the NFS in writing that sets forth any applicable terms and conditions.

### 6.2.8 Risk and Uncertainty

Risk and uncertainty are intrinsic in water resources planning and design. This section describes various categories of risk and uncertainty pertinent to the study. Risk and uncertainty will be further considered during feasibility-level design and analysis.

### 6.2.9 Residual Damages and Residual Risks

Incorporating nonstructural measures in addition to the Darlington Dam structural component of the TSP is a plan formulation strategy being used to further reduce residual damages in areas where the Darlington Dam is not effective at reducing flood stages. By incorporating the nonstructural plan in conjunction with the dam, USACE is limiting the potential for high residual damages.

### 6.2.10 Potential Induced Flooding

No potential induced flooding is anticipated except for the in-pool area. The potential induced flooding will be further investigated during feasibility-level design. If the induced flooding is confirmed, measures would be formulated to appropriately address the issue.

# Section 7
# Mitigation Assessment

Law, regulations, and USACE policy ensure that adverse impacts to significant resources have been avoided or minimized to the extent practicable and that remaining, unavoidable impacts have been compensated to the extent justified. Section 1508.20 of the National Environmental Policy Act defines mitigation as the following actions:

- Avoiding the impact altogether by not taking a certain action or parts of an action.
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensating for the impact by replacing or providing substitute resources or environments

The appropriate application of mitigation is to formulate an alternative that first avoids, then minimizes, and lastly, compensates for unavoidable adverse impacts. Potential alternatives for the compensatory mitigation plan for the Amite Study are evaluated in this DEIS.

Section 2036(a)(3)(A) of WRDA 2007 gives guidance on how USACE Civil Works mitigation plans shall be planned and implemented. It states:

> To mitigate losses to flood damage reduction capabilities and fish and wildlife resulting from a water resources project, the Secretary shall ensure that the mitigation plan for each water resources project complies with the mitigation standards and policies established pursuant to the regulatory programs administered by the Secretary. (Section 2036(a)(3)(A) of WRDA 2007)

These components are summarized in the mitigation plan in Appendix C-5.

## 7.1 HABITAT MITIGATION

A general mitigation plan has been developed based on a site visit and preliminary habitat analysis. A detailed mitigation plan would be developed in coordination with the Interagency Team and set forth in the final IFR and EIS and prior to signing of the ROD.

During a preliminary aerial survey of Darlington Dam, CEMVN identified approximately 1,332 AAHUs of bottomland hardwood within the Darlington Dam footprint of the occasionally inundated reservoir. In addition, there will likely be impacts within the staging area(s) and borrow excavation sites. However, because those locations have not yet been determined, their impacts will be discussed in the Final EIS. WVA assumptions will be addressed in the final IFR and EIS. See the general mitigation plan in Appendix C-5.

The following mitigation options may be considered respectively:

1. Purchasing BLH Mitigation Bank Credits

   At the time of screening, mitigation banks in Lake Pontchartrain Basin existed that had BLH credits available for purchase. Many of these banks also had in-kind credits that could be released in the future. It is not known which banks would be available when the decision whether to purchase bank credits or not is made: some banks may not have enough credits remaining, some may be closed, and additional mitigation banks may be approved. As such, a general mitigation bank for BLH habitat, including in and out of coastal zone options, was assumed for the next step of the mitigation project analysis using information obtained from existing banks in the basin and no specific banks were identified. The Regulatory In lieu fee and Bank Information Tracking System (RIBITS) (https://ribits.usace.army.mil/) has information on all currently approved banks in the basin including their credit availability.

2. Potential BLH Corps-constructed Mitigation Sites

   Mitigation for the TSP could include creation and restoration and enhancement of bottomland hardwoods (BLH) habitat as compensatory mitigation for some of the BLH impacts resulting from construction of the Darlington Dam. The BLH restoration and enhancement areas (mitigation areas) would be located in abandoned agriculture, scrub/shrub, pasture, and other non-forested areas of lower habitat value. Required earthwork for each mitigation site would primarily consist of removal of remnant spoil material (sand, sediments, gravel) in various portions of each of the mitigation sites in an effort to establish an appropriate hydroperiod for BLH plant species. Grading and gapping to ensure appropriate drainage, establishing access roads, and tillage are also required in preparing the site. Following initial earthwork, native canopy and midstory plants typical of BLH-dry habitats would be installed in the mitigation areas following completion of the initial earthwork. See Table 7-1 for a summary of potential BLH mitigation sites.

*Table 7-1. Darlington Dam Summary Data for Potential BLH Mitigation Sites*

| Mitigation Site ID | Basin | Public Land | Total Acres | AAHUs | AAHUs/acre |
|---|---|---|---|---|---|
| Bottomland Hardwoods-Dry | | | | | |
| 1 | Lake Pontchartrain | | 31.8 | 17.5 | 0.55 |
| 2 | Lake Pontchartrain | | 80.9 | 40.5 | 0.5 |
| 3 | Lake Pontchartrain | | 124 | 74.4 | 0.6 |
| 4 | Lake Pontchartrain | | 38.3 | 17.2 | 0.45 |
| 5 | Lake Pontchartrain | | 99.0 | 59.4 | 0.6 |
| 6 | Lake Pontchartrain | | 38.0 | 19.0 | 0.5 |
| 7 | Lake Pontchartrain | | 48.9 | 26.9 | 0.55 |
| 8 | Lake Pontchartrain | | 80.5 | 40.3 | 0.5 |
| 9 | Lake Pontchartrain | X | 94.7 | 42.1 | 0.44 |
| 10 | Lake Pontchartrain | X | 75.2 | 39.5 | 0.52 |
| 11 | Lake Pontchartrain | X | 55.8 | 28.5 | 0.51 |
| 12 | Lake Pontchartrain | X | 267 | 155.6 | 0.58 |
| 13 | Lake Pontchartrain | X | 134.9 | 54.1 | 0.40 |
| 14 | Lake Pontchartrain | X | 1,246.0 | 296.5 | 0.54 |
| 15 | Barataria | | 324.0 | 168.0 | 0.52 |
| 16 | Terrebonne | X | 89.3 | 42.4 | 0.47 |
| 17 | Terrebonne | X | 483.8 | 248.3 | 0.51 |
| 18 | Terrebonne | X | 224.8 | 112.6 | 0.50 |
| 19 | Atchafalaya | X | 147.2 | 72.7 | 0.49 |
| Totals | | | **3684.1** | **1555.5** | |

Notes:

* = All mitigation sites in these categories are elements of the Tentatively Selected Plan

Acres indicated are the total acres of mitigation areas within each site. Values do not include the acreage encompassed by the overall property boundaries.

BLH = Bottomland Hardwood Forest

AAHUs = Average Annual Habitat Units (as determined by using Wetland Value Assessment model for BLH)

| Mitigation Site ID | Basin | Public Land | Total Acres | AAHUs | AAHUs/acre |
|---|---|---|---|---|---|
| Bottomland Hardwoods-Dry | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 1 | Lake Pontchartrain | | 31.8 | 17.5 | 0.55 |
| 2 | Lake Pontchartrain | | 80.9 | 40.5 | 0.5 |
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Notes:

* = All mitigation sites in these categories are elements of the Tentatively Selected Plan

Acres indicated are the total acres of mitigation areas within each site. Values do not include the acreage encompassed by the overall property boundaries.

BLH = Bottomland Hardwood Forest

AAHUs = Average Annual Habitat Units (as determined by using Wetland Value Assessment model for BLH)

## 7.2 MONITORING

Monitoring requirements for mitigation covers habitat restoration and enhancement success criteria over the 50-year project life. See Appendix C-5, Section 1.9 for the requirements for the Corps-constructed mitigation in the draft mitigation plan.

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## 7.3 ADAPTIVE MANAGEMENT

Adaptive management is considered to mitigate for bottomland hardwood impacts from the tentatively selected plan (TSP). The Water Resources Development Act (WRDA) of 2007, Section 2036(a) and U.S Army Corps of Engineers (USACE) implementation guidance for Section 2036(a) (CECW-PC Memorandum dated August 31, 2009: “Implementation Guidance for Section *2036 (a) of the Water Resources Development* Act of 2007 (WRDA 2007) – Mitigation for Fish and Wildlife and Wetland Losses”) require adaptive management be included in all mitigation plans for fish and wildlife habitat and wetland losses. Full descriptions of the mitigation projects will be included in the final IFR and EIS, due to the current lack of information.

See Appendix C-5, Section 1.11 for the requirements for the Corps-constructed mitigation in the draft mitigation plan.

## 7.4 ENVIRONMENTAL CONSEQUENCES MATRIX

Table 7-2 below provides a summary of impacts to relevant resources from the two mitigation options.

*Table 7-2 Summary of impacts for proposed mitigation options*

| **Relevant Resource** | **Corps-constructed BLH Mitigation Site** | **Mitigation Bank** |
|---|---|---|
| Wetland Resources | Positive impact; ag land and degraded BLH habitat converted to higher habitat value BLH | No impact |
| Upland Resources | Positive impact; ag land and degraded upland habitat converted to higher habitat value upland habitat | No impact |
| Aquatic Resources/Fisheries | No impact | No impact |
| Wildlife | Positive impact; improved habitat for various species | No impact |
| Threatened, Endangered, and Protected Species | Positive impact; improved habitat for various T&E | No impact |

| | | |
|---|---|---|
| | species | |
| Prime and Unique Farmland | Impact depends on acreage and location | No impact |
| Water Quality | Positive impact; temporary disturbance, long-term improvement. | No impact |
| Air Quality | No impact | No impact |
| Cultural | Potential negative impact Archaeological | No impact |
| Recreation | Potential positive impact from improved habitat for rec activities | No impact |
| Aesthetics | Temporary negative; long-term positive improvement | No impact |
| Socioeconomic Resources | Potential negative to commercial, residential, and industrial properties | No impact |
| Environmental Justice | Potential negative to minority populations disproportionately impacted | No impact |
| HTRW | Low probability of encountering HTRW | No impact |

### 7.5 INFLATED HEELSPLITTER MITIGATION

If the inflated heelsplitter mussel is found in the project footprint during field survey, then a biological assessment would be conducted. The mitigation for the inflated heelsplitter mussel may include relocating individuals upstream and downstream to maintain gene flow.

## Section 8

# Environmental Laws and Regulations

### 8.1 EXECUTIVE ORDER (E.O.) 11988 FLOODPLAIN MANAGEMENT

Executive Order 11988 directs Federal agencies to reduce flood loss risk; minimize flood impacts on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by flood plains. Agencies must consider alternatives to avoid adverse and incompatible development in the flood plain. If the only practical alternative requires action in the flood plain, agencies must design or modify their action to minimize adverse impacts. The proposed action represents the least environmentally damaging alternative to accomplish the needed risk reduction system modifications.

## 8.2 CLEAN AIR ACT OF 1970

The Clean Air Act (CAA) sets goals and standards for the quality and purity of air. It requires the Environmental Protection Agency to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The Darlington Dam project area is in Saint Helena and East Feliciana Parish, which is currently in attainment of NAAQS. The Louisiana Department of Environmental Quality is not required by the CAA and Louisiana Administrative Code, Title 33 to grant a general conformity determination.

## 8.3 CLEAN WATER ACT OF 1972 – SECTIONS 401 AND 404

The Clean Water Act (CWA) sets and maintains goals and standards for water quality and purity. Section 401 requires a Water Quality Certification from the Louisiana Department of Environmental Quality (LDEQ) that a proposed project does not violate established effluent limitations and water quality standards. Coordination with LDEQ for a State Water Quality Certification will be completed at a later date to determine that the requirements for a WQC have been met.

Section 305(b) of the Clean Water Act requires each state to monitor and report on surface and groundwater quality, which the Environmental Protection Agency (EPA) synthesizes into a report to Congress. The Louisiana Department of Environmental Quality (LDEQ) produces a Section 305(b) Water Quality Report that provides monitoring data and water quality summaries for hydrologic units (subsegments) throughout the state. See Appendix C-1 for the listing of impaired water bodies in the study area.

As required by Section 404(b)(1) of the CWA, an evaluation to assess the short- and long-term impacts associated with the placement of fill materials into waters of the United States resulting from the TSP is currently ongoing. The Section 404(b)(1) public notice would be later mailed for concurrent public and agency review with final integrated report.

## 8.4 ENDANGERED SPECIES ACT OF 1973

The Endangered Species Act (ESA) is designed to protect and recover threatened and endangered (T&E) species of fish, wildlife and plants. A NLAA letter may be issued at a later date for listed T&E species, including Atlantic sturgeon and inflated heelsplitter mussel, migratory shorebirds, and species of management concern (i.e. rare and very rare species) that are known to occur or believed to occur within the vicinity of the project area. No plants were identified as being threatened or endangered in the project area (Appendix C-4).

The proposed action would include Standard Manatee Conditions for In-Water Activities with the contractor instructing all personnel regarding the potential presence of manatees in the project area, and the need to avoid collisions with these animals. If a manatee(s) is sighted within 100 yards of the project area, moving equipment must be kept at least 50 feet away from the manatee or shut down. There would be restrictions on vessel operation, restrictions on the use of siltation barriers, and mandatory signage designed to avoid any harm to manatees in the project area. More specific information would be contained in the dredging contracts. This DEIS has been made available to agencies and coordination with FWS is ongoing to determine if the project could have an adverse impact to the threatened inflated heelsplitter mussel (Appendix C-4).

## 8.5 FISH AND WILDLIFE COORDINATION ACT OF 1934

The Fish and Wildlife Coordination Act (FWCA) provides authority for the FWS involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It requires federal agencies that construct, license or permit water resource development projects to first consult with the FWS, NMFS and state resource agencies regarding the impacts on fish and wildlife resources and measures to mitigate these impacts. Section 2(b) requires the FWS to produce a Coordination Act Report (FWCAR) that details existing fish and wildlife resources in a project area, potential impacts due to a proposed project and recommendations for a project. The FWS reviewed the proposed action project described in this DEIS and provided a FWCAR with project specific recommendations on 30 October, 2019. The ROD will be signed prior to completion of all coordination.

The final IFR and EIS will include responses to the final FWCAR. The draft FWCAR, dated 30 October, 2019, can be found in Appendix C-4 and recommendations are as follows:

1. The Darlington Dam should be designed to allow continuous upstream and downstream fish passage. The 10' x 10' box culverts should be installed slightly below grade to prevent “perching” and provide benthic macroinvertebrates and bottom dwelling fish (including the host fish for at-risk and listed mussels) free passage. Ideally, culverts should be installed to a depth that allows sediment to accumulate in the bottom, typically 20 percent of the height. If this reduces the required volume of flow to an unacceptable level then larger or more culverts should be installed.

2. Depending on the design and configuration of culverts at the Darlington Dam, [FWS] may require a fish passage study. The USACE should coordinate culvert design and configuration with the [Fish and Wildlife] Service.

3. If ring levees are proposed as part of the “non-structural” component of the TSP, the levee alignments should be located to avoid and minimize impacts to both herbaceous wetlands and forested communities (wet and non-wet) as much as possible. The acreage of wetlands and forested habitat enclosed within ring levees also should be minimized to the maximum extent practicable.

4. Any clearing of riparian vegetation should be limited to a single bank and when possible that bank should be either the eastern or northern bank.

5. Important fish and wildlife habitat (emergent wetlands, forested wetlands, and non-wetland forest) should be conserved by avoiding and minimizing the acreage of those habitats directly impacted by project features.

6. Any forest clearing associated with project features should be conducted during the fall and winter to minimize impacts to nesting migratory songbirds, when practicable.

7. Avoid impacts to threatened and endangered species, at risk species, and species of concern such as the bald eagle, and wading bird nesting colonies.

8. West Indian manatee conservation measures from Appendix A [of the draft FWCAR (See Appendix C-4)] should be included in all contracts, plans, and specifications for in-water work in areas where the manatee may occur.

9. Consultation should continue for the Alabama heelsplitter mussel. Any conservation measures that are identified through consultation should be included in all contracts, plans, and specifications for any work that may adversely impact the heelsplitter.

10. Compensation should be provided for any unavoidable losses of stream habitat, wetland habitat, and non-wetland forest caused (directly or indirectly) by project features. All mitigation should be developed/coordinated with the [Fish and Wildlife] Service and other natural resource agencies. Only after forest restoration opportunities along the Amite River (abandoned sand and gravel mines) have been implemented to the maximum extent practicable should other mitigation opportunities be pursued. The Service will not be able to agree to the suitability of other mitigation proposals until after ROE allows onsite evaluation of the resources to be impacted to ensure no net loss of “in-kind” habitat value.

11. Borrow material required for construction should be acquired in accordance with the Borrow Site Prioritization Criteria provided in Appendix B [of the draft FWCAR (See Appendix C-4)].

## 8.6 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

A Phase I Environmental Site Assessment is required for all USACE Civil Works Projects, to facilitate early identification and appropriate consideration of potential Hazardous, Toxic, and Radioactive Waste (HTRW) problems. HTRW includes any material listed as a “Hazardous Substance” under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Other regulated contaminants include those substances that are not included under CERCLA but pose a potential health or safety hazard. Examples include, but are not limited to, many industrial wastes, naturally occurring radioactive materials, many products and wastes associated with the oil and gas industry, herbicides, and pesticides. Engineer Regulation 1165-2-132 and Division Regulation 1165-2-9 established policies for conducting HTRW review for USACE Civil Works Projects.

A preliminary HTRW Phase 1 Environmental Site Assessment (ESA) was conducted for the current draft draft IFR and DEIS. The ART study area was surveyed via aerial photography and environmental database searches in the study area’s respective zip codes.

The preliminary ESA identified the following potential HTRW issues within or near the study area:

1. Three National Priorities List (Superfund) sites that are currently under remediation and review by the U.S. Environmental Protection Agency (EPA): Petro-Processors of Louisiana, Inc. and Devil's Swamp Lake in East Baton Rouge Parish and Combustion, Inc. in Livingston Parish. Petro Processors and Devil's Swamp Lake are located outside of the ART study area near Scotlandville, Louisiana and Combustion, Inc. is located within the ART study area near Denham Springs, Louisiana.

2. Four former Superfund sites that have undergone remediation and review by the EPA and have been deleted from the National Priorities List: Central Wood Preserving Co. in East Feliciana Parish; Dutchtown Treatment Plant, Old Inger Oil Refinery, and the Cleve Reber site in Ascension Parish. All four of these sites are currently under a 30-year Operation and Maintenance plan that is managed by the EPA and LDEQ.

The preliminary ESA also identified the presence of several active, inactive, and plugged and abandoned oil/gas wells, several injection wells, and several oil and gas pipelines within the study area. Several industrial facilities such as chemical plants and refineries were also noted in the study area. There is a low probability of encountering HTRW from the wells, pipelines, and industrial facilities during construction of the project.

This preliminary ESA was conducted to facilitate early identification and consideration of HTRW issues. Several potential HTRW issues were identified in this ESA; however, a full Phase I ESA will be required upon the selection of the Tentatively Selected Plan and will be included in the final IFR and EIS

## 8.7 MIGRATORY BIRD TREATY ACT

The project area is known to support colonial nesting wading/water birds (e.g., herons, egrets, ibis, night-herons and roseate spoonbills) and shorebirds (terns and gulls). Based on review of existing data, site visits, and with the use of FWS guidelines, the CEMVN finds that implementation of the proposed actions would have no effect on colonial nesting water/wading birds or shorebirds. FWS and USACE biologists would survey the proposed project area before construction to confirm no nesting activity as suitable habitat and the potential for nesting exist within the project area. If active nesting exists within 1,000 feet (water birds) or 1,300 feet (shorebirds) of construction activities then USACE, in coordination with FWS, would develop specific measures to avoid adverse impacts to those species. A detailed nesting prevention plan may be necessary in order to deter birds from nesting within the aforementioned buffer zones of the project footprint in order to avoid adverse impacts to these species. If a nesting prevention plan is necessary, it would be prepared in coordination with FWS.

The bald eagle was removed from the List of Endangered and Threatened Species in August 2007, but continues to be protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Treaty Act of 1918, as amended (MBTA). During nesting season, construction must take place outside of FWS/LDWF buffer zones. A USACE

Biologist and a FWS Biologist would survey for nesting birds. This would be done prior to the start of construction.

## 8.8 E.O. 12898 ENVIRONMENTAL JUSTICE

USACE is obligated under E.O. 12898 of 1994 and the Department of Defense's Strategy on Environmental Justice of 1995, which direct federal agencies to identify and address any disproportionately high adverse human health or environmental effects of federal actions to minority and/or low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, Pacific Islander, or 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 are those whose income is the Census Bureau's statistical poverty threshold for a family of four. The Census Bureau defines a "poverty area" as a census tract or block numbering area with 20 percent or more of its residents below the poverty threshold level and an "extreme poverty area" as one with 40 percent or more below the poverty threshold level.

There is the potential for high, adverse, disproportionate, direct impacts to minority and low-income communities from construction of the Darlington Dam. A disproportionately high and adverse effect means 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 considering offsetting benefits. The high, adverse impact of relocation is potentially disproportionate to minority or low-income homeowners if they comprise a vast majority of homes being acquired. According to Census data, it is likely that the vast majority of housing within the dam footprint is minority-owned. The community would likely relocate to housing in an area outside of a floodplain. All structures within the footprint of the proposed Darlington Dam and the FEMA regulatory floodway would be acquired, with relocation assistance provided to displaced persons per the Uniform Relocation Assistance Act (URA). According to the U.S. Census Bureau data, housing considered for the acquisition plan is located in census block groups that have a majority (73 percent) of population identifying as minority. For more information on the Demographic Indicators, refer to Appendix C, Table C1-22. Additionally, 23 percent of the households in the census block groups that comprise the dam footprint have incomes below the poverty level (Table C1-21). Both the minority and low-income criteria used to identify EJ communities are met.

The voluntary nonstructural measures may directly impact EJ communities but these impacts are likely not disproportionately high and adverse. Eligible structures within the 0.04 AEP floodplain could be voluntarily floodproofed or elevated; therefore, all residents, irrespective of race, ethnicity, or income, would be able to choose to participate in the plan.

## 8.9 NATIONAL HISTORIC PRESERVATION ACT OF 1966

A detailed synopsis of the Cultural Resources compliance activities is provided in Appendix C-1, Section 3.

## 8.10 TRIBAL CONSULTATION

It is the policy of the federal government to consult with Federally recognized Tribal Governments on a Government-to-Government basis as required in EO 13175 ("Consultation and Coordination with Indian Tribal Governments;" U.S. President 2000). The requirement to conduct coordination and consultation with federally recognized Tribes on and off of Tribal land finds its basis in the constitution, Supreme Court cases, and is clarified in later planning laws, such as the National Environmental Policy Act. When conducting a civil works planning activity (http://www.usace.army.mil/Missions/Civil-Works/Tribal-Nations/), USACE is directed to follow six principles when engaging with Tribal Governments: these principles emphasize Tribal Sovereignty, the federal governments trust responsibility, Government-to-Government consultation, early and pre-decisional consultation, recognition of tribal self-reliance, focusing USACE on efforts at tribal capacity building, and requiring USACE to protect natural and cultural resources during project development and implementation. Moreover, the USACE Planning and Guidance Notebook (ER 1105-2-100), including Smart Planning, gives guidance in Appendix B, Public Involvement, Collaboration and Coordination (B-8) and Appendix C, Environmental Evaluation and Compliance (C-4), reinforcing the same authorities and processes. The most explicit and accessible guidance regarding USACE and Tribal interaction can be found in USACE's Tribal Consultation Policy (1 Nov 2012).

In addition to consulting with Tribes under the NHPA as described above (NHPA 1966 Section), USACE, is consulting in accordance with EO 13175, NEPA, and its 2012 Tribal Policy. The 2012 Tribal Consultation Policy directs that consultation should begin at the earliest planning stages before decisions are made and actions are taken (paragraph 3b); provides guidance that USACE should contact "[t]ribes whose aboriginal territories extend to the lands where an activity would occur…sufficiently early to allow a timely review of the proposed action" (paragraph 5.d.(1); and goes on to state that the USACE official interacting with federally recognized tribes should maintain open lines of communication through consultation with Tribes during the decision making process for matters that have the potential to significantly affect protected tribal resources, tribal rights (including treat rights), and Indian lands (paragraph 6. d.). In sum, all of this guidance directs the agency to start early and to coordinate often.

USACE started the Tribal Consultation process by inviting Tribes to participate in the early scoping process via letter on December 4, 2018 (also see Section 2.4. Public Scoping). The letters were directed to the leadership of each of the Tribal governments whose aboriginal and historic territories or historic removal routes extended to the lands where the proposed activities would occur (i.e., the ACTT, CTL, CNO, CT, MBCI, JBCI, STF, SNO, and TBTL). Two responses were received that did not address the substance of the request. The MBCI participated in a scoping meeting and raised the issue of effects to pre-contact archaeological sites from any of the then-proposed alternatives. Next, on April 10, 2019, USACE provided an email distribution of the April 2, 2019 Notice of Intent to produce an EIS as well as the advertisement of public meetings for this project. No responses were received regarding this distribution. USACE also invited each of the tribes to participate as a cooperating agency in the development of the EIS at a meeting on June 18, 2019. Only the MCN responded to this correspondence, indicating that the tribe was choosing to consult under the NHPA, rather than participate as a cooperating agency. USACE intends to keep the lines of communication open throughout the study, relying on the "Section 106 Process" to capture significant tribal concerns regarding historic properties, but remains open to the need to undertake Government-to-Government consultation, as necessary.

# Section 9
# Public Involvement

A Public Notice for the ART draft IFR and DEIS will be published in the Baton Rouge and New Orleans Advocate for the 45-day comment period beginning November 29, 2019 and ending January 13, 2019.

Preparation of this IFR and DEIS has been coordinated with appropriate Congressional, federal, Tribal, state, and local interests, as well as environmental groups and other interested parties. The following agencies, as well as other interested parties, will receive copies of the draft IFR and DEIS:

U.S. Department of the Interior, Fish and Wildlife Service
U.S. Environmental Protection Agency, Region VI
U.S. Department of Commerce, National Marine Fisheries Service
U.S. Natural Resources Conservation Service, State Conservationist
Coastal Protection and Restoration Authority Board of Louisiana
Advisory Council on Historic Preservation
Governor's Executive Assistant for Coastal Activities
Louisiana Department of Wildlife and Fisheries
Louisiana Department of Natural Resources, Coastal Management Division
Louisiana Department of Natural Resources, Coastal Restoration Division
Louisiana Department of Environmental Quality
Louisiana State Historic Preservation Officer
Louisiana Departments of Transportation and Development

# Section 10
# Conclusion

## 10.1 RECOMMENDATION

CEMVN has assessed the environmental impacts of the recommended TSP for the ART on relevant resources in this draft IFR and DEIS. The TSP would have both temporary and permanent impacts to these resources. Future environmental impact assessments in the project footprint of the Darlington Dry Dam would be completed to more fully address them in the final report. Additionally, impacts to borrow sources and staging area(s), along with mitigation measures, will be evaluated and determined in the final IFR and DEIS. In order to reduce impacts to these resources, refinements in the TSP design may also be addressed in PED.

## 10.2 PATH FORWARD

This Draft IFR and DEIS is available for public review beginning November 29, 2019. The official closing date for the receipt of comments is January 13, 2020 which is 45 days from the date on which the notice of availability of this Draft IFR and EIS appears in the Federal Register during this review period. Comments may be mailed to the address listed below. Comments may also be emailed to the email address listed below.

U.S. Army Corps of Engineers
Attention: Project Management
CEMVN–PMR, Room 331,
7400 Leake Avenue
New Orleans, LA 70118
Email: AmiteFS@usace.army.mil

Public meeting dates and locations for this draft IFR and DEIS are listed below.

17 Dec 2019
North Park Recreation Center
30372 Eden Church Road
Denham Springs. LA 70726
6:30 pm-830pm

18 Dec 2019
Clinton United Methodist Church
11321 Old S Dr.
Clinton, LA 70722
6pm-8pm

# List of Preparers

This Draft Integrated Feasibility Report and Environmental Impact Statement (DEIS), and associated ROD were prepared by Daniel Meden, Biologist, & Lesley Prochaska, Planner, U.S. Army Corps of Engineers, New Orleans District; Regional Planning and Environment Division South, MVN-PD; 7400 Leake Avenue, New Orleans, Louisiana 70118.

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# List of Acronyms and Abbreviations

| | |
|---|---|
| ACHP | Advisory Council on Historic Preservation |
| ACS | American Community Survey |
| ACTT | Alabama-Coushatta Tribe of Texas |
| AEP | Annual Exceedance Probability |
| APE | Area of Potential Effects |
| ARB | Amite River Basin |
| ARBC | Amite River Basin Commission |
| ART | Amite River and Tributaries East of the Mississippi River, Louisiana. |
| BCR | Benefit to Cost Ratio |
| BGEPA | Bald and Golden Eagle Protection Act |
| BMP | Best Management Practices |
| BREC | Recreation and Park Commission for the Parish of East Baton Rouge |
| CDBG | Community Development Block Grant |
| CEMVN | USACE New Orleans District |
| CEQ | Council on Environmental Quality |
| CNO | Choctaw Nation of Oklahoma |
| CPRA | Coastal Protection and Restoration Authority |
| CT | Coushatta Tribe of Louisiana |
| CTL | Chitimacha Tribe of Louisiana |
| CWA | Clean Water Act |
| DEIS | Draft Integrated Feasibility Report and Environmental Impact Statement |
| EFH | Essential Fish Habitat |
| EIS | Environmental Impact Statement |
| EJ | Environmental Justice |

| | |
|---|---|
| EO | Executive Order |
| EPA | Environmental Protection Agency |
| EQ | Environmental Quality |
| ER | Engineer Regulation |
| ESA | Endangered Species Act |
| FDR | Federal Discount Rate |
| FEIS | Integrated Feasibility Report and Environmental Impact Statement |
| FEMA | Federal Emergency Management Agency |
| FMA | Flood Mitigation Assistance |
| FPPA | Farmland Protection Policy Act of 1981 |
| FRM | Flood Risk Management |
| FS | Focused Structural |
| FWCA | Fish and Wildlife Coordination Act |
| FWCAR | Coordination Act Report |
| FWS | Fish and Wildlife Services |
| FWOP | Future With Out Project |
| GCJV | Gulf Coast Joint Venture |
| GOMESA | Gulf of Mexico Energy Security Act |
| GOSHEP | Louisiana Governor's Office of Homeland Security and Emergency Preparedness |
| H&H | Hydraulics and Hydrology |
| HMGP | Hazard Mitigation Grant Program |
| HTRW | Hazardous, Toxic, and Radioactive Waste |
| HW | Hold Water |
| IFR | Integrated Feasibility Report |
| JBCI | Jena Band of Choctaw Indians |

| | |
|---|---|
| LCA | LA Coastal Area |
| LDEQ | Louisiana Department of Environmental Quality |
| LDOA | Louisiana Division of Archaeology |
| LADOTD | Louisiana Department of Transportation and Development |
| LDWF | Louisiana Department of Wildlife and Fisheries |
| LPR | Livingston Parks and Recreation |
| LWCF | Land and Water Conservation Fund |
| LWFMP | Louisiana Statewide Comprehensive Water Based Floodplain Management Program |
| MBCI | Mississippi Band of Choctaw Indians |
| MBTA | Migratory Bird Treaty Act |
| MCACES MII | Micro-Computer Aided Cost Estimating System, 2nd Generation |
| MCN | Muscogee (Creek) Nation |
| MSL | Mean Sea Level |
| NAAQS | National Ambient Air Quality Standards |
| NAWMP | North American Waterfowl Management Plan |
| NBEM | National Bald Eagle Management |
| NCDC | National Climatic Data Center |
| NED | National Economic Development |
| NEPA | National Environmental Policy Act |
| NFS | Non- Federal Sponsor |
| NGVD | National Geographic Vertical Datum |
| NHPA | National Historic Preservation Act |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOI | Notice of Intent |

| | |
|---|---|
| NOX | Nitrogen Oxide |
| NPS | National Park Service |
| NRC | National Research Council |
| NRCS | Natural Resource Conservation Service |
| NRHP | National Register of Historic Places |
| NS | Nonstructural |
| NSI | National Structure Inventory |
| NWS | US National Weather Service |
| O&M | Operation and Maintenance |
| OCD | Office of Community of Development |
| OMRR&R | Operations, Maintenance, Repair, Rehabilitation, and Replacement |
| OSE | Other Social Effects |
| PA | Public Assistance |
| PA | Programmatic Agreement |
| PARDS | Parks and Recreation of Denham Springs |
| PDM | Pre-Disaster Mitigation Program |
| PED | Planning, Engineering and Design |
| PPA | Project Partnership Agreement |
| REC | Recognized Environmental Condition |
| RED | Regional Economic Development |
| ROD | Record of Decision |
| ROE | Right of Entry |
| RPDES | Regional Planning and Environment Division South |
| RSLR | Relative Sea Level Rise |
| RW | Remove Water |
| SHPO | State Historic Preservation Officer |

| | |
|---|---|
| SLC | Sea Level Change |
| SNO | Seminole Nation of Oklahoma |
| STF | Seminole Tribe of Florida |
| T&E | Threatened and Endangered |
| TBTL | Tunica-Biloxi Tribe of Louisiana |
| THPO | Tribal Historic Preservation Officers |
| TSP | Tentatively Selected Plan |
| UL | Upper and Lower Basin |
| URA | Uniform Relocation Assistance Act |
| USACE | United States Army Corps of Engineers |
| USDA | US Department of Agriculture |
| USGS | United States Geological Survey |
| VOC | Volatile Organic Compound |
| WMA | Wildlife Management Area |
| WRRDA | Water Resources Reform and Development Act |
| WVA | Wetland Value Assessment |

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Amite River and Tributaries East of the Mississippi River, Louisiana (ART)

## Appendix A: Engineering

## November 2019

# CONTENTS

# LIST OF TABLES



# LIST OF FIGURES

# Section 1
# General

This draft Engineering Appendix documents the feasibility level engineering and design for the structural study alternatives. Development of this appendix was in accordance with Engineering Regulation (ER) 1110-2-1150, "Engineering and Design for Civil Works Projects," dated 31 August 1999.

The study area is the Amite River Basin and tributaries. The Amite River Basin begins in southwest Mississippi and flows southward, crossing the state line into southeastern Louisiana. The Amite River Basin includes 2,200 square miles flowing into the Amite River and its tributaries. It includes portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana.

The study area is similar to the 1984 Amite Rivers and Tributaries Flood Control Initial Evaluation Study by the US Army Corps of Engineers (USACE); however, it was expanded to include areas that are impacted by backwater flooding to the southeast and east because they are hydraulically connected to the Amite River Basin and tributaries. The alternatives below were analyzed by the Civil, Geotechnical, and Structures Branches of USACE, Mississippi Valley Division, New Orleans District (MVN), Engineering Division.

# Section 2
# Structural Alternatives

## 2.1 DARLINGTON DRY DAM/DARLINGTON REDUCED WET DAM

Darlington Dry Dam/Darlington Reduced Wet Dam, the Darlington Dam alternative, consists of an earthen dam on the Amite River with the option of being a wet or dry dam. The dam would include an outlet feature (currently three 10 feet by 10 feet box culverts) and a large spillway. The spillway would require a concrete base and walls. Because it is on an earthen base, the spillway would likely require anchor piles and a seepage cutoff. Structural components would also require flip bucket or baffle field and there is the possibility that of gate control towers would be needed. Minor structures could include debris booms, trash racks, etc. Because this alternative was previously studied, data for analyzing it is available in the “Amite River and Tributaries, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope),” dated September 1997.

## 2.2 DRY DAM ON SANDY CREEK

The Dry Dam on Sandy Creek alternative consists of an earthen dam on Sandy Creek, a tributary of the Amite River. Limited data is available; therefore, many assumptions were made such as the geology of the area, the dam theoretical section, the outlet and spillway structure design, and borrow material and quantities.

## 2.3 DRY DAMS ON DARLINGTON, LILLEY, AND BLUFF CREEKS

The dry dams for the Darlington, Lilley, and Bluff Creek alternative consists of three earthen dams on Darlington Creek, Lilley Creek, and Bluff Creek, all tributaries of the Amite River. Limited data is available; therefore, many assumptions were made such as the geology of the area, the dam theoretical section, the outlet and spillway structure design, and borrow material and quantities.

A map showing the locations of the dry retention dams is provided in Figure A:2-1.

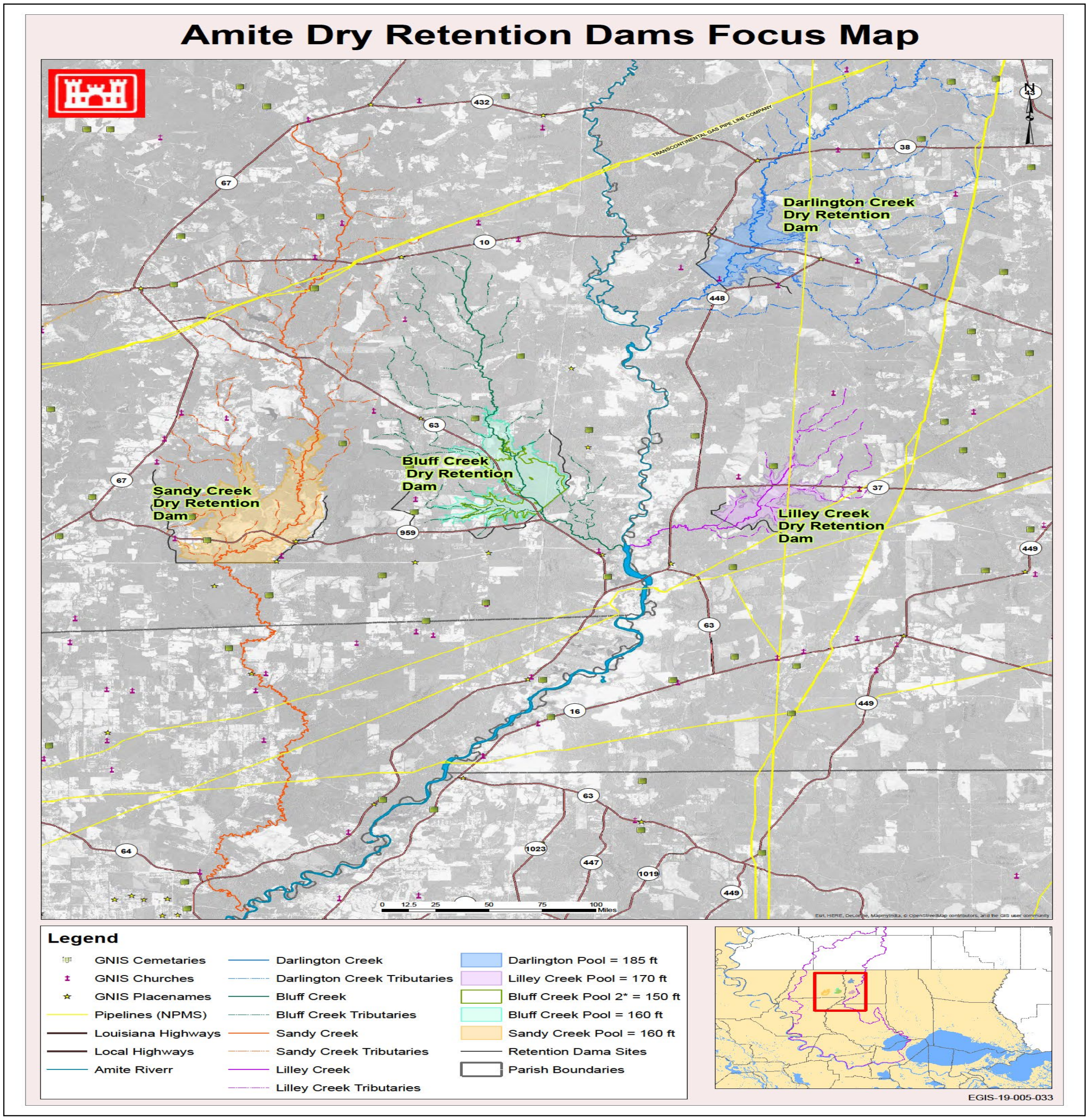



*Figure A:2-1. Amite River Dry Retention Dams Focus Maps*

# Section 3
# Geotechnical Investigations and Design

This portion of the report contains the initial feasibility level geotechnical review performed for the Amite River and Tributaries Study. Alternatives assessed within this study include:

- Darlington Dry Dam/Darlington Reduced Wet Dam alternative
- Dry Dam on Sandy Creek alternative
- Dry Dams on Darlington Creek, Lilley Creek, and Bluff Creek alternative

## 3.1 DARLINGTON DRY DAM/DARLINGTON REDUCED WET DAM

This section presents the results of the geotechnical design assessment of the proposed Darlington Dam. An initial feasibility level study was conducted in 1992 and revised in 1997 for the Darlington Dam. Findings from these studies are documented in the “Amite River and Tributaries, Darlington Reservoir Feasibility Study,” dated September 1992 (1992 study) and in the “Amite River and Tributaries, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope),” dated September 1997 (1997 study).

No new borings or other subsurface investigation was conducted for this project and no additional geotechnical designs were performed as part of this study. In order to assess technical feasibility and update cost estimation, existing geotechnical investigations and analyses were re-evaluated to compare to the current design requirements as per USACE manuals, specifications, and criteria.

The Darlington Dry Dam/Darlington Reduced Wet Dam alternative were analyzed using the same design section, taken from the 1997 report. The dry dam would have a crown elevation 1 foot lower than the reduced wet. The dam would consist of a clay core with a random fill outer layer. The design section would consist of a reservoir with a 24 feet wide crown at elevation 202.8 feet National Geodetic Vertical Datum of 1929 (NGVD 29) and side slopes of 1 vertical on 3 horizontal from the crown to elevation 172.8 feet NGVD 29, the elevation of the flood control pool. On the flood side, from the flood control elevation to the conservation pool elevation, the slope is 1 vertical on 6 horizontal. The flatter slope is to reduce the chances of sudden drawdown failures that tend to occur in this zone. Below the conservation pool elevation, the slope is 1 vertical on 4 horizontal. On the protected side, from the flood pool elevation to the conservation pool, the slope is 1 vertical on 5 horizontal. The flatter slope in this area would increase stability and would resist seepage forces that may concentrate in the lower portion of the dam. Below the conservation pool, the slope is 1 vertical on 3 horizontal. The outlet structure for the dam is three 10 feet x 10 feet box culverts with an emergency spillway.

### 3.1.1 Geology

The Darlington Reservoir Feasibility Study report describes the geology in the project area as:

The study area is in the Southern Pine Hills of the Eastern Gulf Coastal Plain. Topography in the northern portion of the basin is dominated by plateaus and ridgetops underlain by the Citronelle Formation. The southern portion is dominated by gently sloping Pleistocene terrace surfaces.

The maximum elevation within the basin is approximately 500 feet MSL. Elevations are between 35 feet and 40 feet MSL near the junction of the Comite River and Amite River near Denham Springs. Minimum elevations are between 0 and 5 feet in the lower part of the basin near Lake Maurepas.

Although older sediments are found at depth in the study area, only the Plio-Pleistocene and Holocene sediments exposed at the surf ace and found near the surface are discussed. Four distinct geologic units are found within the basin: the Citronelle Formation, the Pleistocene terraces, the loess deposits and Holocene alluvium. The Citronelle Formation, which varies in age from late Pliocene to Pleistocene, generally consists of a gradational sequence of fluvial gravels, cross bedded sands, silts and clays with the coarser grained material occurring at the base of this sequence. South of the outcrop of the Citronelle Formation are found the relatively flat Pleistocene terraces of less variable lithology than that of the Citronelle Formation. Generally, these terraces are comprised of sediments consisting of silt and sandy clay which grade downward into a fine to coarse grained sand with some gravel.

The study area is located in a stable area of low seismicity. Earthquake activity is relatively rare and is usually less severe than average. Resulting damage to structures and levees (dikes) in the project area would be expected to be minor. (USACE, 1992)

### 3.1.2 General Dam Design Discrepancy

The design section developed using slope stability analyses in the 1997 study was designed with a top width of 24 feet. The top width of the dam does not meet EM 1110-2-2300 (General Design and Construction Considerations for Earth and Rock-Fill Dams), Article 4-3, which requires a minimum top width between 25 and 40 feet based on the dam height. However, EM 1110-2-2300 also states that the top width has little effect on stability and is governed by the functional purpose the top of the dam must serve. A thorough assessment of the dam section is recommended to account for design discrepancy prior to the Agency Decision Milestone (ADM). A field investigation plan can be developed pre-ADM with the intent of further exploration post-ADM for final changes.

### 3.1.3 Geotechnical Data Available for Assessment

No borings or soil testing were performed for this study. The assessment was based on borings and soil testing performed in the 1997 study. Seven undisturbed borings (DD-1U to DD-7U) were taken for the 1992 study, one on each dam abutment and five along the center of the dam. Four additional undisturbed borings (DD-8U, DD-9U, DD-10U, and DD-11U) were taken during the 1997 study (see Figure A:3-1), as well as two exploratory trench excavations. The earth core material data obtained from two exploratory trench excavations is adequate for embankment fill construction. There are gaps where no boring information is available along the east and west terraces. In addition, consolidation test data was limited to two borings (DD-9U and DD-10U) located at the center of the dam. It is recommended that additional boring data be taken to supplement existing borings used during the feasibility study.


*Figure A:3-1. Boring Locations*

### 3.1.4 Shear Strength Data

Shear strength tests, including unconsolidated undrained, consolidated undrained, direct shear, and consolidation, were performed on selected samples to obtain design values at MVN during the 1997 study. The shear strength values selected for design (i.e., clay core, embankment soils, and foundation clays, and granular foundation soils) are consistent with current design criteria.

### 3.1.5 Stability Analyses

Stability analyses conducted in the 1992 and 1997 studies were performed for the dam section as per USACE EM 1110-2-1902 (Engineering and Design Stability of Earth and Rock-Fill Dams), dated 1 April 1970. As part of the 1992 study, stability analyses were performed for seven separate reaches along the length of the dam: the east abutment terrace, east abutment, river closure, east river terrace, west abutment terrace, west river terrace, and west abutment. Stability analyses for these runs included end of construction analyses (required Factor of Safety [FOS] of 1.3, long-term analysis (required FOS of 1.5), and a sudden draw-down analysis (required FOS of 1.0). In all cases analyzed in 1992, the construction case (short-term) governed the design cross-section of the dam. The scope of the stability analyses conducted for the 1997 study was limited to using new boring and strength data in order to determine if a reduced dam cross section is feasible in order to reduce cost of the structure. Analysis in the 1997 report was limited to the East River Terrace reach, which was chosen because it has clay strata closer to the ground surface and is more critical from a stability viewpoint. The 1997 study analyzed the critical end of construction analysis (both upstream and downstream) for this reach, but did not look at long-term, maximum surcharge pool, or sudden draw-down cases. The end of construction analyses resulted in a safety factor greater than 1.4. Several additional end of construction analyses were assessed using modified parameters to simulate a direct shear value for the core and strain softening of the foundation clay.

The current EM 1110-2-1902, (Slope Stability) dated 31 October 2003, specifies a minimum FOS 1.3 (for end-of-construction including stage construction for both upstream and downstream), 1.5 (Long-term for steady seepage, maximum storage pool, spillway crest or top of gates at downstream), 1.4 (maximum surcharge pool at downstream), and 1.1-1.3 (Rapid drawdown from maximum surcharge pool and storage pool, respectively at upstream). The analyses run for the 1997 study are adequate for cost estimation purposes for the Darlington Dam alternative. To comply with the current EM 1110-2-1902, the full range of stability analyses are required for final design and construction. USACE Method of Planes using the Stability with Uplift program and Spencer's method using the Slope/W program are recommended for stability analyses. This analysis can be completed post ADM with additional exploration data.

### 3.1.6 Seepage Analysis

Seepage analyses were not performed in the 1997 study due to lack of information. However, the following seepage control methods were recommended for embankment, foundation, abutments, and spillway section areas. A clay core with a 4 feet crest width at elevation 192 and 30 feet width at the ground surface was proposed to control seepage through the embankment. A 70 feet deep slurry trench was proposed to control seepage through the foundation. An upstream drainage control blanket was recommended to control seepage at abutment areas. The spillway section (i.e., see in the plate 12 in 1997 study report) with sheetpile at upstream and downstream were proposed to control the seepage. Boring DD-11U, taken near the location of the spillway, shows a clay layer of approximately 20 feet thick. The 20 feet clay layer, in combination with the clay core of the dam, were assumed to reduce seepage in spillway areas. To comply with EM 1110-2-1901, a thorough seepage analysis to include mitigation features, including proposed cutoffs and upstream blanket, is recommended to adequately assess and design seepage control measures for embankment, foundation, abutments, and spillway section areas. This analysis can be completed post ADM with additional exploration data.

### 3.1.7 Foundation Settlement

Settlement analyses were not performed in the 1997 study due to a limited scope and money restraints. Consolidation tests revealed a stiff clay deposit with high preconsolidation values, thus it was assumed that only one percent foundation settlement would occur. However, consolidation testing was only available in two of the 11 borings taken through the length of the dam. For this assessment, an additional 15 percent of embankment fill and 25 percent of compacted clay core fill was included in cost estimates to account for construction and foundation settlement. It is recommended that additional borings be taken and a complete settlement analysis be conducted during engineering design, to adequately assess settlement conditions. This analysis can be completed post ADM with additional exploration data.

### 3.1.8 Conclusion and Recommendations

It was determined that the limited analyses performed for the 1997 study are considered adequate for cost estimating purposes of the Darlington Reservior alternative. It is recommended that additional boring data be taken during engineering design to supplement existing borings used during the feasibility study. Complete stability designs on all reaches should be conducted to all cases specified in EM 1110-2-1902. It is recommended that a seepage analysis be performed based on EM 1110-2-1901, to better assess seepage conditions and accurately define seepage mitigation measures. A complete settlement analyses is recommended during engineering design to adequately assess settlement conditions.

## 3.2 DRY DAMS ALTERNATIVES

Two additional dry retention dam alternatives were considered as part of this study, the Dry Dam on Sandy Creek alternative and the Dry Dam on Darlington, Lilley, and Bluff Creek alternative. These dry dams would be placed on tributaries along the Amite River. These dry dams were considered as a conceptual alternative. Foundation conditions are unknown within the proposed alignments and no subsurface investigations were conducted as part of this study. For cost estimating purposes, a scaled down dam cross section was derived from the Darlington Dam cross section. These design sections are conceptually based on site specific assumptions used in the 1997 report. No site specific geotechnical analyses were performed at the individual dry dam locations.

# Section 4
# Datum and Topography

Light Detection and Ranging (LIDAR) was obtained from the Louisiana Department of Transportation (LADOTD). The datasource was LADOTD LIDAR for Amite Watershed, Louisiana. LIDAR data acquisition occurred from January to March 2018.

- 2 foot LIDAR; Digital Elevation Model (DEM) grid developed by LADOTD
- Vertical Control = North American Vertical Datum of 1988 (NAVD 88) (2009.55) GEOID12B
- LASOUTH 1702 NAD83 map projection

The geographic information system (GIS) software tool, ArcGIS, was used to extract raster data around the Amite Dam and dry dam sites and generate contours at 1 foot intervals for all sites.

# Section 5
# Civil Design

## 5.1 DARLINGTON DAM

### 5.1.1 Two Options: Dry Dam and Reduced-Wet Dam

The design section was taken from the 1997 report and consists of a reservoir with a 24 feet wide crown at elevation 202.8 feet (NGVD 29), side slopes of 1 vertical on 3 horizontal, from the crown to the elevation of the flood control pool at 172.8 feet (NGVD 29). On the floodside, from the flood control elevation to the conservation pool elevation, the slope is 1 vertical on 6 horizontal. The flatter slope is to reduce the chances of sudden drawdown failures that tend to occur in this zone. Below the conservation pool elevation, the slope is 1 vertical on 4 horizontal. On the protected side, from the flood pool elevation to the conservation pool, the slope is 1 vertical on 5 horizontal. The flatter slope in this area will increase stability and will resist seepage forces that may concentrate in the lower portion of the dam. Below the conservation pool, the slope is 1 vertical on 3 horizontal. The outlet structure consists of three 10 feet x 10 feet concrete box culverts with a spillway at the flood control pool elevation. Updated quantities were obtained and provided to Cost Engineering.

### 5.1.2 Borrow Assumptions

The top 5 feet of surface material would not be used for clay or random fill. For clay fill, assume a depth of 12 feet below the surface material, for a total depth of 17 feet. For random fill, assume a depth of 15 feet below the surface material, for a total depth of 20 feet. A ratio of 2:1 would be used for losses. For every 1.0 cubic yard (CY) of material needed, 2.0 CY of material would be obtained from the borrow source.

## 5.2 DRY DAM ON SANDY CREEK

### 5.2.1 Data & Analysis

No borings were taken or geotechnical analysis performed on this alternative. All embankment dimensions were copied from the 1992 study, for the dry dam alternative. The dam consists of a clay core with a random fill outer layer. Similarly, no hydraulic analysis was performed on the outlet structure. For cost purposes, the cost of the outlet structure for Darlington Dam on the Amite River would be used for the outlet structures for these dry dams, with a scale factor provided by the Hydraulic, Hydrology, and Coastal Engineering (HH&C) Branch. During a rain event, sluice gates would be closed to prevent flow and create a pool of water behind the dam. An emergency spillway would be placed at the flood control pool max elevation.

### 5.2.2 Borrow Assumptions

Borrow assumptions for this alternative are the same as those described in section 5.1.2.

Dam Dimensions:

- Crown Width: 24 feet
- Embankment Slope 1:5

### 5.2.3 Quantities

Table A:5-1 provides pertinent dam dimensions for the Sandy Creek Dam that was used to generate quantities for the development of cost estimates.

*Table A:5-1. Sandy Creek*

| | | | |
|---|---|---|---|
| **Maximum Elevation (ft) (NGVD29)** | 160 | | |
| **Estimated Average Ground Elevation (ft) (NGVD29)** | 130 | | |
| **0.01 (100 yr) Annual Exceedance Probability (AEP) Pool Elevation (ft) (NGVD29)** | 150.4 | | |
| **0.002 (500 yr) AEP Pool Elevation (ft) (NGVD29)** | 155.3 | | |
| **Length (ft)** | 7,719 | | |
| **Contour 160 foot Acreage (AC)** | 3,552.37 | | |
| **Dam Footprint (AC)** | 58 | | |
| **Borrow Acres (AC) (clay + random = total)** | 20 + 132 = 152 | | |
| **Outlet Cost Scale Factor** | 0.15 | | |
| **Quantities** | **Clay** | 195,405.06 | CY |
| | **Random Fill** | 1,602,172.79 | CY |
| | **Foundation Excavation** | 463,140.00 | CY |
| | **Slurry Trench** | 540,330.00 | SF |
| | **Outlet Cost Factor** | 0.15 | |

## 5.3 DRY DAM ON DARLINGTON, LILLEY, AND BLUFF CREEK

### 5.3.1 Data & Analysis

Data and analysis for this alternative are the same as described in Section 5.2.1.

### 5.3.2 Borrow Assumptions

Borrow assumptions for this alternative are the same as those described in section 5.1.2.

Dam Dimensions:

- Crown Width: 24 feet
- Embankment Slope: 1:5

Tables A:5-2 through A:5-4 provide pertinent dam dimensions that were used to generate quantities for the development of cost estimates.

*Table A:5-2. Darlington Creek*

| | | | |
|---|---|---|---|
| **Maximum Elevation (ft) (NGVD 29)** | 185 | | |
| **Estimated Average Ground Elevation (ft) (NGVD 29)** | 165 | | |
| **0.01 (100 yr) AEP Pool Elevation (ft) (NGVD 29)** | 179.4 | | |
| **0.002 (500 yr) AEP Pool Elevation (ft) (NGVD 29)** | 182.6 | | |
| **Length (ft)** | 3,975 | | |
| **Contour 185 foot Acreage (AC)** | 1,399.03 | | |
| **Dam Footprint (AC)** | 21 | | |
| **Borrow Acres (AC) (clay + random = total)** | 8 + 31 = 39 | | |
| **Outlet Cost Scale Factor** | 0.059 | | |
| **Quantities** | **Clay** | 81,773.19 | CY |
| | **Random Fill** | 378,050.97 | CY |
| | **Foundation Excavation** | 164,722.96 | CY |
| | **Slurry Trench** | 277,970.00 | SF |
| | **Outlet Cost Factor** | 0.059 | |

*Table A:5-3. Lilley Creek*

| | | | |
|---|---|---|---|
| **Maximum Elevation (ft) (NGVD29)** | 170 | | |
| **Estimated Average Ground Elevation (ft) (NGVD29)** | 135 | | |
| **0.01 (100 yr) AEP Pool Elevation (ft) (NGVD29)** | 161.9 | | |
| **0.002 (500 yr) AEP Pool Elevation (ft) (NGVD29)** | 166.8 | | |
| **Length (ft)** | 2,781 | | |
| **Contour 170 foot Acreage (AC)** | 1,034.54 | | |
| **Dam Footprint (AC)** | 24 | | |
| **Borrow Acres (AC) (clay + random = total)** | 9 + 64 = 73 | | |
| **Outlet Cost Scale Factor** | 0.057 | | |
| **Quantities** | **Clay** | 84,627.38 | CY |
| | **Random Fill** | 770,837.07 | CY |
| | **Foundation Excavation** | 192,610.00 | CY |
| | **Slurry Trench** | 194,670.00 | SF |
| | **Outlet Cost Factor** | 0.057 | |

*Table A:5-4. Bluff Creek*

| | | | |
|---|---|---|---|
| **Maximum Elevation (ft) (NGVD29)** | 150 | | |
| **Estimated Average Ground Elevation (ft) (NGVD29)** | 130 | | |
| **0.01 (100 yr) AEP Pool Elevation (ft) (NGVD29)** | 143.5 | | |
| **0.002 (500 yr) AEP Pool Elevation (ft) (NGVD29)** | 145.8 | | |
| **Length (ft)** | 4,978 | | |
| **Contour 150 foot Acreage (AC)** | 1,218.04 | | |
| **Dam Footprint (AC)** | 26 | | |
| **Borrow Acres (AC) (clay + random = total)** | 10 + 39 = 49 | | |
| **Outlet Cost Scale Factor** | 0.033 | | |
| **Quantities** | **Clay** | 98,868.61 | CY |
| | **Random Fill** | 477,164.35 | CY |
| | **Foundation Excavation** | 206,494.81 | CY |
| | **Slurry Trench** | 348,460.00 | SF |
| | **Outlet Cost Factor** | 0.033 | |

# Section 6
# Structural Design

Structures Branch evaluated all data from various reports and/or previous studies to confirm that their assumptions and findings are still valid. The only alternative that had structural design aspects was the Darlington Dam alternative. Within that alternative, a reinforced concrete spillway and reinforced concrete outlet were the only structures planned in the earthen dam. No design criteria or calculations are provided within the 1992 study or the 1997 study reports. Consequently, those structures were not able to be thoroughly analyzed, with the exception of their quantities. Quantities for the 1997 re-evaluation for the 0.04 (25 yr) AEP Reduced Wet Darlington Dam were completed and compared to the original 1992 report. For quantities that were not easily calculated (due to little or no information), best estimates with contingencies were made. Structures Branch also coordinated with others branches within Engineering Division to provide an assessment on the other proposed nonstructural alternatives.

## 6.1 QUANTITIES

Table A:6-1 provides estimated quantiites from the 1992 study for the Darlington Dam 0.04 (25 yr) AEP Reduced Wet alternative that were projected to the 1997 study.

*Table A:6-1. Darlington Dam Quantities*

| 0.04 (25 yr) AEP Reduced Wet<br>Amite River and Tributaries<br>Probable Construction Cost<br>Alternative 12 - Darlington Dam 0.04 (25 yr) AEP Reduced Wet Reservoir | | | |
|---|---|---|---|
| | | | |
| **Item Descriiption** | **New Quantity** | **Old Quantity** | **Unit** |
| | | | |
| **Dam Structure** | Heigtht of Dam: 202.8 LF | Levee Length: 19,100 LF | |
| | | | |
| **Mobilization & Demobilization** | 1 | 1 | JOB |
| | | | |
| **Access Roads** | | | |
| **Low Level Outlet** | | | |
| Site Access Roads | 1 | 1 | JOB |
| **Spillway** | | | |
| Site Access Roads | 1 | 1 | JOB |
| | | | |
| **Care and Diversion of Water**<br>**Dam** | | | |
| Cofferdam | 1 | 1 | JOB |
| **Low Level Outlet** | | | |
| Dewatering Systems - Sumps & Pumps | 1 | 1 | JOB |
| **Spillway** | | | |
| Dewatering Systems - Sumps & Pumps | 1 | 1 | JOB |
| | | | |
| **Earthwork for Structure** | | | |
| **Dam** | | | |
| **Site Work - General** | | | |
| Clearing and Grubbing (no stumps) | 450 | 270 | AC |
| Foundation Excavation (with stumps) - Adjacent Disposal | 3,069,000 | 255,000 | CY |
| Slurry Trench Excavation - 70 ft Depth Avg | 1,260,000 | 1,260,000 | SF |
| Gravel Filter Material | 0 | 1,165,000 | CY |
| Filter Fabric | 0 | 635,000 | SY |
| Semicompacted Fill - Random (Neat + 15%) (includes foundation fill) | 11,800,000 | 9,010,000 | CY |
| Compacted Fill - Select Clay (Neat + 25%) | 856,000 | 1,040,000 | CY |
| Fertilizing & Seeding | 450 | 275 | AC |

| | | | |
|---|---|---|---|
| Pond Elevation Riprap 400 lb Stone 24 inch Thick | 21,000 | | TN |
| **Low Level Outlet** | | | |
| **Site Work - General** | | | |
| Clearing and Grubbing | 0 | 0 | AC |
| Structural Excavation - Adjacent Disposal | 90,000 | 120,000 | CY |
| **Site Work - Inlet and Outlet Channels** | | | |
| Clearing and Grubbing | 8 | 10 | AC |
| Common Excavation - Adjacent Disposal | 90,000 | 120,000 | CY |
| 24 inch Rip Rap | 4,700 | 4,700 | TN |
| 36 inch Rip Rap | 15,000 | 15,000 | TN |
| 6 inch Bedding | 2,500 | 2,500 | CY |
| Filter Fabric | 0 | 22,000 | SY |
| **Spillway** | | | |
| **Site Work - General** | | | |
| Clearing and Grubbing | 20 | 20 | AC |
| Structural Excavation - Adjacent Disposal | 600,000 | 600,000 | CY |
| Semicompacted Fill - Random | 15,000 | 15,000 | CY |
| Compacted Fill - Select Clay | 115,000 | 115,000 | CY |
| Compacted Fill - Select Sand | 26,000 | 26,000 | CY |
| 42 inch Rip Rap | 0 | 123,000 | TN |
| 36 inch Rip Rap | 105,464 | 0 | TN |
| 6 inch Bedding Material | 12,000 | 12,000 | CY |
| **Site Work - Drainage** | | | |
| Slurry Trench Excavation - 75 ft Depth | 76,000 | 76,000 | SF |
| Gravel Filter Material | 34,000 | 34,000 | CY |
| 6 inch Perforated PVC Pipe | 46,000 | 46,000 | LF |
| 12 inch PVC Pipe | 1,800 | 1,800 | LF |
| **Site Work - Spillway Channel** | | | |
| Clearing and Grubbing | 100 | 100 | AC |
| Common Excavation - Adjacent Disposal | 6,200,000 | 6,200,000 | CY |
| **Foundation Piling** | | | |
| **Low Level Outlet** | | | |
| Sheetpile, PZ-22 | 5,000 | 5,000 | SF |
| **Spillway** | | | |
| Sheetpile, PZ-27 | 33,000 | 33,000 | SF |
| **Concrete** | | | |
| **Low Level Outlet** | | | |
| **Culvert Structure - Reinforced Concrete** | | | |
| Stabilization Slab | 5,500 | 7,300 | CY |

| | | | |
|---|---|---|---|
| Wall & Roof | 10,400 | 10,400 | CY |
| Gate Tower | 380 | 380 | CY |
| Alignment Collars | 750 | 750 | CY |
| Stoplogs | 60 | 60 | CY |
| **Culvert Structure - Unreinforced Concrete** | | | |
| Stabilization Slab | 500 | 650 | CY |
| **Spillway** | | | |
| Sand Cement Foundation Treatment | 9,000 | 9,000 | CY |
| **Overflow Section - Reinforced Concrete** | | | |
| Overlay | 50,000 | 50,000 | CY |
| Dowels | 290,000 | 290,000 | LB |
| **Overflow Section - Unreinforced Concrete** | | | |
| Roller Compacted Concrete | 135,000 | 180,000 | CY |
| | | | |
| **Metals** | | | |
| **Low Level Outlet** | | | |
| Trash Racks | 30,000 | 30,000 | LB |
| **Miscellaneous Metals** | | | |
| 24 inch Vent Pipe | 1,600 | 1,600 | LF |
| 3-Bulb Waterstop | 3,500 | 3,500 | LF |
| Expansion Joint Filler | 11,500 | 11,000 | SF |
| | | | |
| **Gate and Equipment** | | | |
| **Low Level Outlet** | | | |
| Sluice Gates (Wt. 7,500 lb ea) | 3 | 3 | EA |
| **Mechanical** | | | |
| **Low Level Outlet** | | | |
| Gate Operation Machinery | 3 | 3 | EA |
| | | | |

# Section 7
# Relocations

## 7.1 GENERAL

The Fifth Amendment to the Constitution of the United States provides that just compensation will be paid for the taking of private property for public use. This “taking” of an interest in real estate, is necessary for Federal Government to subordinate such interest in real estate. In publicly-owned roads and utility systems, the Federal Courts have held that the liability of the United States for such acquisition is the cost of providing substitute facilities where substitute facilities are, in fact, necessary. This is the basis of the facility and utility relocation process. Therefore, it is incumbent that the MVN, Engineering Division, Design Services Branch, Relocations Team perform an investigation of the existing public utilities, facilities, and cemeteries located within the proposed project areas that may be impacted, while taking into account the current design requirements for the recommended plan. In the event that such a facility, utility, cemetery, or town would affect the construction, operation, maintenance, repair, replacement, or rehabilitation of a USACE project, then the MVN Relocations Team must determine the appropriate disposition of the impacted facility. Some facilities may require either a permanent or temporary physical adjustment or displacement to support project activities, engineering requirements, and operation and maintenance needs.

The MVN Relocations Team was tasked with investigating, identifying, and verifying public facilities and utilities located within four dry creek retention dams: Darlington Creek, Lilley Creek, Bluff Creek, and Sandy Creek. Database research included the National Pipeline Database, State Online Natural Resources Information System (SONRIS), Louisiana Department of Natural Resources (LADNR), HTST-IHS, Penwell, Google Earth Pro, and the National Pipeline Mapping System (NPMS) data.

Based on the research and investigations conducted by the MVN Relocations Team, multiple facilities or utilities have been marked, labeled, and identified within the project areas of the aforementioned alternatives. Figures A:7-1 through A:7-4 show the various roads, powerlines, pipelines, and cemetaries located within each alternative.

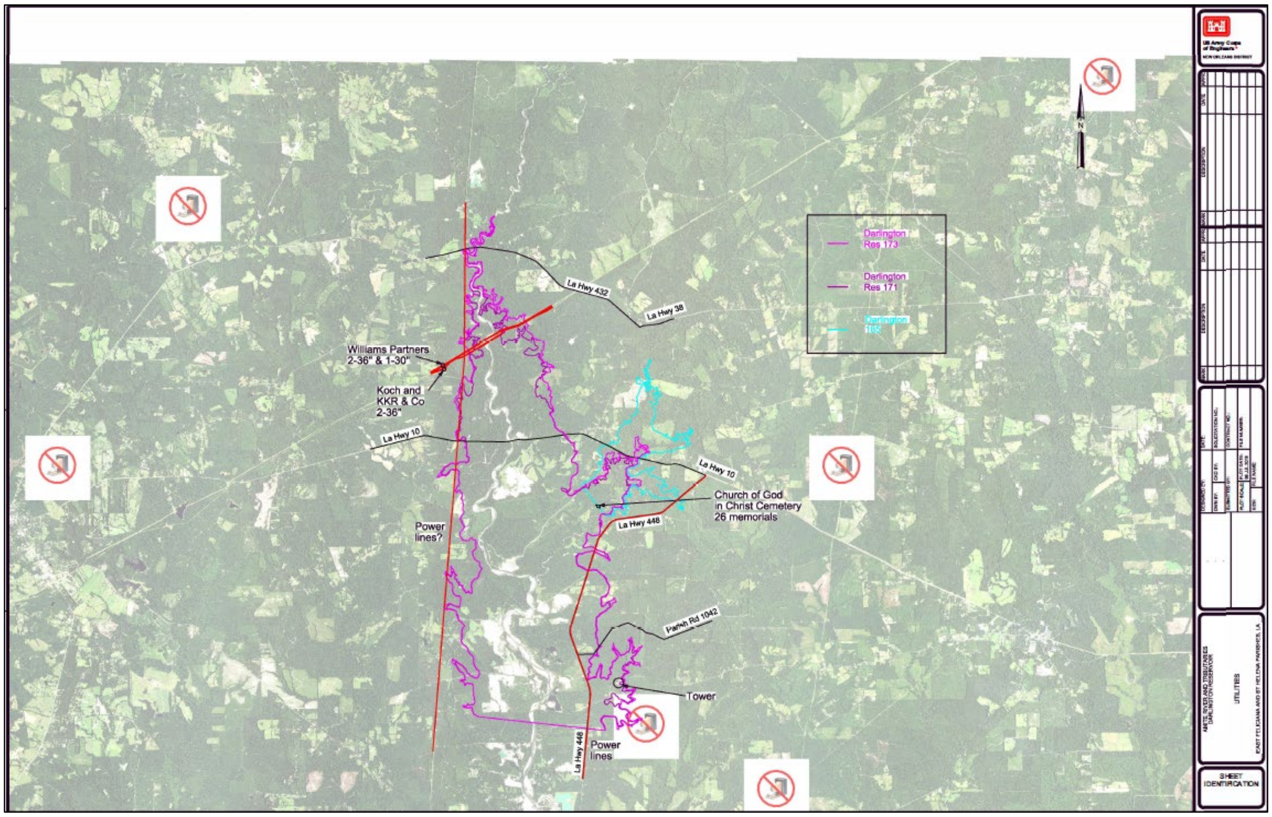



*Figure A:7-1. Darlington Dam – Reduce Wet/Dry Reservoir Alternative*

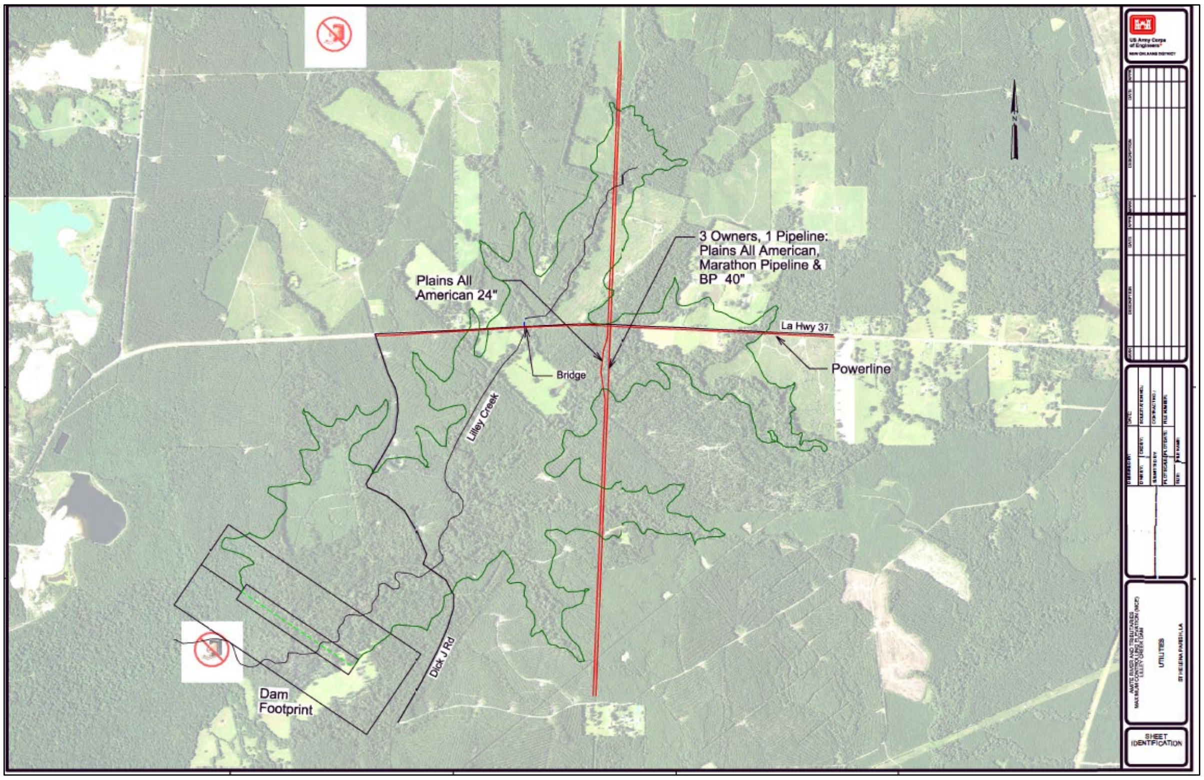



*Figure A:7-2. Bluff Creek – Dry Dam Reservoir Alternative*

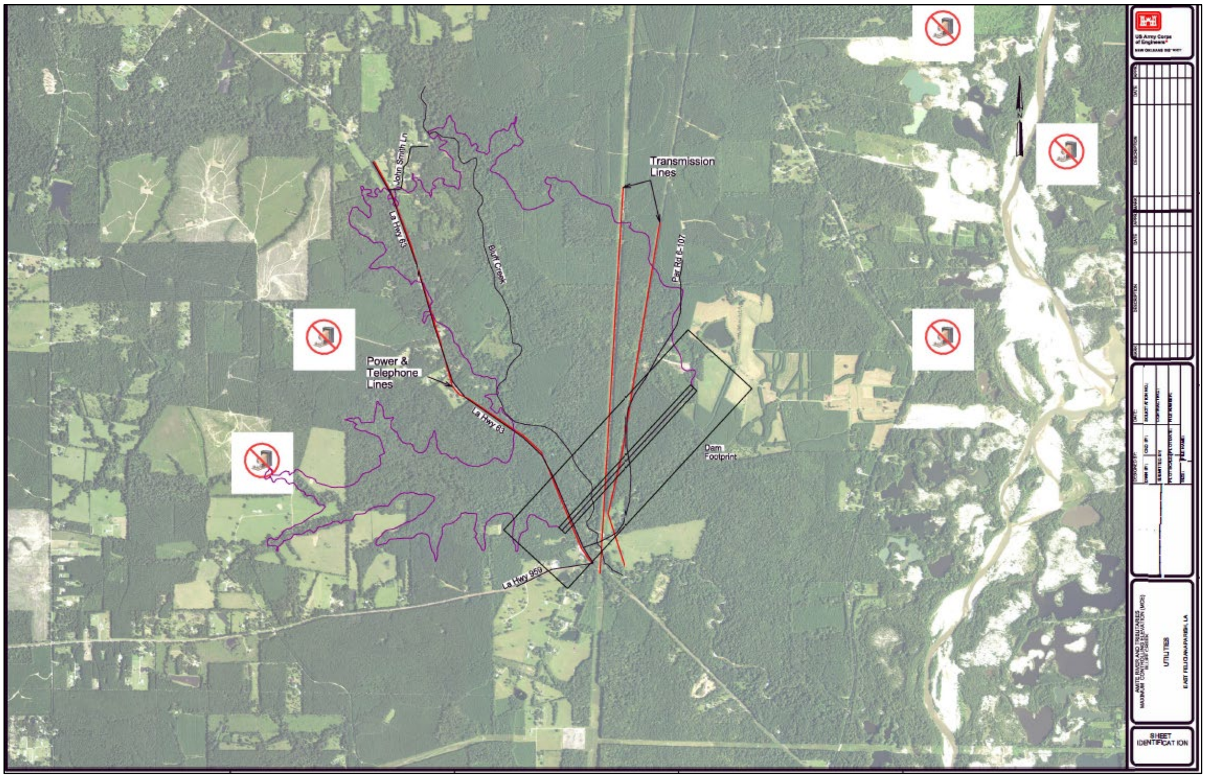



*Figure A7:7-3. Lilley Creek – Dry Dam Reservoir Alternative*

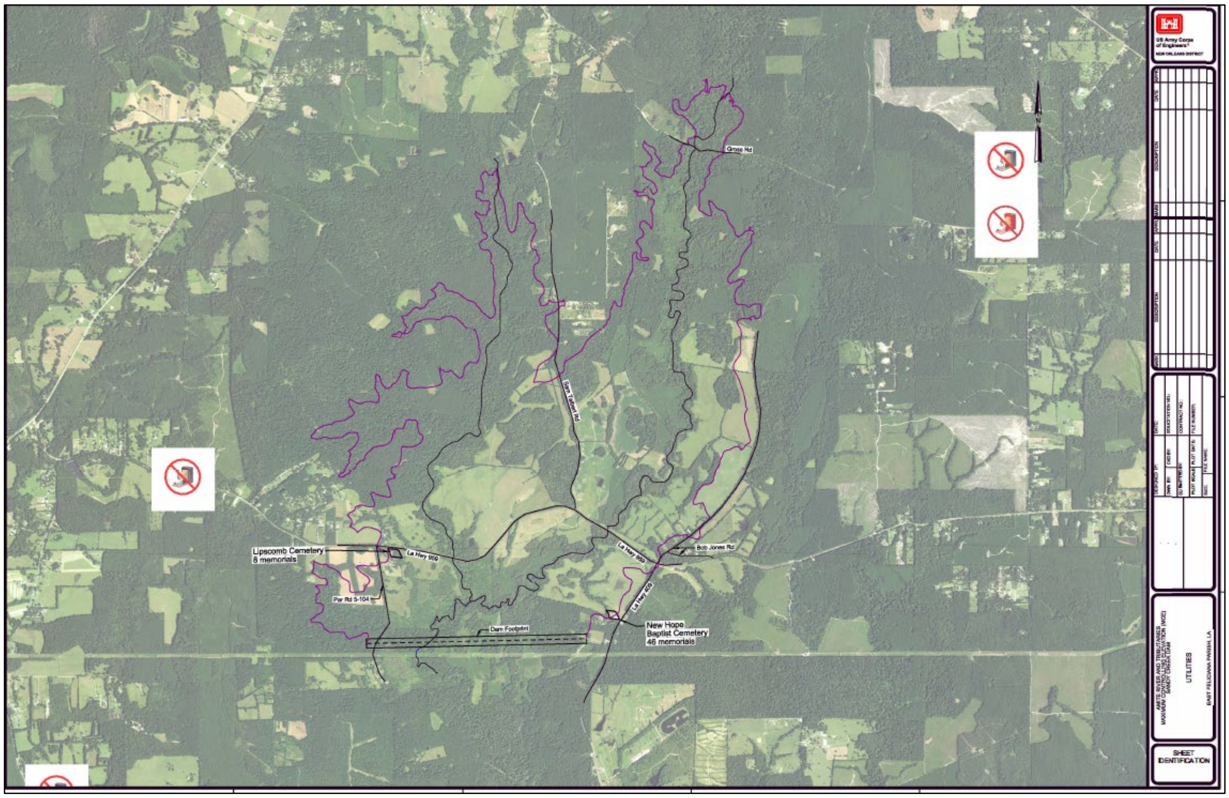



*Figure A:7-4. Sandy Creek – Dry Dam Reservoir Alternative*

## 7.2 ROADWAY RELOCATIONS

Roadway relocations were generally agreed upon to be raised above 0.01 (100 yr) AEP flood elevation full reservoir. Selective roadways were chosen for evacuation routes, only in the case of emergencies. All other existing highways and roads that traverse the proposed reservoir would not be considered to be relocated, rerouted, or raised to accommodate a 0.01 (100 yr) AEP flood event, in accordance with LADOTD standards. Roads that only provide access to areas inside the reservoir limits would be considered abandoned and therefore were excluded from this study. However, one highway (LA Highway 448) located within the Darlington Creek dry reservoir and two secondary roads (Otis and Willie Matthews Road and David Lee Lane) located within the Darlington Creek wet reduced reservoir were impacted by the proposed earthen dams alignments at these two reservoirs; thus, requiring them to be relocated up and over the proposed flood protection required for continuing access for local traffic.

As potential evacuation routes, the following roadways were evaluated as ascertain whether they were above the 0.01 (100 yr) AEP flood elevation:

- Darlington Creek – LA Highway 10 (Figure A:7-1)
- Bluff Creek – Highway 63 (Figure A:7-2)
- Lilley Creek – Highway 37 (Figure A:7-3)
- Sandy Creek – LA Highway 409/Parish Road 104 (Figure A:7-4)

It was determined that only portions of Highway 37 and Highway 63 fell below the 0.01 (100 yr) AEP flood elevation; therefore, requiring minimum relocations to raise them. LA Highway 10 required no relocation. Highway 959 crossing Sandy Creek was considered an evacuation route; however, due to an initial high cost estimate to raise over 2 miles of roadway over the 0.01 (100 yr) AEP flood elevation, it was determine not to be a feasible alternative. The selective route chosen at Sandy Creek was to re-route traffic south, either onto LA Highway 409 or onto Parish Road 104 to Pride, Louisiana as a by-pass alternative route.

The proposed design elevation of the top surface of the replacement of the selected road relocations and the stringer beams of replacement bridges are the 0.01 (100 yr) AEP design flood elevation plus an additional 3 feet of freeboard. Roadway design calls for 24 feet surface roadway with 8 foot shoulders. Highways 37 and 63 would require one bridge replacement at each segment of road relocation.

## 7.3 POWERLINE AND TELEPHONE RELOCATIONS

There are minimum impacts of power distribution lines and telephone lines to be relocated. The only telephone and distribution power lines requiring relocation are along Otis and Willie Matthews Road, David Lee Lane, Highway 37, and LA Highway 448. No transmission lines would require relocation through Bluff Creek and no distribution power lines or telephone lines along Highway 63 would require relocation. Confirmation is required to determine what type of lines (distribution power or transmission lines) are located east of the Darlington Dam–Reduce Wet/Dry Reservoir Alternative; however, it does not appear that they would be impacted.

## 7.4 PIPELINE RELOCATIONS

Pipelines located under proposed permanent water would not be required to be relocated or weighted down to offset negative buoyancy. All pipeline crossings were buried below ground at a minimum of 3 to 5 feet in depth. Minimum requirement for crossing permanent water is 8 to 10 feet in depth.

A. Darlington Dam – Reduce Wet/Dry Reservoir Alternative (Figure A:7-1)
   1. Williams Partners (2 – 36 inch and 1 – 30 inch pipelines)
   2. Koch and KKR & Co. (2 – 36 inch pipelines)

B. Lilley Creek – Dry Dam Reservoir Alternative (Figure A:7-5)
   1. Plains All American (24 – inch pipeline)
   2. Plains All American/Marathon/BP (40–inch pipeline)

## 7.5 CEMETERIES AND CHURCH RELOCATIONS

Three cemeteries have been identified and would be required to be relocated:

- Darlington Creek: Church of God in Christ Cemetery (Figure A:7-5)
- Sandy Creek: Lipscomb Cemetery and New Hope Baptist Cemetery (Figure A:7-4)

Preliminary investigations were conducted to identify the number of memorials at each cemetery. Eight memorials were identified at Lipscomb Cemetery, 46 memorials were identified at New Hope Cemetery, and 26 memorials were identified at Church of God in Christ Cemetery. There is easy access to relocate each cemetery to a nearby proposed site location that is within a 1 mile distance outside of each creek reservoir. Historical investigations, including contact of descendants, excavations, and re-interments including grave markers and burial vaults must meet state and local guidelines and regulations.

The Church of God in Christ Church, located adjacent to its cemetery, would have to be relocated outside the limits of Darlington Creek. This church's structure is estimated to have a living space of 5,000 square-feet, which services the local community. It is recommended that the church, along with its cemetery, be relocated to one location.

## 7.6 RELOCATIONS COST

This section details the relocation costs developed for each alternative.

### 7.6.1 Darlington Dam - Reduced Wet Alternative

The relocation costs for this alternative are for one church, one cemetery, Matthew Road, Lee Lane, and LA 448. The base cemetery cost is $195,000. Including a 226 percent contingency, the cost is $637,000. The reason the cost contingency is very high is due to the likelihood for significant impacts related to Scope Growth. Using internet based research, only one known cemetery was physically located within the boundaries of the flood pool of the dam, but it's believed that further in-depth research would reveal many smaller, unknown cemeteries throughout the project site that would need to be relocated. The base cost for the remaining relocations is $2,839,000. Including a 36 percent contingency, the cost is $3,863,000. The total relocations cost for this alternative is $4,500,000.

### 7.6.2 Darlington Dam - Dry Alternative

The relocation costs for this alternative are the same as those described in section 7.6.1 for the Darlington Dam – Reduced Wet Alternative.

### 7.6.3 Three Tributary Dry Dams Alternative

The relocation costs required for this alternative are for one cemetery, three roads (O&W Rd/David Lee Rd, LA37 & LA63), and two bridges (LA37 & LA63). The base cost for the Cemetery Relocation is $195,000. Including a 222 percent contingency, the cost is $627,000. The cost contingency is very high for cemeteries due to the likelihood for significant impacts related to Scope Growth. Using internet based research one known cemetery was physically located within the boundaries of the flood pool of the dam, but it's believed that further in-depth research would reveal several smaller, unknown cemeteries throughout the project site that would need to be relocated. The base cost for the remainder relocations is $7,525,000. Including a 51 percent contingency, the cost is $11,350,000. The total relocations cost for this alternative is $11,977,000.

### 7.6.4 Sandy Creek Dry Dam Alternative

The only relocation costs required for this alternative are for two cemeteries. The base cost is $415,600. Including a 222 percent contingency, the cost is $1,337,000. The cost contingency is very high due to the likelihood for significant impacts related to Scope Growth. Using internet based research two known cemeteries were physically located within the boundaries of the flood pool of the dam, but it's believed that further in-depth research would reveal several more smaller, unknown cemeteries throughout the project site that would need to be relocated.

# Section 8
# References

USACE, New Orleans District, Amite River and Tributaries, Darlington Reservoir Feasibility Study, dated September 1992.

Harza Consultants (Response to original feasibility study), *Harza Engineering Report*, dated April 1995.

USACE, New Orleans District, (response to Harza Engineering Report), *Amite River and Tributaries, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope)*, dated September 1997.

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Amite River and Tributaries Study East of the Mississippi River, Louisiana (ART)

## Appendix B: Cost Engineering

## November 2019

# CONTENTS

# LIST OF TABLES

# Section 1
# General

## 1.1 COST ESTIMATE DEVELOPMENT

Cost estimates for Structural Alternatives were developed at a Class 4 Level of effort utilizing Parametric costs, Historical costs, or the latest MCACES MII cost estimating software. The cost estimates used the standard approaches for a feasibility estimate structure regarding labor, equipment, materials, crews, unit prices, quotes, and sub and prime contractor markups. This philosophy was taken wherever practical within the time constraints. It was supplemented with estimating information from other sources, where necessary, such as quotes, bid data, and Architect-Engineer (A-E) estimates. The intent was to provide or convey a “fair and reasonable” estimate that depicts the local market conditions. The estimates assume a typical application of tiered subcontractors. All of the construction work (e.g., dam structure, dredging, excavation, dewatering, pilings, rock, etc.) is common to the Gulf Coast region. The construction sites are accessible from land and access is easily provided from various local highways.

The cost estimates for the Non-Structural Alternatives were developed by the US Army Corps of Engineers, Mississippi Valley Division, New Orleans District (MVN) Economist, and are discussed in the Appendix: F Economics and Main Report.

## 1.2 ESTIMATE STRUCTURE

The estimates are structured to reflect the projects performed. The estimates have been subdivided by alternative and US Army Corps of Engineers (USACE) feature codes.

## 1.3 BID COMPETITION

It is assumed that there will not be an economically saturated market and that there will be bidding competition

## Section 2

# Contract Acquisition Strategy

There is no declared contract acquisition plan/types at this time. It is assumed that the contract acquisition strategy will be similar to past projects with large, unrestricted, design/bid/build contracts

# Section 3
# Labor Shortages

It is assumed there will be a normal labor market.

## Section 4

# Labor Rate

Local labor market wages are above the local Davis-Bacon Wage Determination, so actual rates have been used. Local payroll information was not available; therefore, regional gulf coast information was used from MVN construction representatives and estimators with experiences in past years.

# Section 5
# Materials

Cost quotes are used on major construction items when available. Recent cost quotes may include concrete, steel sheet piling, rock, gravel, and sand. The assumption is that materials will be purchased as part of the construction contract. The estimate does not anticipate government furnished materials, except for borrow materials. Prices include delivery of materials.

All borrow material is assumed government furnished. Specific sources for borrow material have not yet been established. The non-Federal local sponsor has assisted with researching possible sources and stated there is very likely acceptable borrow for random fill within a 5 mile radius of the project and within a 20 mile radius of the project for clay fill. An assumed average one-way haul distance of 5 miles was used for random fill and an average one way haul distance of 20 miles for clay fill was used, until a borrow source has been confirmed. Haul speeds are estimated using a 40 mph speed average, given the rural access roads and highways.

The borrow quantity calculations followed the MVN Geotechnical guidance:

> Hauled Levee: 10 BCY (bank cubic yards) of borrow material = 12 LCY (loose cubic yards) hauled = 8 ECY (embankment cubic yards) compacted.

Soil compaction factors can vary considerably with soil material gradation and moisture content. As borrow data was not available at this time materials obtained for fill were assumed to mimic Bonnet Carre Spillway borrow materials.

# Section 6
# Quantities

Quantities for dam alternatives were provided by civil and structural designers for the various alternatives.

# Section 7
# Equipment

Rates used are based from the latest USACE Engineer Pamphlet (EP)-1110-1-8, Region III. Adjustments are made for fuel, filters, oil, and grease (FOG) prices and Facility Capital Cost of Money (FCCM). Judicious use of owned verses rental rates was considered based on typical contractor usage and local equipment availability. Only a few select pieces of marine/marsh equipment are considered rental. Full FCCM/Cost of Money rate is latest available; MII program takes the EP recommended discount, no other adjustments have been made to the FCCM. Equipment was chosen based on historical knowledge of similar projects.

# Section 8
# Severe Rates

Severe equipment rates were used, where applicable, for various pieces of equipment in the hydraulic dredging crews where they may come in contact with any harsh environment.

Rental rates were used, where applicable, for various pieces of marine and marsh equipment, where rental is typical, such as marsh backhoes.

# Section 9

# Fuels

Fuels (gasoline, on and off-road diesel) were based on local market averages for on-road and off-road for the Gulf Coast area. Historic data gathered in the Greater New Orleans area over the last 10 years shows fuel cost have risen and fallen at irregular rates; therefore, an average fuel cost was assumed.

# Crews

Major crew and productivity rates were developed and studied by senior USACE estimators familiar with the type of work. All of the work is typical to the Gulf Coast area and MVN Cost Engineers. The crews and productivities were checked by local MVN estimators, discussions with contractors and comparisons with historical cost data. Major crews include haul, earthwork, piling, concrete, and hydraulic dredging.

Most crew work hours are assumed to be 10 hours, 6 days/week, which is typical to the area. Marine based bucket excavation/dredging operators are assumed to work two 12 hours shifts, 7 days/week.

A 10 percent markup on labor for weather delay is selectively applied to the labor in major earthwork placing detail items and associated items that would be affected by weather making it unsafe or difficult to place (trying to run dump trucks on a wet levee) or be detrimental/non-compliant to the work being done (trying to place/compact material in the rain). The 10 percent markup is to cover the common practice of paying for labor arriving to the job site and then being sent home due to minor weather, which is part of known average weather impacts as reflected within the standard contract specifications. The markup was not applied to small quantities where this can be scheduled around.

## Section 10

# Unit Prices

The unit prices found within the various project estimates will fluctuate within a range between similar construction units such as floodwall concrete, earthwork, and piling. Variances are a result of differing haul distances (trucked or barged), small or large business markups, subcontracted items, designs, and estimates by others.

# Section 11

# Relocation Costs

Relocation costs are defined as the relocation of public roads, bridges, railroads, and utilities required for project purposes. In cases where potential significant impacts were known, costs were included within the cost estimate.

## Section 12

# Mobilization

Contractor mobilization and demobilization (mob/demob) are based on the assumption that most of the contractors will be coming from within the Gulf Coast/Southern region. Mob/demob costs are based on historical studies of detailed Government estimate mob/demob, which are in the range of approximately 3 to 5 percent of the construction costs. With undefined acquisition strategies and assumed individual project limits, the estimate utilizes a slightly more comprehensive, approximate 4 percent value (min) applied at each contract rather than risking minimizing mob/demob costs by detailing costs based on an assumed number of contracts. This value also matches well with values previously prescribed by USACE Walla Walla District, which has studied historical rates.

## Section 13

# Field Office Overhead

The estimate used a field office overhead rate of 12 percent for the prime contractors at budget level development. Based on historical studies and experience, USACE Walla Walla District has recommended typical rates ranging from 9 percent to 11 percent for large civil works projects; however, the 9-11 percent rate does not consider possible incentives such as camps, allowances, travel trailers, meals, etc., which have been used previously to facilitate large or remote projects. With undefined acquisition strategies and assumed individual project limits, the estimate utilizes a more comprehensive percentage based approach applied at each contract rather than risking minimizing overhead costs by detailing costs based on an assumed number of contracts. The applied rates were previously discussed among numerous USACE Cost Engineers including Walla Walla, Vicksburg, Norfolk, Huntington, St. Paul, and New Orleans Districts.

## Section 14

# Overhead Assumptions

Overhead assumptions may include superintendent, office manager, pickups, periodic travel, costs, communications, temporary offices (contractor and government), office furniture, office supplies, computers and software, as-built drawings and minor designs, tool trailers, staging setup, camp/facility/kitchen maintenance and utilities, utility service, toilets, safety equipment, security and fencing, small hand and power tools, project signs, traffic control, surveys, temp fuel tank station, generators, compressors, lighting, and minor miscellaneous.

## Section 15

# Home Office Overhead

Estimate percentages range based upon consideration of 8(a), small business, and unrestricted prime contractors. The rates are based upon estimating and negotiating experience, and consultation with local construction representatives. Different percent are used when considering the contract acquisition strategy regarding small business 8(a), competitive small business and large business, high to low respectively. The applied rates were previously discussed among numerous USACE Cost Engineers including Walla Walla, Vicksburg, Norfolk, Huntington, St. Paul, and New Orleans Districts.

## Section 16

# Taxes

Local taxes will be applied based on the parishes that contain the work. Reference the tax rate website for Louisiana: http://www.salestaxstates.com.

# Section 17
# Bond

Bond is assumed 1 percent applied against the prime contractor, assuming large contracts. No differentiation was made between large and small businesses.

## Section 18

# Planning, Engineering & Design (PED)

The PED cost includes such costs as project management, engineering, planning, designs, investigations, studies, reviews, value engineering and Engineering During Construction (EDC). Historically, a rate of approximately 12 percent for Engineering and Design (E&D) plus small percentages for other support features is applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis, and St. Louis have reported values ranging from 10-15 percent for E&D. Additional support features might include project management, engineering, planning, designs, investigations, studies, reviews, and value engineering. An E&D rate of 12 percent was applied.

## Section 19

# Supervision & Administration (S&A)

Historically, a range from 5 percent to 15 percent, depending on project size and type, was applied against the estimated construction costs. Other USACE civil works districts such as St. Paul, Memphis, and St. Louis report values ranging from 7.5-10 percent. Consideration includes that a portion of the S&A effort could be performed by contractors. S&A costs are percentage based. An S&A rate of 11 percent was applied.

# Section 20
# Contingencies

Contingencies for the focused array of Structural Alternatives were developed using the USACE Abbreviated Cost Risk Analysis (ARA) program. An ARA is a qualitative approach used by PDT to address key risk concerns for major features of work and their impact to cost and schedule drivers such as Project Scope Growth, Acquisition Strategy, Construction Elements, Quantities, Specialty Fabrication or Equipment, Cost Estimate Assumptions, and External Project Risks. A separate ARA was prepared for each alternative to differentiate between the alternatives. Each alternative had very similar features of work and similar risk concerns, but the Sandy Creek Dry Dam and the three Tributary Dams had higher risk contingencies due of lack of geotechnical and Hydrological data and historical information in the area of these smaller dams and design scaled down some quantities of the larger Darlington Dam to minimize design effort at this phase.

# Section 21
# Escalation

Escalation used is based upon the latest version of the USACE Engineering Manual (EM) 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS).

## Section 22

# Hazardous, Toxic, and Radioactive Waste

The estimate does not include costs for any potential Hazardous, Toxic, and Radioactive Waste (HTRW). A Phase I Environmental Site Assessment will be conducted prior to the Final IFR and EIS. The final report will include any estimated costs to address potential HTRW.

# Section 23
# Schedule

The project schedule for each alternative was developed based on the construction line items for each feature of work.

For the Darlington Dam – Reduced Wet and Dry Dam Alternatives, it was assumed Engineering and Design (E&D), Cultural Resources Surveys and Cultural Mitigation, Environmental T&E Species and Habitat Mitigation, and Real Estate acquisition would start in 2021 and construction would begin in 2022. The construction duration for each alternative would be 4 years, with completion in 2026.

For Sandy Creek Dry Dam and the three Tributary Dry Dam Alternatives it was assumed E&D, Cultural Resources Surveys and Cultural Mitigation, Environmental T&E Species Investigation and Habitat Mitigation, and Real Estate acquisition would start in 2021 and construction would begin in 2024. The construction duration for each alternative would be for 2 years, with completion by 2026.

# Section 24
# Cost Estimate

Tables B:24-1 through B:24-4 show the baseline project cost for each focused array alternative.

*Table B:24-1. Darlington Dam – Reduced Wet*

| Feature | Cost | Contingency | Total |
|---|---|---|---|
| 01 Lands & Damages | $133,490,000 | $30,785,000 | $164,275,000 |
| 02 Relocations | $3,034,000 | $1,466,000 | $4,500,000 |
| 04 Dams | $448,369,000 | $178,595,000 | $626,964,000 |
| 06 Fish & Wildlife Facilities | $569,050,000 | $112,762,000 | $681,812,000 |
| 18 Cultural Resources Preservation | $83,445,000 | $28,624,000 | $112,069,000 |
| 30 PED | $92,538,000 | $36,912,000 | $129,450,000 |
| 31 Construction Management | $49,654,000 | $19,807,000 | $69,461,000 |
| **TOTAL** | $1,379,580,000 | $408,951,000 | **$1,788,531,000** |

*Table B:24-2. Darlington Dam - Dry*

| Feature | Cost | Contingency | Total |
|---|---|---|---|
| 01 Lands & Damages | $133,299,000 | $30,722,000 | $164,021,000 |
| 02 Relocations | $3,034,000 | $1,466,000 | $4,500,000 |
| 04 Dams | $441,389,000 | $175,260,000 | $616,649,000 |
| 06 Fish & Wildlife Facilities | $159,894,000 | $31,684,000 | $191,578,000 |
| 18 Cultural Resources Preservation | $78,506,000 | $27,607,000 | $106,113,000 |
| 30 PED | $91,107,000 | $36,229,000 | $127,336,000 |
| 31 Construction Management | $48,887,000 | $19,439,000 | $68,326,000 |
| **TOTAL** | $956,116,000 | $322,407,000 | **$1,278,523,000** |

*Table B:24-3. Sandy Creek Dry Dam*

| Feature | Cost | Contingency | Total |
|---|---|---|---|
| 01 Lands & Damages | $12,568,000 | $3,395,000 | $15,963,000 |
| 02 Relocations | $416,000 | $921,000 | $1,337,000 |
| 04 Dams | $80,773,000 | $39,709,000 | $120,482,000 |
| 06 Fish & Wildlife Facilities | $29,681,000 | $5,881,000 | $35,562,000 |
| 18 Cultural Resources Preservation | $41,947,000 | $17,313,000 | $59,260,000 |
| 30 PED | $16,644,000 | $8,329,000 | $24,973,000 |
| 31 Construction Management | $8,931,000 | $4,469,000 | $13,400,000 |
| **TOTAL** | $190,960,000 | $80,017,000 | **$270,977,000** |

*Table B:24-4. Three Tributary Dry Dams*

| Feature | Cost | Contingency | Total |
|---|---|---|---|
| 01 Lands & Damages | $15,366,000 | $3,662,000 | $19,028,000 |
| 02 Relocations | $7,720,000 | $4,257,000 | $11,977,000 |
| 04 Dams | $99,105,000 | $47,604,000 | $146,709,000 |
| 06 Fish & Wildlife Facilities | $33,696,000 | $6,677,000 | $40,373,000 |
| 18 Cultural Resources Preservation | $57,464,000 | $24,443,000 | $81,907,000 |
| 30 PED | $21,899,000 | $10,632,000 | $32,531,000 |
| 31 Construction Management | $11,751,000 | $5,704,000 | $17,455,000 |
| **TOTAL** | $247,001,000 | $102,979,000 | **$349,980,000** |

Additionally, there were two nonstructural alternatives that were included in the Focused Array of Alternatives which were assessments of all residential and non-residential structures located within the 0.04 and 0.02 AEP flood plains of the study area. The cost estimates for the 0.04 and 0.02 AEP nonstructural features were developed based on the cost of reducing risk of damage to the structures in the year 2026 respective flood plains. Details of these costs and their development are presented in Appendix F.

- Nonstructural 0.04 AEP Alternative - First Cost - $1,335,282,000
- Nonstructural 0.02 AEP Alternative - First Cost - $2,160,836,000

Based on the economic analysis of the focused array the National Economic Development (NED) plan is the Darlington Dry Dam, which is also the PDT's Tentatively Selected Plan (TSP). To further evaluate possible inclusion of nonstructural features into the TSP, Economics performed preliminary analysis of the flood risk that remains in the floodplain after the proposed alternative is implemented. This is known as the residual flood risk and nonstructural measures can be used to reduce the residual risk associated with the TSP. The preliminary analysis found a total of 3,252 residential structures and an additional 314 non-residential structures in the 0.04 AEP floodplain that were considered eligible for acquisition, elevation and flood proofing conditional to certain criteria as described in Appendix F. The baseline project cost for the TSP/NED plan which includes the Darlington Dry Dam combined with the nonstructural measures is shown in Table 24-5.

*Table B:24-5. Darlington Dry Dam With 0.04 AEP Elevations & Floodproofing*

| Feature | Cost | Contingency | Total |
|---|---|---|---|
| 01 Lands & Damages | $133,299,000 | $30,722,000 | $164,021,000 |
| 02 Relocations | $3,034,000 | $1,466,000 | $4,500,000 |
| 04 Dams | $441,389,000 | $175,260,000 | $616,649,000 |
| 06 Fish & Wildlife Facilities | $159,894,000 | $31,684,000 | $191,578,000 |
| 18 Cultural Resources Preservation | $78,506,000 | $27,607,000 | $106,113,000 |
| 30 PED | $91,107,000 | $36,229,000 | $127,336,000 |
| 31 Construction Management | $48,887,000 | $19,439,000 | $68,326,000 |
| Nonstructural 0.04 AEP - First Cost | $761,485,000 | $262,713,000 | $1,024,198,000 |
| **TOTAL** | $1,717,601,000 | $585,120,000 | **$2,302,721,000** |

Further details of how the Nonstructural 0.04 AEP - First Cost was developed can be found in Appendix F.

Mississippi River Valley Division,
Regional Planning and Environment Division South

# Amite River and Tributaries East of the Mississippi River, Louisiana (ART)


## Appendix C-1 – Supporting Information
## November 2019

# CONTENTS

**List of Tables**

# LIST OF FIGURES

# Section 1
# Inventory and Forecast Conditions

## 1.1 ENVIRONMENTAL SETTINGS

### 1.1.1 Land Use

Table C1-1 and Figure C1-1 below show the land use classification in acres in 2015 in the study area. This data indicate that majority of the land in the Study consists of forested wetlands (i.e. Woody Wetlands), Shrub/Scrub, and Evergreen Forest. The lower half of the Amite River Basin (ARB) is also more developed compared to the lands in the upper ARB.

*Table C1-1. Land Use Classification in the Study Area*

| Amite Land Use | | |
|---|---|---|
| Type | Acres | Percent |
| Open Water | 0 | 0% |
| Developed, Open Space | 414,851 | 6% |
| Developed, Low Intensity | 343,755 | 5% |
| Developed, Medium Intensity | 143,804 | 2% |
| Developed, High Intensity | 42,675 | 1% |
| Hay/Pasture | 624,560 | 9% |
| Cultivated Crops | 362,253 | 5% |
| Barren Land | 39,880 | 1% |
| Deciduous Forest | 171,630 | 2% |
| Evergreen Forest | 1,116,398 | 16% |
| Mixed Forest | 239,171 | 3% |
| Shrub/Scrub | 1,165,556 | 17% |
| Herbaceuous | 137,011 | 2% |
| Woody Wetlands | 2,123,732 | 30% |
| Emergent Herbaceuous Wetlands | 104,067 | 1% |
| Total | 7,029,343 | 100% |
| | | |
| Developed | 945,085 | 14% |
| Agricultural | 986,813 | 14% |
| Undeveloped | 5,097,445 | 72% |
| Total | 7,029,343 | 100% |
| Source: USGS National Land Cover Database 2015 | | |

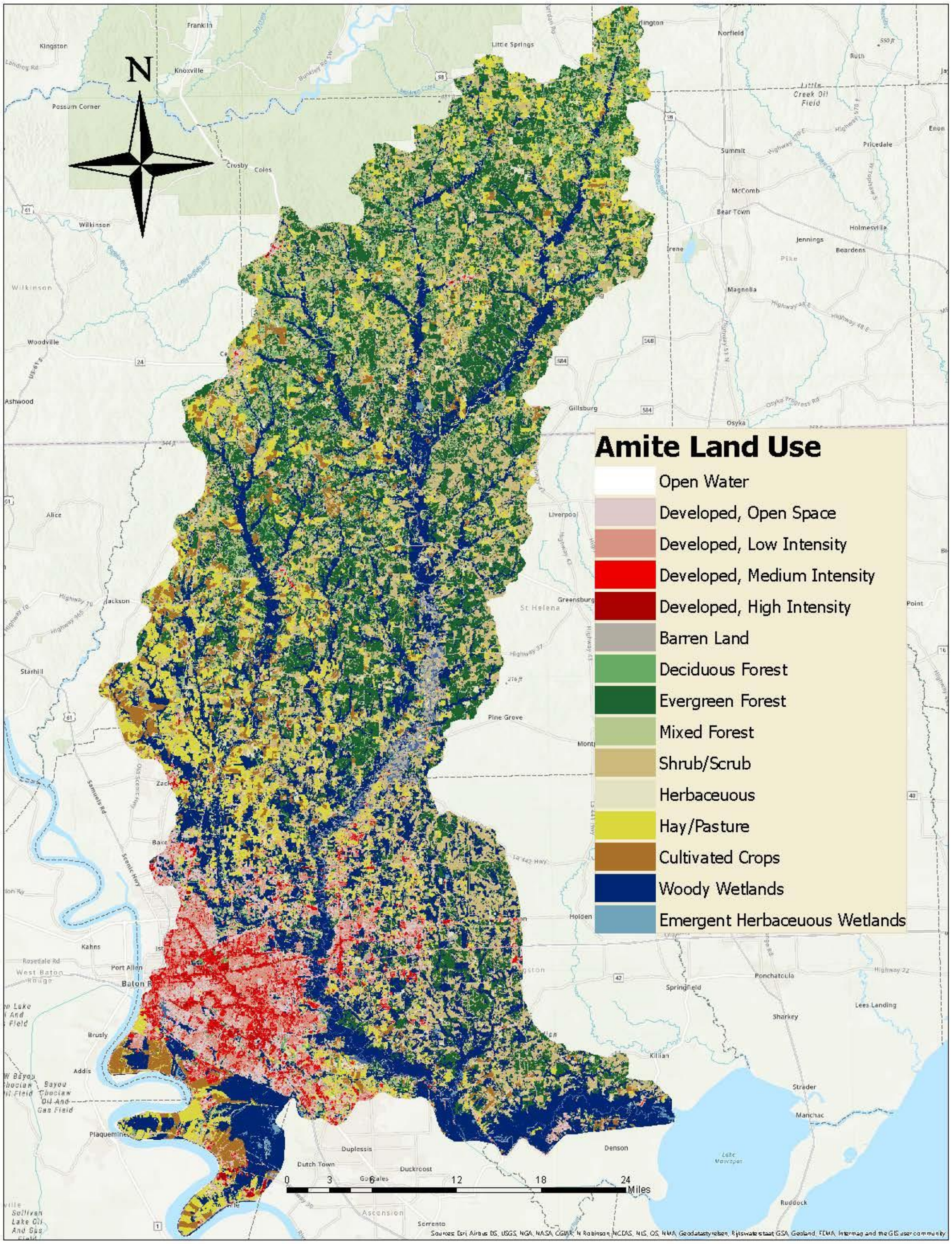



*Figure C1-1. Land Use Classification*

### 1.1.2 Climate

Table C1-2 consists of the monthly temperature normals recorded from the Baton Rouge Metro Airport, LA monitoring station by the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC). Retrieved 15 April 2019 from https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

*Table C1-2. 1981-2010 Temperature Normals from Baton Rouge Metro Airport, LA US*

| MONTH | PRECIP (IN) | MIN TMP (°F) | AVG TMP (°F) | MAX TMP (°F) |
|---|---|---|---|---|
| Jan | 5.72 | 41.2 | 51.7 | 62.3 |
| Feb | 5.04 | 44.5 | 55.1 | 65.7 |
| Mar | 4.41 | 50.3 | 61.5 | 72.7 |
| Apr | 4.46 | 56.8 | 68.1 | 79.3 |
| May | 4.89 | 65.2 | 75.7 | 86.2 |
| Jun | 6.41 | 71.4 | 81.1 | 90.9 |
| Jul | 4.96 | 73.7 | 83.0 | 92.2 |
| Aug | 5.82 | 73.4 | 82.9 | 92.5 |
| Sep | 4.54 | 68.5 | 78.6 | 88.7 |
| Oct | 4.70 | 57.9 | 69.3 | 80.8 |
| Nov | 4.10 | 48.9 | 60.4 | 71.9 |
| Dec | 5.60 | 42.7 | 53.4 | 64.1 |

Normal annual precipitation for the Amite River Basin (ARB) is 60.5 inches, although for the period 1980 through 1991 rainfall averaged 64 inches a year. The ARB experienced drought conditions (-2 or less on the Palmer Drought Severity Index) during the modern era years of 1952, 1963, 1981, 1999, and 2000. Southerly, maritime winds prevail for much of the year, resulting in the potential for highly variable rainfall over the ARB. Daily variations are frequently measured in inches. Even for a 30-year averaging period annual precipitation at various weather stations throughout the ARB ranged from 56 to 67 inches. The wettest month is December with an average monthly normal rainfall of 6.14 inches. October is the driest month averaging 3.50 inches.

High cumulative rainfall events (e.g., 6 inches or more in less than 72 hours) over large areas of the ARB are caused under two typical scenarios: slow moving cold fronts encountering warm moist coastal air in late-winter or early spring; and slow moving tropical storms in summer or early fall. High short-term localized rainfall intensities (e.g., over one inch in an hour) can occur under these two scenarios, and are also experienced in a third scenario—heavy summer-time thunderstorms. Severe riverine flooding in the lower ARB has occurred under extreme examples of all three scenarios, with minor localized flood events typically occurring at least once per year in small, poorly drained catchments. Record floods often result when significant rainfall events occur in the context of above-average seasonal rainfall patterns, which sustain high soil moisture saturation and floodplain water levels. In addition to rainfall-riverine flood events, the lower ARB is also subject to wind-driven coastal flooding associated with slow-moving tropical storms. Prolonged heavy southerly winds cause high water levels along the southeastern Louisiana coast (e.g., Breton and Mississippi Sounds), causing back-step rises in Lakes Borgne, Pontchartrain, and Maurepas. Lake Maurepas levels above 3 ft. mean sea level (MSL) typically impact the lower ARB at least once per year. Tropical storms have pushed levels above 6 ft. MSL.

### 1.1.3 Flood Events

Table C1-3 indicates the top 10 pre-2016 crests based on USGS gauges for the Amite River at Denham Springs and Comite River at Joor Rd (with peak stage data as far back as 1921 and 1943, respectively) and the peak discharge for five of the Amite River floods at Denham Springs.

*Table C1-3. Pre-August 2016 ARB Flood Crests for Amite and Comite Rivers (2017 ARB Drainage and Water Conservation District)*

| | **Amite River at Denham Springs, LA US 190** | | | **Comite River at Comite, LA Joor Road** | |
|---|---|---|---|---|---|
| | **Gauge Datum (ft)** | **Discharge (cfs)** | **Date** | **Gauge Datum (ft)** | **Date** |
| 1 | 41.5 | 112,000 | 4/8/1983 | 30.99 | 6/9/2001 |
| 2 | 41.08 | 110,000 | 4/23/1977 | 29.72 | 4/7/1983 |
| 3 | 39.88 | | 1/27/1990 | 27.58 | 1/21/1993 |
| 4 | 39.27 | | 3/15/1921 | 27.45 | 9/4/2008 |
| 5 | 38.34 | 82,700 | 6/9/2001 | 27.22 | 4/28/1997 |
| 6 | 38.15 | | 1/22/1993 | 26.54 | 1/26/1990 |
| 7 | 36.7 | 68,600 | 4/24/1979 | 26.38 | 4/12/1995 |
| 8 | 36.5 | 60,200 | 3/27/1973 | 26.16 | 3/12/2016 |
| 9 | 36.33 | | 5/20/1953 | 25.99 | 4/23/1979 |
| 10 | 36.23 | | 9/5/2008 | 25.64 | 5/19/1953 |
| Conversion from Gauge Datum to ft NAVD88 | | | | | |
| | - 1.35 | | | + 22.1 | |

See NOAA, Advanced Hydrologic Prediction Services websites for gauges.

Table C1-4 presents a summary of estimated damages from the August 2016 Louisiana flooding.

*Table C1-4: Summary of Damages by Category*

| Damages Category | Loss in Millions |
|---|---|
| Residential Housing Structures | $3,844.2 |
| Residential Housing Contents | $1,279.8 |
| Automobiles | $378.8 |
| Agriculture | $110.2 |
| Business Structures | $595.6 |
| Business Equipment | $262.8 |
| Business Inventories | $1,425.5 |
| Business Interruption Loss | $836.4 |
| Total | $8,733.3 |

Source: Terrell, D. 2016. The Economic Impact of August 2016 Floods on the State of Louisiana. http://gov.louisiana.gov/assets/docs/RestoreLA/SupportingDocs/Meeting-9-28-16/2016-August-Flood-Economic-Impact-Report_09-01-16.pdf

## 1.2 RELEVANT RESOURCES

This section contains a description of relevant resources that could be impacted by the proposed project. The important resources described are those recognized 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. Relevant resources discussed in this section include both natural and human resources.

Relevant resources that could be impacted from implementation of the project are: wetlands; uplands; aquatic resources and fisheries; wildlife; threatened, endangered, and protected species; geology, soils and water bottoms, and prime and unique farmland; water quality; air quality; noise and vibration; aesthetic; cultural, historic, and Tribal trust; environmental justice; socioeconomics; and recreational resources. Navigation  and essential fish habitat would not be affected by the proposed project.

# Section 2
# Natural Resources

## 2.1 WETLANDS

Figure C1-2 shows the National Wetlands Inventory data within the study area (https://www.fws.gov/wetlands/).

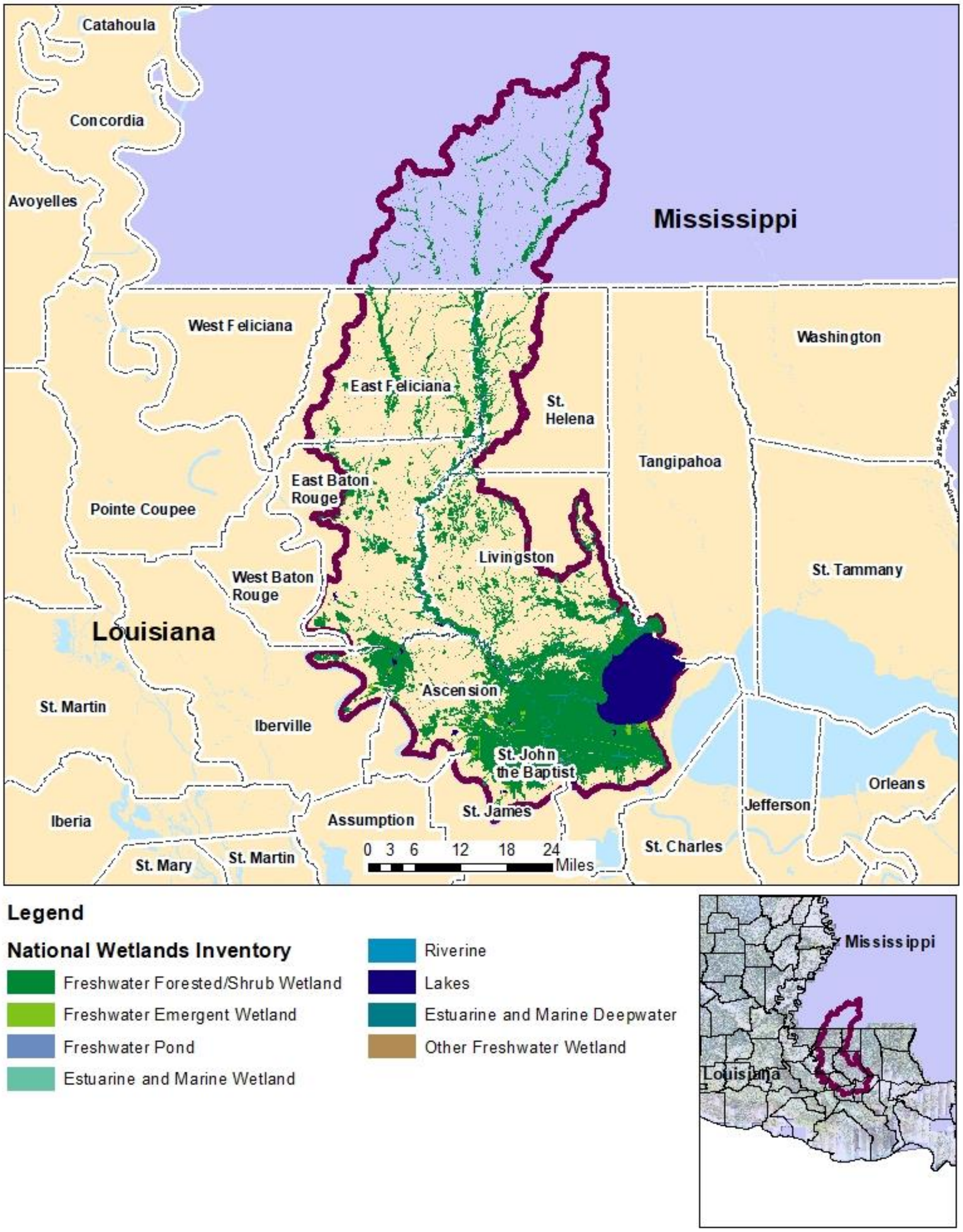



*Figure C1-2. Study Area Wetlands (National Wetlands Inventory)*

*Table C1-5. National Wetlands Inventory for the Study Area*

| Wetland classification | Acres |
|---|---|
| Estuarine and Marine Deepwater | 11.91 |
| Freshwater Emergent Wetland | 8,450.29 |
| Freshwater Forested/Shrub Wetland | 367,324.26 |
| Freshwater Pond | 7,984.49 |
| Lake | 61,879.89 |
| Riverine | 13,353.02 |

Mississippi Alluvial Plain vegetation includes:

- Swamp, found in low-lying areas typically adjacent to waterways, is dominated by cypress and tupelo-gum trees.
- Riverine habitats along stream and river bottoms and bottomland forests are comprised of water tupelo, willow, sycamore, cottonwoods, green ash, pecan, elm, cherrybark oak, and white oak trees; these are often interspersed with Chinese tallow. Depending upon the locations, riverine habitats grade into higher elevated and better drained areas comprised of oak-pine forests.
- Oak-pine forest types dominate the better drained areas especially surrounding Lake Charles and Sulfur and include longleaf pine, loblolly pine, slash pine, sweetgum, elm, southern red oak, water oak, black gum and Chinese tallow trees.
- Pasture and rangelands with mixtures of perennial grasses and legumes (e.g., bermundagrass, Pensacola bahiagrass, tall fescue, and white clover) comprise the majority of the outlying areas surrounding the cities of Abbeville, Erath, and Delcambre.

Mississippi Alluvial Plain consists of back barrier vegetated areas; freshwater, intermediate, brackish, and saline marsh; interspersed with bayous, lakes, ponds and other waters some of which may include submerged aquatic vegetation (SAVs). Vegetation typically follows the salinity gradient (O'Neil 1949; Chabreck et al. 1972; Gosselink et al. 1979; Visser et al. 2000).

- Gulf shorelines vegetation includes sea-beach orach, sea rocket, pigweed, beach tea, salt grass, seaside heliotrope, common and sea purslane, marsh-hay cordgrass, and coastal dropseed (LCA, 2004, Gosselink et al., 1979).
- Marsh types: Visser et al. (2000), expanding on previous studies by Penfound and Hathaway (1938) and Chabreck (1970), classified freshwater marsh in the Chenier Plain as a combination of maidencane and bulltongue arrowhead; intermediate marsh as sawgrass, saltmeadow cordgrass, and California bulrush;

brackish marsh as saltmeadow cordgrass, chairmaker’s bulrush, and sturdy bulrush; and saline marsh as smooth cordgrass, needlegrass rush, and saltgrass.
- Submerged Aquatic Vegetation: wild celery, duckweed, pickerelweed, sago pondweed, southern naiad.

## 2.2 INVASIVE PLANTS

Invasive plants include water hyacinth, alligatorweed, hydrilla, common salvinia, giant salvinia, Chinese tallow, Chinese privet, Cogon grass, Johnsongrass, Japanese privet, Japanese honeysuckle, common ragweed, rescuegrass, sticky Chickweek, purple nutsedge, mimosa tree. These invasive species compete with native flora for resources such as nutrients and light, community structure and composition, and ecosystem processes. Water hyacinth, common salvinia, giant salvinia, and hydrilla all limit the amount of light penetrating the water column which affects plankton biomass production. Alligatorweed, Chinese tallow and Chinese privet are of minimal wildlife value and can proliferate until they become the only dominant plant species in the area, limiting food available for wildlife.

## 2.3 WETLAND LOSS

The processes of wetland loss can result from the gradual decline of marsh vegetation due to inundation and saltwater intrusion, as well as from storm surge events, both of which can eventually lead to complete loss of marsh vegetation. As marsh vegetation is lost, underlying soils are more susceptible to erosion and are typically lost as well, leading to deeper water and precluding marsh regeneration. Significant accretion of sediments is then required in order for marsh habitat to reestablish.

Perhaps the most serious and complex problem in the study area is the rate of land and habitat loss. Coastal Louisiana wetlands are one of the most critically threatened environments in the United States. These wetlands are in peril because Louisiana currently experiences greater coastal wetland loss than all other states in the contiguous United States combined (Couvillion, et al., 2017). The Louisiana coastal plain accounts for 90 percent of the total coastal marsh loss in the nation (USACE 2004). Couvillion et al. (2011) analyses shows coastal Louisiana has undergone a net change in land area of about -1,883 square miles of wetlands from 1932 to 2010. Trend analyses from 1985 to 2010 show a wetland loss rate of about 16.57 square miles per year.

Some wetland loss might also be related to livestock grazing. Moderate grazing alone is not believed to cause wetland loss, but it may be the "final straw" in marshes experiencing additional stresses such as flooding or saltwater intrusion.

The effects of recent hurricanes have accelerated forested wetland loss.

## 2.4 FUTURE CONDITIONS FOR VEGETATION RESOURCES AND INVASIVE PLANT SPECIES

The current wetland gain/loss trends as well as a change in wetland composition would continue to area vegetation zones.

Wetland losses are predicted to result in:

- Some unknown extent of existing riverine bottomland hardwood (BLH) and associated swamp habitats would be converted to more efficient water conveyance channels as human populations and development increase.
- Some unknown extent of existing pasture and rangelands would be converted to rural, suburban and urban human habitats, generally in the order presented, as human populations and development increase.
- Habitat switching would occur due to increasing sea level rise, subsidence, shoreline erosion and other land loss drivers.
- Gulf shoreline recession rates, varying between +8 ft to -52.9 ft per year, would result in Gulf shoreline rollover onto interior marshes thereby converting these existing habitats to barrier shorelines.
- Inland ponds and lakes shoreline loss rates, varying between 3.6 ft and 9.3 ft, would result in conversion of existing salt, brackish, and intermediate/fresh marsh to shallow open water habitats.

Invasive species will continue to proliferate. New species will become problematic in the future. This will add additional pressures to native animals and natural ecosystems. Invasive species management is and will continue to use money that could have been used for managing natural systems.

## 2.5 UPLANDS

**Rare, Unique, and Imperiled Vegetative Communities.** The Louisiana Natural Heritage Program (LNHP) documented the following rare, unique, and imperiled communities. These communities contribute to the diversity and stability of the coastal ecosystem. Table C1-6 displays information from the LNHP database identifying rare, unique or imperiled vegetative communities.

*Table C1-6. Louisiana Natural Heritage Program Rare, Unique, or Imperiled Vegetative Communities*

| Vegetative Communities | Basins or Parish(es) |
|---|---|
| Cypress Swamp | Iberville |
| Cypress-Tupelo Swamp | Ascension, Iberville, Livingston, St. James, St. John the Baptist, |
| Bondcypress-Swamp Blackgum Swamp | Florida Parishes on northshore of Lake Maurepas |
| Bottomland Hardwood Forest | All Parishes |
| Small Stream Forest | All Florida Parishes |
| Hardwood Slope Forest | E. Feliciana, St. Helena |
| Spruce Pine-Hardwood Flatwood | Livingston, East Baton Rouge and Ascension Parishes |

(http://www.wlf.louisiana.gov/wildlife/species-parish-list?tid=228&type_1=fact_sheet_community)
December 2, 2018

Small stream forests (also called “Riparian Forests”) are relatively narrow wetland forests occurring along small rivers and large creeks in central, western, southeastern, and northern Louisiana. They are seasonally flooded for brief periods. The percentage of sand, silt, calcareous clay, acidic clay, and organic material in the soil is highly variable (depending on local geology) and has a significant effect on species composition. Soils are typically classified as siltloams. This community includes the phase formerly designated as riparian sandy branch 29 bottom. At times, the community is quite similar in species composition to hardwood slope forests (beech-magnolia forests). For a list of tree species in this community, see Table C1-7 below.

**Rare Vegetation Communities Future Conditions.** Existing conditions and trends of land loss and development are expected to continue resulting over time in the loss of these valuable vegetative communities.

*Table C1-7. Rare Vegetative Species List for Forest Communities in the project area (From LDWF Natural Communities of Louisiana)*

| Small Stream Forest (Overstory Species) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| southern magnolia | *Magnolia grandiflora* |
| blackgum | *Nyssa sylvatica* |
| white oak | *Quercus alba* |
| laurel oak | *Quercus laurifolia* |
| sweetgum | *Liquidambar styraciflua* |
| red maple | *Acer rubrum* |
| shagbark hickory | *Carya ovata* |
| white ash | *Fraxinus americana* |
| cherry laurel | *Prunus caroliniana* |
| yellow poplar | *Liriodendron tulipifera* |
| baldcypress | *Taxodium distichum* |
| sweet bay | *Magnolia virginiana* |
| beech | *Fagus grandifolia* |
| swamp white oak | *Quercus michauxii* |
| water oak | *Quercus nigra* |
| cherrybark oak | *Quercus pagoda* |
| sycamore | *Platanus occidentalis* |
| river birch | *Betula nigra* |
| bitternut hickory | *Carya cordiformis* |
| water ash | *Fraxinus caroliniana* |
| winged elm | *Ulmus alata* |
| spruce pine (Florida Parishes) | *Pinus glabra* |
| loblolly pine | *Pinus taeda* |
| **Small Stream Forest (Midstory and Understory Species)** | |
| **COMMON NAME** | **SCIENTIFIC NAME** |
| silverbell | *Halesia diptera* |
| arrow-wood | *Viburnum dentatum* |
| sweetleaf | *Symplocos tinctoria* |

| | |
|---|---|
| wild azalea | *Rhododendron canescens* |
| ironwood | *Carpinus caroliniana* |
| Virginia willow | *Itea virginica* |
| hazel alder | *Alnus serrulata* |
| bigleaf snowbell | *Styrax grandifolia* |
| starbush (FL Parishes) | *Illicium floridanum* |
| swamp cyrilla (FL Parishes) | *Cyrilla racemiflora* |
| leucothoe (FL Parishes) | *Leucothoe axillaris* |
| winterberry (FL Parishes) | *Ilex verticillata* |
| sebastian bush (FL Parishes) | *Sebastiana fruticosa* |
| fetterbush (FL Parishes) | *Lyonia lucida* |
| leucothoe (FL Parishes) | *Leucothoe racemosa* |

## 2.6 AQUATIC RESOURCES AND FISHERIES

*Table C1-8. Fish Species in the Amite River Watershed by Family, Scientific and Common Names (from LDWF Amite River Water Body Management Plan)*

| | |
|---|---|
| **Achiridae – American soles** | |
| *Trinectes maculates* | northern hogchoker |
| **Acipenseridae – sturgeons** | |
| *Acipenser oxyrhynchus desotoi* | Gulf sturgeon |
| **Amiidae – bowfin** | |
| *Amia calva* | bowfin |
| **Aphredoderidae – trout perches** | |
| *Aphredoderus sayanus* | pirate perch |
| **Anguillidae – freshwater eels** | |
| *Anguilla rostrata* | American eel |
| *Atherinopsidae* | New World silversides |
| *Labidesthes sicculus* | brook silverside |
| *Menidia beryllina* | inland silverside |
| **Catostomidae – suckers** | |
| *Carpiodes carpio* | river carpsucker |
| *Erimyzon sucetta* | lake chubsucker |
| *Erimyzon oblongus* | creek chubsucker |
| *Erimyzon claviformis* | western creek chubsucker |
| *Erimyzon tenuis* | sharpfin chubsucker |
| *Hypentelium nigricans* | northern hogsucker |
| *Minytrema melanops* | spotted sucker |
| *Moxostoma poecilurum* | blacktail redhorse |
| *Ictiobus bubalus* | smallmouth buffalo |
| *Ictiobus cyprinellus* | bigmouth buffalo |
| *Ictiobus niger* | black buffalo |
| **Centrarchidae - sunfishes** | |
| *Ambloplites ariommus* | shadow bass |
| *Centrarchus macropterus* | flier |
| *Elassoma zonatum* | banded pygmy sunfish |

| | |
|---|---|
| *Lepomis cyanellus* | green sunfish |
| *Lepomis humilis* | orangespotted sunfish |
| *Lepomis macrochirus* | bluegill |
| *Lepomis gulosus* | warmouth |
| *Lepomis marginatus* | dollar sunfish |
| *Lepomis megalotis* | longear sunfish |
| *Lepomis microlophus* | redear sunfish |
| *Lepomis symmetricus* | bantam sunfish |
| *Micropterus punctulatus* | spotted bass |
| *Micropterus salmoides* | largemouth bass |
| *Pomoxis annularis* | white crappie |
| *Pomoxis nigromaculatus* | black crappie |
| **Clupeidae – herrings** | |
| *Alosa chrysochloris* | skipjack herring |
| *Dorosoma cepedianum* | gizzard shad |
| *Dorosoma petenense* | threadfin shad |
| *Brevoortia patronus* | Gulf menhaden |
| **Cyprinidae - carps and minnows** | |
| *Macrhybopsis aestivalis* | speckled chub |
| *Macrhybopsis storeriana* | silver chub |
| *Hybopsis winchelli* | clear chub |
| *Notemigonus crysoleucas* | golden shiner |
| *Hybopsis amnis* | pallid shiner |
| *Luxilus chrysocephalus* | striped shiner |
| *Lythrurus fumeus* | ribbon shiner |
| *Notropis longirostris* | longnose shiner |
| *Notropis maculatus* | taillight shiner |
| *Lythrurus roseipinnis* | cherryfin shiner |
| *Notropis texanus* | weed shiner |
| *Cyprinella venusta* | blacktail shiner |
| *Notropis volucellus* | mimic shiner |
| *Opsopoeodus emiliae* | pugnose minnow |
| *Pimephales promelas* | fathead minnow |

| | |
|---|---|
| *Pimephales vigilax* | bullhead minnow |
| *Hybognathus hayi* | cypress minnow |
| *Cyprinus carpio* | common carp |
| *Notropis atherinoides* | emerald shiner |
| *Hypophthalmichthys molitrix* | silver carp |
| **Elopidae – tarpons** | |
| *Elops saurus* | ladyfish |
| **Engraulidae – anchovies** | |
| *Anchoa mitchilli* | bay anchovy |
| **Esocidae – pikes** | |
| *Esox americanus* | grass pickerel |
| *Esox niger* | chain pickerel |
| **Fundulidae – topminnows and killifishes** | |
| *Fundulus chrysotus* | golden topminnow |
| *Fundulus catenatus* | studfish |
| *Fundulus notatus* | blackstripe topminnow |
| *Fundulus olivaceus* | blackspotted topminnow |
| *Fundulus euryzonus* | broadstripe topminnow |
| **Ictaluridae - North American catfishes** | |
| *Ameiurus melas* | black bullhead |
| *Ameiurus natalis* | yellow bullhead |
| *Ameiurus nebulosus* | brown bullhead |
| *Ictalurus furcatus* | blue catfish |
| *Ictalurus punctatus* | channel catfish |
| *Pylodictis olivaris* | flathead catfish |
| *Noturus gyrinus* | tadpole madtom |
| *Noturus leptacanthus* | speckled madtom |
| *Noturus miurus* | brindled madtom |
| *Noturus nocturnes* | freckled madtom |
| **Lepisosteidae - gars** | |
| *Lepisosteus oculatus* | spotted gar |
| *Lepisosteus osseus* | longnose gar |
| *Lepisosteus platostomus* | shortnose gar |

| | |
|---|---|
| *Lepisosteus spatula* | alligator gar |
| **Moronidae – temperate basses** | |
| *Morone mississippiensis* | yellow bass |
| *Morone chrysops* | white bass |
| **Mugilidae – mullets** | |
| *Mugil cephalus* | striped mullet |
| *Petromyzontidae* | northern lampreys |
| *Ichthyomyzon gagei* | southern brook lamprey |
| **Paralichthyidae – flounders** | |
| *Paralichthys lethostigma* | southern flounder |
| **Percidae – perches** | |
| *Ammocrypta beanii* | naked sand darter |
| *Etheostoma chlorosomum* | bluntnose darter |
| *Etheostoma fusiforme* | swamp darter |
| *Etheostoma proeliare* | cypress darter |
| *Etheostoma stigmaeum* | speckled darter |
| *Etheostoma swaini* | Gulf darter |
| *Etheostoma zonale* | banded darter |
| *Percina maculata* | blackside darter |
| *Percina nigrofasciata* | blackbanded darter |
| *Percina vigil* | saddleback darter |
| *Percina sciera* | dusky darter |
| *Ammocrypta vivax* | scaly sand darter |
| *Percina caprodes* | logperch |
| **Poeciliidae – livebearers** | |
| *Gambusia affinis* | western mosquitofish |
| *Poecilia latipinna* | sailfin molly |
| *Heterandria formosa* | least killifish |
| **Polyodontidae – paddlefishes** | |
| *Polyodon spathula* | paddlefish |
| **Sciaenidae – drums** | |
| *Aplodinotus grunniens* | freshwater drum |
| *Micropogonias undulatus* | Atlantic croaker |

| **Sparidae – porgies** | |
|---|---|
| *Archosargus probatocephalus* | sheepshead |
| *Lagodon rhomboides* | pinfish |
| **Syngnathidae – pipefishes and seahorses** | |
| *Syngnathus scovelli* | Gulf pipefish |

## 2.7 WILDLIFE

*Table C1-9. Game and Non-Game Birds in Study Area*

| COMMON AND SCIENTIFIC NAME | OCCURENCE |
|---|---|
| American Kestrel (*Falco sparverius paulus*) | September to March |
| Anhinga (*Anhinga anhinga*) | July to March (FWS) |
| Bald Eagle (*Haliaeetus leucocephalus*) | August to May |
| Barn Swallow (*Hirundo rustica*) | February to November |
| Barred Owl (*Strix varia*) | Resident |
| Belted Kingfisher (*Megaceryle alcyon*) | Resident |
| Blue Jay (*Cyanocitta cristata*) | Resident |
| Carolina Chickadee (*Poecile carolinensis*) | Resident |
| Carolina Wren ( *Thryothorus ludovicianus*) | Resident |
| Cattle Egret (*Bubulcus ibis*) | September to April (FWS) |
| Cedar Waxwing (*Bombycilla cedrorum*) | November to May |
| Chimney Swift (*Chaetura pelagica*) | March to November |
| Double-crested Cormorant (*Phalacrocorax auritus*) | July to March (FWS) |
| Downy Woodpecker (*Picoides pubescens*) | Resident |
| Eastern Phoebe (*Sayornis phoebe*) | October to March |
| European Starling (*Sturnus vulgaris*) | Resident |
| Great Egret (*Ardea alba*) | August to February (FWS) |
| Reddish Egret | August to March (FWS) |
| Hooded Merganser (*Lophodytes cucullatus*) | November to May |
| Kentucky Warbler (*Oporornis formosus*) | March to September |
| Killdeer (*Charadrius vociferus*) | Resident |
| Lesser Scaup (*Aythya affinis*) | October to March |

| | |
|---|---|
| Little Blue Heron (*Egretta caerulea*) | Resident |
| Great Blue Heron | August to February (FWS) |
| Tricolored Heron | August to March (FWS) |
| Green Heron | September to March (FWS) |
| Black-crowned Night-Heron | September to March (FWS) |
| Yellow-crowned Night-Heron | September to March (FWS) |
| Mallard (*Anas platyrhynchos*) | Resident |
| Mississippi Kite (*Ictinia mississippiensis*) | April to August |
| Mourning dove (*Zenaida macroura*) | Resident |
| Northern Mockingbird (*Mimus polyglottos*) | Resident |
| Prothonotary Warbler (*Protonotaria citrea*) | March to October |
| Red-bellied Woodpecker (*Melanerpes erythrocephalus*) | Resident |
| Red-shouldered Hawk (*Buteo lineatus*) | Resident |
| Red-tailed Hawk (*Buteo jamaicensis*) | Resident |
| Ring-billed Gull (*Larus delawarensis*) | November to April |
| Ring-necked Duck (*Aythya collaris*) | October to March |
| Roseate Spoonbill (*Platalea ajaja*) | August to April (FWS) |
| Ruby-throated Hummingbird (*Archilochus colubris*) | Resident |
| Snowy Egret (*Egretta thula*) | August to March (FWS) |
| Turkey Vulture (*Cathartes aura*) | Resident |
| White Ibis (*Eudocimus albus*) | September to April (FWS) |
| White-eyed Vireo (*Vireo griseus*) | Resident |
| White-throated Sparrow (*Zonotrichia albicollis*) | October to April |
| Wood duck (*Aix sponsa*) | Resident |
| Wood Thrush (*Hylocichla mustelina*) | March to October |
| Yellow-billed Cuckoo (*Coccyzus americanus*) | March to October |

*Table C1-10. Mammals in the Study Area*

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| fox squirrel | *Sciurus niger* |
| grey squirrel | *Sciurus carolinensis* |
| mink | *Neovison vison* |
| opossum | *Didelphis virginiana* |
| raccoon | *Procyon lotor* |
| swamp rabbit | *Sylvilagus aquaticus* |
| white-tailed deer | *Odocoileus virginianus* |

*Table C1-11. Amphibians in the Study Area*

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| bullfrog | *Lithobates catesbeianus* |
| cricket frog | *Acris crepitans* |
| Gulf coast toad | *Incilius valliceps* |
| southern leopard frog | *Lithobates sphenocephalus* |

*Table C1-12. Reptiles in the Study Area*

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| American alligator | *Alligator mississippiensis* |
| snapping turtle | *Chelydra serpentina* |
| eastern spiny softshell | *Apalone spinifera* |
| red-eared slider | *Trachemys scripta elegans* |
| speckled kingsnake | *Lampropeltis holbrooki* |
| broad-banded water snake | *Nerodia fasciata confluens* |
| western cottonmouth | *Agkistrodon piscivorus leucostoma* |

## 2.8 THREATENED, ENDANGERED, AND PROTECTED SPECIES

Factors regarding the existing conditions for threatened and endangered species in the study area principally stem from the alteration, degradation, and loss of habitats; and human disturbance. The continued high rate of commercial development throughout the study area continues to reduce available wetland habitat to threatened and endangered species. This creates increased intra- and interspecific competition for rapidly depleting resources between not only the various threatened and endangered species but also other more numerous fauna.

On March 13, 2019, U.S. Army Corps of Engineers (USACE), Mississippi Valley Division, New Orleans District (CEMVN) obtained from the USFWS lists of threatened and endangered species that may occur in the proposed project location, and/or may be affected by the proposed project (See Appendix C-4). Table C1-13 provides a summary of these findings including the presence of critical habitat. Descriptions for species that may be affected follow below.

*Table C1-13. Threatened (T), Endangered (E), & Protected (P) Species*

| Scientific name | Common name and status (T, E, or P) | Found in Study Area | Found in Project Area | Determination of Effects: May Affect, Not Likely to Adversely Affect (NLAA), or Likely to Adversely Affect (LAA) |
|---|---|---|---|---|
| *Potamilus inflatus* | Alabama Heelsplitter Mussel (T) | Yes | Yes | May affect |
| *Acipenser oxyrhynchus desotoi* | Atlantic Sturgeon (T) | Yes | No | NLAA |
| *Trichechus manatus* | West Indian Manatee (T) | Yes | No | NLAA |
| *Haliaeetus leucocephalus* | Bald Eagle (P) | Yes | Yes | NLAA |

### 2.8.1 West Indian Manatee

Federally listed as a threatened species, *Trichechus manatus* (West Indian manatees) occasionally enter Lakes Pontchartrain and Maurepas, and associated coastal waters and streams during the summer months (i.e., June through September). Manatee occurrences appear to be increasing, and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of

Louisiana. The manatee has declined in numbers due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Cold weather and outbreaks of red tide may also adversely affect these animals.

Public data on manatee sightings have provided benefits for conservation efforts, according to Hieb et al. (2017). Ongoing manatee population growth, future climate change, or other large-scale environmental perturbations are likely to continue altering the timing, duration, and location of manatee visits to the northern Gulf of Mexico. Although publicly sourced data and citizen-science efforts have inherent biases, on a decadal time scale these datasets could provide comprehensive information on manatee habitat use than is possible by direct observations.

### 2.8.2 Atlantic Sturgeon

Acipenser oxyrhynchus desotoi (the Atlantic sturgeon), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Gulf sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain basin, and adjacent estuarine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May).  Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

On March 19, 2003, the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (Volume 68, No. 53) designating critical habitat for the Gulf sturgeon in Louisiana, Mississippi, Alabama, and Florida. The proposed project; however, does not occur within nor would it impact designated Gulf sturgeon critical habitat.

### 2.8.3 Inflated Heelsplitter Mussel

Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) was historically found in Louisiana in the Amite, Tangipahoa, and Pearl Rivers. Many life history aspects of the species are poorly understood but are likely similar to that of other members of the Unionidae family. Although the primary host fish for the species is not certain, investigation by K. Roe et al. (1997) indicates that the freshwater drum (Aplodinotus grunniens) is a suitable glochidial host for the species.

Based on the most recent survey data, the currently known range for the Alabama heelsplitter in Louisiana occurs only in the lower third of the Amite River along the East Baton Rouge/Livingston Parish line from Spiller's Creek, which is in the vicinity of Denham Springs downstream to the vicinity of Port Vincent. Because it has not been used widely for past or present gravel mining operations, the lower third of the Amite River (between Louisiana Highway 37 and Louisiana Highway 42) is more typical of a coastal plain river; being characterized by a silt substratum, less channelization, and slower water flow, all of which are characteristic of heelsplitter habitat. This freshwater mussel is typically found in soft, stable substrates such as sand, mud, silt, and sandy gravel, in slow to moderate currents. Heelsplitter mussels are usually found in depositional pools below sand point bars and in shallow pools between sandbars and river banks.

Major threats to this species in Louisiana are the loss of habitat resulting from sand and gravel dredging and channel modifications for flood control, as shown by the apparent local extirpation of the species in the extensively modified upper portions of the Amite River.

## 2.9 PROTECTED SPECIES

### 2.9.1 Bald Eagle

The project-area forested wetlands provide nesting habitat for *Haliaeetus leucocephalus* (the bald eagle), which was officially removed from the List of Endangered and Threatened Species on August 8, 2007. There is one active bald eagle nest that is known to exist within the proposed project area; however, other nests may be present that are not currently listed in the database maintained by the Louisiana Department of Wildlife and Fisheries.

Bald eagles nest in Louisiana from October through mid-May. They typically nest in mature trees (e.g., bald cypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water in the southeastern Parishes. Areas with high numbers of nests include the north shore of Lake Pontchartrain and the Lake Salvador area. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants (i.e., organochlorine pesticides and lead).

Breeding bald eagles occupy “territories” that they will typically defend against intrusion by other eagles, and that they likely return to each year. A territory may include one or more alternate nests that are built and maintained by the eagles, but which may not be used for nesting in a given year. Potential nest trees within a nesting territory may, therefore, provide important alternative bald eagle nest sites. Bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during this critical period may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

Although the bald eagle has been removed from the List of Endangered and Threatened Species, it continues to be protected under the MBTA and the Bald and Golden Eagle Protection Act (BGEPA). The USFWS developed the National Bald Eagle Management (NBEM) Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles, particularly where such impacts may constitute "disturbance," which is prohibited by the BGEPA. A copy of the NBEM Guidelines is available at:

http://www.fws.gov/southeast/es/baldeagle/NationalBaldEagleManagementGuidelines.pdf.

Those guidelines recommend: (1) maintaining a specified distance between the activity and the nest (buffer area); (2) maintaining natural areas (preferably forested) between the activity and nest trees (landscape buffers); and (3) avoiding certain activities during the breeding season. On-site personnel should be informed of the possible presence of nesting bald eagles within the project boundary, and should identify, avoid, and immediately report any such nests to this office. If a bald eagle nest is discovered within or adjacent to the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/es/baldeagle. Following completion of the evaluation, that website will provide a determination of whether additional consultation is necessary. A copy of that determination should be provided to this office.

## 2.10 GEOLOGY, SOILS AND WATER BOTTOMS, AND PRIME AND UNIQUE FARMLAND

Figure C1-3 below shows the study area divided into three regions with distinctive landforms, topographies, and associated floodplain characteristics.

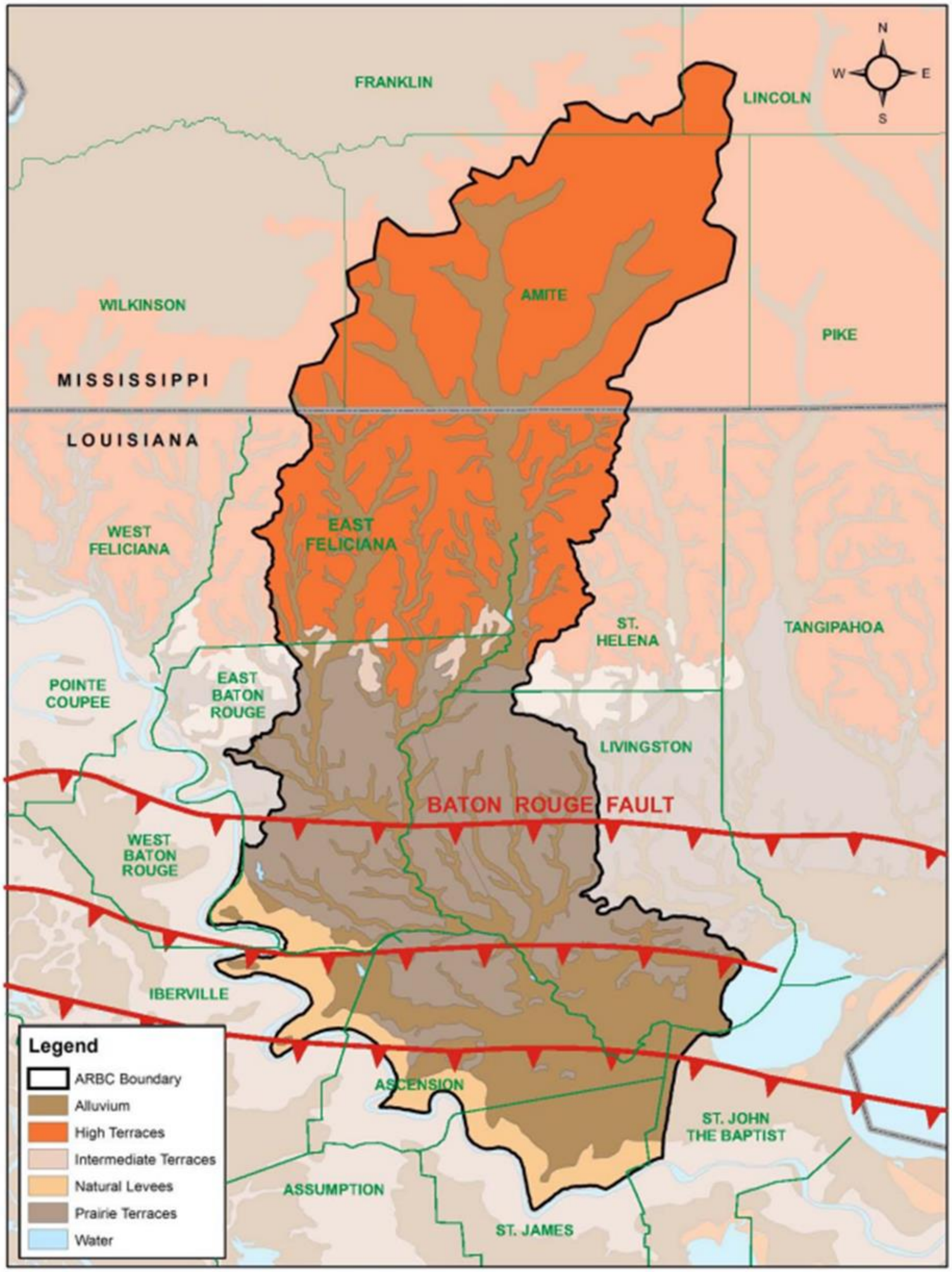



*Figure C1-3. Study area landforms*

## 2.11 SOILS, WATER BOTTOMS, AND PRIME AND UNIQUE FARMLAND

The Farmland Protection Policy Act of 1981 (FPPA) was enacted to minimize the extent that Federal programs contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses, and to assure that Federal programs are administered in a manner that, to the extent practicable, would be compatible with State, unit of local government, and private programs and policies to protect farmland.

Under this policy, soil associations are used to classify areas according to their ability to support different types of land uses, including urban development, agriculture, and silviculture. The USDA Natural Resource Conservation Service (NRCS) designates areas with particular soil characteristics as either “Farmland of Unique Importance,” “Prime Farmland,” “Prime Farmland if Irrigated,” or variations on these designations. Prime farmland, as defined by the FPPA, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. Farmland of unique importance is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, drought-prone, and less productive, and cannot be easily cultivated as compared to prime farmland (NRCS 2016).

For a map of the the soil textures, see Figure C1-4.

For a map and acreage of land classification of prime and unique farmlands, see Figure C1-5 and Table C1-14.

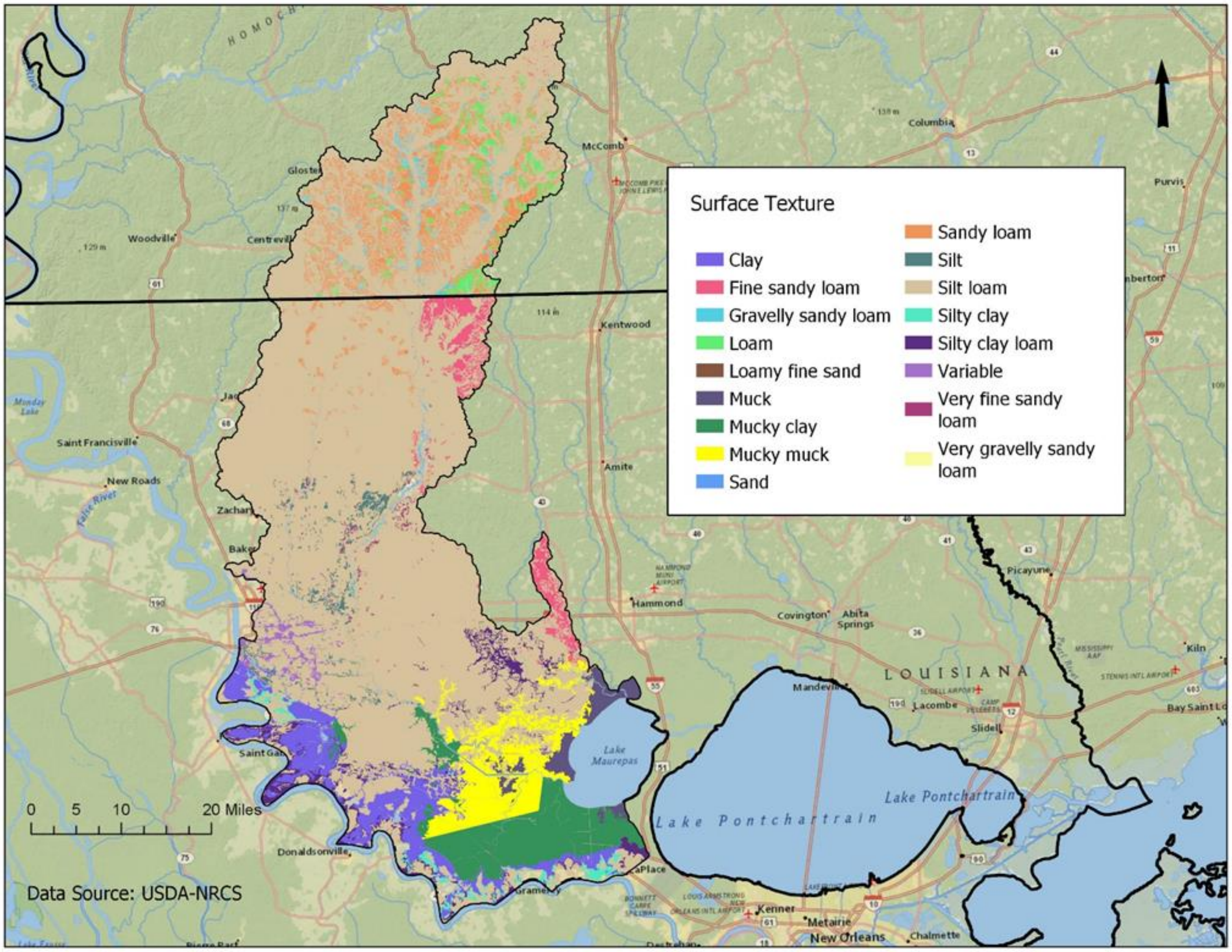



*Figure C1-4. Soil textures in the study area*

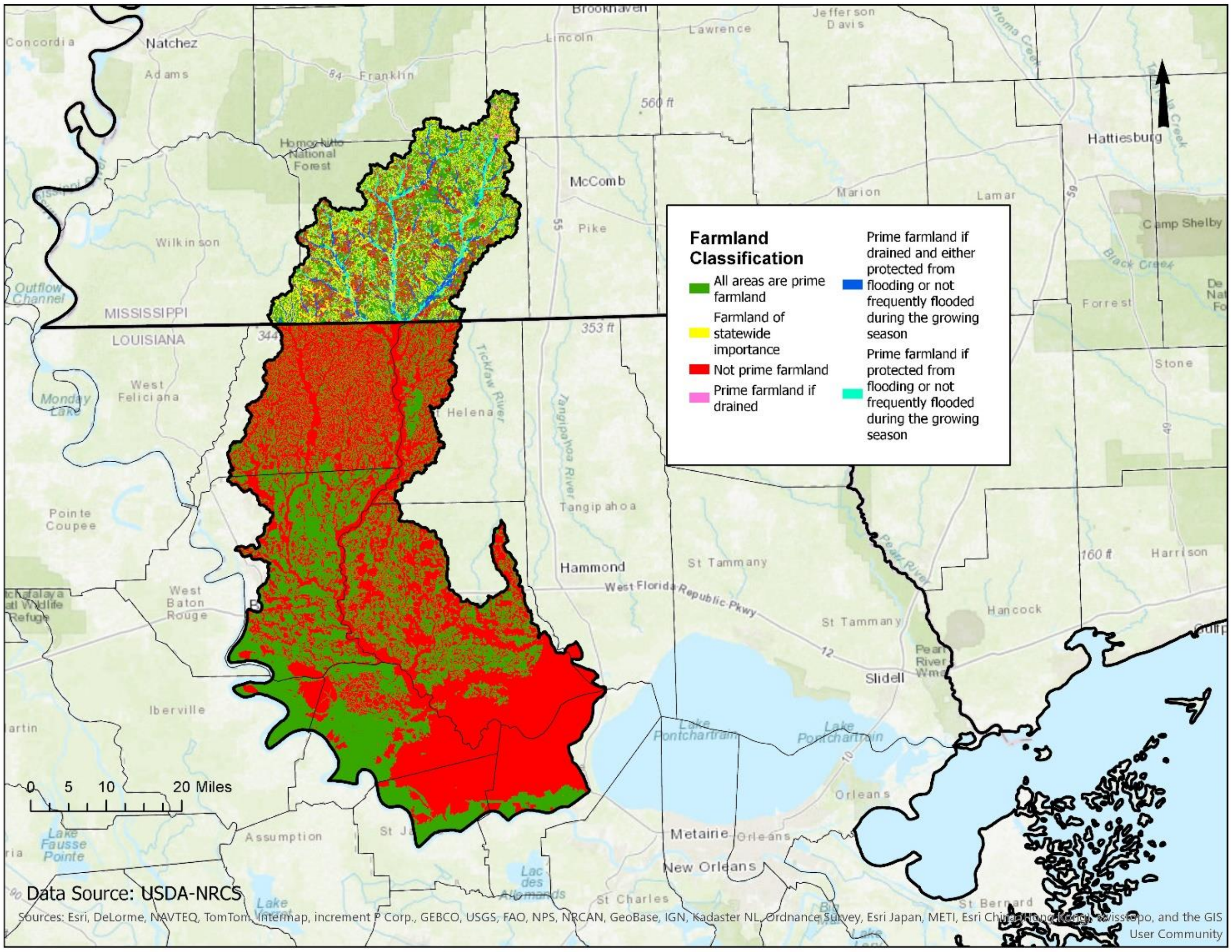



*Figure C1-5. Prime and unique farmland classification map of study area*

*Table C1-14. Prime and unique farmland acres in the study area*

**Mississippi Counties**

| Acres | Farmland Type |
|---|---|
| 148,443.12 | All areas are prime farmland |
| 94,551.75 | Farmland of statewide importance |
| 58,333.22 | Not prime farmland |
| 1,624.24 | Prime farmland if drained |
| 35,413.52 | Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season |
| 31,044.76 | Prime farmland if protected from flooding or not frequently flooded during the growing season |
| **369,410.63** | **Total** |

**Louisiana Parishes**

| Acres | Farmland Type |
|---|---|
| 503,703.59 | All areas are prime farmland |
| 755,798.58 | Not prime farmland |
| **1,259,502.16** | **Total** |

## 2.12 WATER QUALITY

Nineteen water bodies in the Amite Watershed are listed as impaired for one or more designated uses in the *2016 Integrated Report of Water Quality in Louisiana.* Designated uses include swimming, boating, fishing, drinking water, and outstanding natural resource (i.e. Louisiana Scenic Rivers).

Most of the segments are impaired for fish and wildlife propagation and swimming. In the Amite Watershed, the top five suspected causes of impairment are 1) dissolved oxygen, 2) nitrate/nitrite (nitrite plus nitrate as N), 3) fecal coliform, 4) Phosphorus (Total), and 5) Turbidity (See Table C1-15 below).

*Table C1-15. Water Quality 305(b) impaired waterbodies in the study area*

| Sub-segment Number | Subsegment Description | Size (mi) | Designated Water Body Uses* | | | | | Impaired Use for Suspected Cause | Suspected Causes of Impairment | Suspected Sources of Impairment |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | PCR | SCR | FWP | DWS | ONR | | | |
| LA040301_00 | Amite River-From Mississippi state line to La. Highway 37 (Scenic) | 30 | F | N | N | | N | Fish and Wildlife Propogation (FWP) | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040301_00 | Amite River-From Mississippi state line to La. Highway 37 (Scenic) | 30 | F | N | N | | N | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040301_00 | Amite River-From Mississippi state line to La. Highway 37 (Scenic) | 30 | F | N | N | | N | FWP | Turbidity | Sand/gravel/rock Mining or Quarries |
| LA040301_00 | Amite River-From Mississippi state line to La. Highway 37 (Scenic) | 30 | F | N | N | | N | FWP | Turbidity | Sand/gravel/rock Mining or Quarries |
| LA040301_00 | Amite River-From Mississippi state line to La. Highway 37 (Scenic) | 30 | F | N | N | | N | FWP | Fecal Coliform | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040302_00 | Amite River-From LA 37 to Amite River Diversion Canal | 69 | N | F | N | | | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040302_00 | Amite River-From LA 37 to Amite River Diversion Canal | 69 | N | F | N | | | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040302_00 | Amite River-From LA 37 to Amite River Diversion Canal | 69 | N | F | N | | | FWP | Oxygen, Dissolved | Natural Sources |
| LA040302_00 | Amite River-From LA 37 to Amite River Diversion Canal | 69 | N | F | N | | | FWP | Fecal Coliform | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040302_00 | Amite River-From LA 37 to Amite River Diversion Canal | 69 | N | F | N | | | FWP | Fecal Coliform | Sanitary Sewer Overflows (Collection System Failures) |
| LA040303_00 | Amite River-From Amite River Diversion Canal to Lake Maurepas | 21 | F | F | N | | | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LA040303_00 | Amite River-From Amite River Diversion Canal to Lake Maurepas | 21 | F | F | N | | | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040303_00 | Amite River-From Amite River Diversion Canal to Lake Maurepas | 21 | F | F | N | | | FWP | Nitrate/Nitrite (Nitrite + Nitrate as N) | Upstream Source |
| LA040303_00 | Amite River-From Amite River Diversion Canal to Lake Maurepas | 21 | F | F | N | | | FWP | Oxygen, Dissolved | Upstream Source |
| LA040303_00 | Amite River-From Amite River Diversion Canal to Lake Maurepas | 21 | F | F | N | | | FWP | Phosphorus (Total) | Upstream Source |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Chloride | Natural Sources |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Nitrate/Nitrite (Nitrite + Nitrate as N) | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Nitrate/Nitrite (Nitrite + Nitrate as N) | Package Plant or Other Permitted Small Flows Discharges |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Oxygen, Dissolved | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Oxygen, Dissolved | Package Plant or Other Permitted Small Flows Discharges |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Phosphorus (Total) | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Phosphorus (Total) | Package Plant or Other Permitted Small Flows Discharges |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Sulfates | Natural Sources |
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Total Dissolved Solids | Natural Sources |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LA040304_00 | Grays Creek-From headwaters to Amite River | 20 | N | F | N | | | FWP | Fecal Coliform | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Nitrate/Nitrite (Nitrite + Nitrate as N) | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Oxygen, Dissolved | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Phosphorus (Total) | On-site Treatment Systems (Septic Systems and Similar Decentralized Systems) |
| LA040305_00 | Colyell Creek; includes tributaries and Colyell Bay | 76 | F | F | N | | | FWP | Total Dissolved Solids | Source Unknown |
| LA040401_00 | Blind River-From Amite River Diversion Canal to mouth at Lake Maurepas (Scenic) | 5 | F | F | N | | N | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040401_00 | Blind River-From Amite River Diversion Canal to mouth at Lake Maurepas (Scenic) | 5 | F | F | N | | N | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040401_00 | Blind River-From Amite River Diversion Canal to mouth at Lake Maurepas (Scenic) | 5 | F | F | N | | N | FWP | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |
| LA040401_00 | Blind River-From Amite River Diversion Canal to mouth at Lake Maurepas (Scenic) | 5 | F | F | N | | N | FWP | Oxygen, Dissolved | Natural Sources |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LA040401_00 | Blind River-From Amite River Diversion Canal to mouth at Lake Maurepas (Scenic) | 5 | F | F | N | | N | FWP | Turbidity | Natural Sources |
| LA040402_00 | Amite River Diversion Canal-From Amite River to Blind River | 10 | F | F | N | | | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040402_00 | Amite River Diversion Canal-From Amite River to Blind River | 10 | F | F | N | | | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040402_00 | Amite River Diversion Canal-From Amite River to Blind River | 10 | F | F | N | | | FWP | Oxygen, Dissolved | Natural Sources |
| LA040403_00 | Blind River-From headwaters to Amite River Diversion Canal (Scenic) | 20 | F | F | N | | F | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040403_00 | Blind River-From headwaters to Amite River Diversion Canal (Scenic) | 20 | F | F | N | | F | FWP | Mercury in Fish Tissue | Source Unknown |
| LA040403_00 | Blind River-From headwaters to Amite River Diversion Canal (Scenic) | 20 | F | F | N | | F | FWP | Non-Native Aquatic Plants | Introduction of Non-native Organisms (Accidental or Intentional) |
| LA040403_00 | Blind River-From headwaters to Amite River Diversion Canal (Scenic) | 20 | F | F | N | | F | FWP | Oxygen, Dissolved | Natural Sources |
| LA040403_00 555632 | Petite Amite River - Located within subsegment LA040403_00. This unit is added for advisory tracking purposes only and is not a subsegment as defined by LAC 33:IX.1123.A. et seq. No other assessment is made for this waterbody. | 11 | | | N | | | FWP | Mercury in Fish Tissue | Atmospheric Deposition - Toxics |
| LA040403_00 555632 | Petite Amite River - Located within subsegment LA040403_00. This unit is added for advisory tracking purposes only and is not a subsegment as defined by LAC 33:IX.1123.A. et seq. No other assessment is made for this waterbody. | 11 | | | N | | | FWP | Mercury in Fish Tissue | Source Unknown |

*Designated Use Descriptions
PCR = Primary Contact Recreation (swimming)
SCR = Secondary Contact Recreation (boating)
FWP = Fish and Wildlife Propagation (fishing)
DWS = Drinking Water Supply
ONR = Outstanding Natural Resource
F = Fully supporting designated use; N = Not supporting designated use

## 2.13 AIR QUALITY

The U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards has set National Ambient Air Quality Standards for six principal pollutants, called “criteria” pollutants. They are carbon monoxide, nitrogen dioxide, ozone, lead, particulates of 10 microns or less in size (PM-10 and PM-2.5), and sulfur dioxide. Ozone is the only parameter not directly emitted into the air but forms in the atmosphere when three atoms of oxygen (03) are combined by a chemical reaction between oxides of nitrogen and volatile organic compounds in the presence of sunlight. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents are some of the major sources of nitrogen and volatile organic compounds, also known as ozone precursors. Strong sunlight and hot weather can cause ground-level ozone to form in harmful concentrations in the air. The Clean Air Act General Conformity Rule (58 FR 63214, November 30, 1993, Final Rule, Determining Conformity of General Federal Actions to State or Federal Implementation Plans) dictates that a conformity review be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more National Ambient Air Quality Standards. A conformity assessment would require quantifying the direct and indirect emissions of criteria pollutants caused by the Federal action to determine whether the proposed action conforms to Clean Air Act requirements and any State Implementation Plan.

The general conformity rule was designed to ensure that Federal actions do not impede local efforts to control air pollution. It is called a conformity rule because Federal agencies are required to demonstrate that their actions “conform with” (i.e., do not undermine) the approved State Implementation Plan for their geographic area. The purpose of conformity is to (1) ensure Federal activities do not interfere with the air quality budgets in the State Implementation Plans; (2) ensure actions do not cause or contribute to new violations, and (3) ensure attainment and maintenance of the National Ambient Air Quality Standards.

The Amite River and Tributaries Study Area includes several parishes in Louisiana and several counties in southwest Mississippi. Four of the Louisiana parishes are located in the Baton Rouge metropolitan area which has been designated by the EPA as a maintenance area for ozone under the 8-hour standard effective December 27, 2016. This classification is the result of area-wide air quality modeling studies, and the information is readily available from the LDEQ, Office of Environmental Assessment and Environmental Services.

Federal activities that are proposed in the ozone-maintenance area may be subject to the State's general conformity regulations as promulgated under LAC 33:III.14.A, Determining Conformity of General Federal Actions to State or Federal Implementation Plans. A general conformity applicability determination is made by estimating the total of direct and indirect volatile organic compound (VOC) and nitrogen oxide ($NO^X$) emissions caused by the construction of the project. Prescribed de minimis levels of 100 tons per year per pollutant are applicable in Ascension Parish. Projects that would result in discharges below the de minimis level are exempt from further consultation and development of mitigation plans for reducing emissions.

## 2.14 NOISE AND VIBRATION

No supporting information is available for this resource.

# Section 3
# Human Resources

## 3.1 CULTURAL, HISTORIC, AND TRIBAL TRUST RESOURCES

The cultural prehistory and history of Southeast Louisiana and Southwest Mississippi is a rich one that is shared with much of the southeast. The generalized Pre-Contact cultural chronology for the region according to Rees (2010:12) is divided into five primary archaeological components, or “periods,” as follows: Paleoindian (11,500-8000 B.C.), Archaic (8000-800 B.C.), Woodland (800 B.C.-1200 A.D.), Mississippian (1200-1700 A.D.), and Historic (1700 A.D.-present). Regionally, these periods have been further divided into sub-periods based on material culture, settlement patterns, subsistence practices, and sociopolitical organization. Specific sub-periods identified within the study area include: Poverty Point, Tchefuncte, Marksville, Baytown, Troyville, Coles Creek, Plaquemine, and Mississippian. Post-Contact Period (ca. 1650 A.D.-present) cultural affiliations within the study area, follow the thematic approach set forth in the Louisiana Division of Archaeology’s (LDOA) *State of Louisiana Site Record Form* (amended August 29, 2018) and are divided into the following temporal groups: *Historic Exploration* (1541-1803 A.D.), *Antebellum Louisiana* (1803-1860 A.D.), *War and Aftermath* (1860-1890 A.D.), *Industrial and Modern* (1890-1945 A.D.), and *Post-WWII* (1945 A.D.-present).

## 3.2 HISTORIC PROPERTIES

Preserving historic properties as important reflections of our American heritage became a national policy through passage of the Antiquities Act of 1906, the Historic Sites Act of 1935, and Section 106 of the National Historic Preservation Act (NHPA), as amended (54 U.S.C. § 306108), and it’s implementing regulations, 36 Code of Federal Regulations [CFR] Part 800. The passage of the NHPA established the National Register of Historic Places (NRHP) and the process for adding properties to it. Historic properties in the study area were identified based on a review of the National Register (NR) database and project files. NR-listed properties typically fall into one of five categories: building, structure, object, site, and district. The National Park Service (NPS) uses the following definitions to differentiate NR historic resource types (NPS 1995):

1. **Building:** A building, such as a house, barn, church, hotel, or similar construction, is created principally to shelter any form of human activity. "Building" may also refer to a historically and functionally related unit, such as a courthouse and jail or a house and barn.
2. **Structure:** The term "structure" is used to distinguish from buildings those functional constructions made usually for purposes other than creating human shelter.

3. **Object:** The term "object" is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or a relatively small in scale and simply constructed. CEMVN's background research indicates that there are no NRHP-listed Objects within the study area.
4. **Site:** A site is the location of a significant event, a prehistoric/historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archeological value regardless of the value of any existing structure.
5. **District:** A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development.

In addition to the five (5) common types of NR properties mentioned above, CEMVN also reviewed the study area for the presence of National Historic Landmarks (NHLs) and archaeological sites not presently listed on the NR (Table C1-16):

**National Historic Landmark:** The NPS has developed criteria for the recognition of nationally significant properties, which are designated NHLs and prehistoric and historic units of the NPS. NHLs are those districts, sites, buildings, structures, and objects designated by the Secretary of the Interior (SOI) as possessing national significance in American history, architecture, archeology, engineering, and culture. NHLs are afforded a special level of protection and Section 110(f) of the NHPA requires that before approval of any federal Undertaking which may directly and adversely affect any NHL, the head of the responsible federal agency shall, to the maximum extent possible, undertake such planning and actions as may be necessary to minimize harm to such landmark, and shall afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the Undertaking.

**Archaeological Sites Not Presently Listed on the National Register:** Not every archaeological site is eligible for the NR because not all archaeological sites possess both significance and sufficient integrity to be considered eligible for listing. Most eligibility determinations made pursuant to the Section 106 process are called “consensus determinations” because agreement between the federal agency and the State Historic Preservation Officer (SHPO)/Tribal Historic Preservation Officer (THPO) is all that is normally required for federal Undertakings; no formal nomination to or listing on the NR is necessary. The LA and MS SHPOs maintain databases of all previously recorded sites within their respective states. Individual alternate actions will be screened against the databases to determine if sites that have been identified as eligible for NR-listing, but not yet enrolled, exist within proposed work areas.

*Table C1-16. Historic Properties within the Study Area*

| County/Parish: | Building | Site | Structure | District | NHL | Archaeological Sites |
|---|---|---|---|---|---|---|
| Mississippi: | | | | | | |
| Amite | 18 | 1 | — | — | — | 29 |
| Franklin | 3 | — | 2 | — | — | — |
| Lincoln | 14 | — | — | 1 | — | — |
| Wilkinson | 11 | 3 | — | 2 | — | 1 |
| Louisiana: | | | | | | |
| Ascension | 17 | 1 | — | 1 | — | 78 |
| East Baton Rouge | 67 | 7 | 2 | 13 | 2 | 20 |
| East Feliciana | 28 | 1 | — | 2 | 1 | 104 |
| Iberville | 21 | — | 1 | 1 | — | 22 |
| Livingston | 13 | — | — | 1 | — | 87 |
| St. Helena | 3 | — | — | — | — | 72 |
| St. James | 19 | — | 1 | 2 | 1 | 41 |
| St. John the Baptist | 14 | 1 | — | 2 | 1 | 14 |

### 3.2.1 Archaeological Sites

Based on a review of the LDOA, *Louisiana Cultural Resources Map* (web-resource), the Mississippi Department of Archives and History (MDAH) *Historic Resources Inventory Map* (web-resource), and pertinent site and survey reports regarding previous investigations, CEMVN determined that approximately 468 archaeological sites (Table C1-16) are recorded within the current study area that collectively span the entire spectrum of Pre-Contact and Post-Contact archaeological components referenced above; encompassing some 10,000 years or more. It is also important to stress that many of the known sites in the study area have occupation spans encompassing more than one of these cultural/temporal periods attesting to the long-ranging cultural importance of the region. Presently, no comprehensive systematic archaeological survey has been conducted throughout the entire study area and the distribution of recorded archaeological sites is largely indicative of project-specific federal and state compliance activities (e.g., linear surveys of roads, pipelines, and power line right-of-ways). Therefore, in addition to considering the known sites within the region, project areas must also be further assessed for archaeological site potential.

### 3.2.2 Archaeological Site Potential

In lieu of additional survey data, *Louisiana's Comprehensive Archaeological Plan* (Girard, et al. 2018) and research conducted by Earth Search, Inc. (Lee et al. 2009) for the *Proposed Amite River and Tributaries, Bayou Manchac Water Shed Feasibility Study, Ascension, East Baton Rouge & Iberville Parishes, Louisiana*, can be used for baseline planning purposes. To a great extent, the unique geomorphology and ecology of the study area has influenced site type and location. To examine how the physical landscape impacts the archaeological record, the LDOA divides the study area into a series of regions that follow the ecoregions classification of the Western Ecology Division of the U.S. Environmental Protection Agency (https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6#pane-16). There are six (6) Regions at Level III, three of which fall within the present study area (*Southern Coastal Plain*, *Mississippi Valley Loess Plain* and *Mississippi Alluvial Plain*). All three Level III Regions are then further divided into sub-regions (Level IV: *Southern Rolling Plains*, *Baton Rouge Terrace*, *Gulf Coast Flatwoods*, *Inland Swamps*, *and Southern Holocene Meander Belts*). Girard, et al. (2018: 24-31) define how the unique environmental, biological, and physiological characteristics of each region influenced cultural development in order to provide context to the distribution of where sites are likely or unlikely to occur as is summarized below:

The *Mississippi Alluvial Plain* Level III ecoregion falls within the southern portion of the present study area and includes the *Southern Holocene Meander Belt* and *Inland Swamp* Level IV ecoregions:

*In the southern portion of the [study area] this region includes the Holocene-age deltaic lobes of the Mississippi River...Sites are found predominantly on higher, better-drained landforms. These are typically natural levees along channels, but may include point bars and other surfaces. In many areas, the distribution and age of sites on the modern surface reflects the geological history of that area, rather than its entire occupational history…The Inland Swamp sub-region represents the transition between freshwater backswamps to fresh, brackish, and saline waters of the deltaic marshes…Much of the land is low-lying and subject to seasonal flooding. Numerous bayous drain the region with their natural levees providing the only elevated ground… Sites are concentrated along natural levees. Channel migration has eroded many landforms, and sediment deposition has buried many others.*

The *Mississippi Valley Loess Plains* Level III ecoregion encompasses the central-southern half of the present study area and includes the *Southern Rolling Plains and Baton Rouge Terrace* Level IV ecoregions:

*This region consists of rolling hills and bluffs immediately east of the Mississippi Alluvial Plain [and] is underlain by Miocene and Pliocene sand, silt, and gravel deposits in the northern half, and by Pleistocene age silts, sands, and clays in the south…The region is dominated by the thick layer of Late Pleistocene loess derived from the Mississippi River valley that is draped over the gently rolling topography…Sites are typically situated on higher* *ridge crests and along stream margins. Sites will occur in surface contents in higher elevations while occasional buried sites may be found in alluvial settings.*

The *Southern Coastal Plain* Level III ecoregion comprises the northern central-half of the present study area, spanning the Louisiana/Mississippi border, and includes the *Gulf Coast Flatwoods* Level IV ecoregion:

*The uplands consist of gently rolling topography dissected by north-south trending streams and rivers…Holocene alluvial deposits are in floodplains and on low terraces along major streams…Sites in the upland areas are concentrated on higher ridge crests and overlooking streams. Most of these deposits are shallow with overlapping occupations and no opportunity for stratified sites. Buried and stratified sites may occur in the floodplains of the larger streams.*

Complimentary to Girard, et al.'s (2018) ecosystem-based model (above), Lee et al. (2009:132) recommend:

*It is essential that investigations be conducted in the fullest consideration and effective integration of available knowledge of landscape dynamics. In doing so, surveys can be designed to provide adequate assessment of all areas, but with greater attention and effort focused on areas that would have been relatively more favorable for prehistoric occupation. Of greater importance, it avoids the expenditure of resources in areas where existing knowledge of geomorphic processes and landscape evolution indicates with confidence that prehistoric activities were precluded or where subsequent natural processes have destroyed the evidence…Geomorphologic data, previous archaeological investigations, and previously recorded sites will constitute the primary data sets utilized in the predictive model. Landform type, elevation, and soils will also be utilized to construct the predictive model. These data will be integrated to determine high probability areas within the riverine and upland portions of the project area.*

Geospatial modeling of cultural landscapes for predictive scientific research is an important emerging approach in contemporary archaeology. Depending on the scale of the final array of project alternatives, it may be advantageous to develop a geospatial predictive model based upon the work of Girard, et al. (2018) and Lee et al. (2009) that incorporates the accumulated environmental and archaeological information specified above as a means to forecast the probability of significant archaeological sites occurring in any particular location that can be used to guide efficient identification and evaluation strategies.

It is estimated that several hundred archaeological sites exist within the proposed study area that cover the range of human occupation from the Paleo-Indian through to historic occupation. It is anticipated that project measures and/or alternative measures will impact these sites. Additional studies and research will need to be conducted subsequent to the execution of the PA.

### 3.2.3 Tribal Areas of Interest

CEMVN utilizes the USACE Tribal Consultation Policy, 1 November 2012, as guidance when implementing its Federal trust responsibility to Tribal Nations. Further, it is the policy of the Federal Government to consult with Tribal Governments on a Government-to-Government basis as required in Executive Order 13175. CEMVN recognizes that Tribes may have sites of religious and cultural significance on or off Tribal Lands, as defined in 36 CFR § 800.16(x), including sites that may contain human remains and/or associated cultural items, that may be affected by this Undertaking. Each Tribe has a THPO who consults with federal agencies regarding activities that may impact archaeological sites of ancestral interest. Ten federally recognized Tribal Nations have identified study parishes within Louisiana as Areas of Interest (AOI; Table C1-17): ACTT, CTL, CNO, CT, JBCI, MBCI, MCN, SNO, STF, and the TBTL. Five (5) federally recognized Tribes have identified study counties within Mississippi as AOIs (Table C1-17): CTL, CNO, JBCI, MBCI, and SNO. Of these Tribes, none currently hold lands within the study area.

*Table C1-17. Federally recognized Tribal Nation Areas of Interest*

| County/Parish: | ACTT | CTL | CNO | CT | JBCI | MBCI | MCN | SNO | STF | TBTL |
|---|---|---|---|---|---|---|---|---|---|---|
| Mississippi: | | | | | | | | | | |
| Amite | No | No | Yes | No | Yes | Yes | No | Yes | No | No |
| Franklin | No | No | Yes | No | Yes | Yes | No | Yes | No | No |
| Lincoln | No | No | Yes | No | Yes | Yes | No | Yes | No | No |
| Wilkinson | No | Yes | Yes | No | Yes | Yes | No | Yes | No | No |
| Louisiana: | | | | | | | | | | |
| Ascension | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| East Baton Rouge | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| East Feliciana | No | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Iberville | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Livingston | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes |
| St. Helena | No | No | Yes | Yes | Yes | Yes | No | No | No | Yes |
| St. James | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes |
| St. John the Baptist | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## 3.3 U.S. CIVIL WAR

The study area is also the setting of at least 11 terrestrial and naval Civil War battles ranging from small skirmishes to major decisive battles. The NPS's American Battlefield Protection

Program (ABPP; 54 U.S.C. 380101-380103), Civil War Sites Advisory Commission (Public Law 101-628), has assigned Preservation Priorities (https://www.nps.gov/abpp/battles/bystate.htm) to five (5) individual battlefields located within the study area: Magnolia Cemetery (East Baton Rouge: Priority IV.1), Donaldsonville 1862 (Ascension Parish; Priority IV.2), Donaldsonville 1863 (Ascension Parish; Priority IV.2), Cox's Plantation (Ascension Parish; Priority IV.1), and Port Hudson (East Baton Rouge Parish and East Feliciana Parish: Priority I.1).

### 3.4 LOUISIANA SCENIC RIVERS ACT

The Louisiana Department of Wildlife and Fisheries is the lead state agency in the State Scenic River Program. Archaeological resources within scenic river corridors are protected by law under the Louisiana Scenic Rivers Act of 1988 (LSRA). The current study area includes the following Louisiana Natural and Scenic Rivers: the Amite River, Comite River, Blind River, and Bayou Manchac. In addition to the extra protections afforded to cultural resources under the LSRA, Bayou Manchac from the Amite River to the Mississippi River is designated as a "Historic and Scenic River," which requires that "full consideration shall be given to the detrimental effect of any proposed action upon the historic and scenic character thereof, as well as the benefits of the prosed use."

### 3.5 NHPA AND TRIBAL COORDINATION

Section 106 of the NHPA lays out four (4) basic steps that must be carried out sequentially: 1) establish the undertaking; 2) identify and evaluate historic properties; 3) assess effects to historic properties; and 4) resolve any adverse effects (avoid, minimize, or mitigate). An agency cannot assess the effects of the undertaking on historic properties until it has identified and evaluated historic properties within the APE. The federal agency must consult with the appropriate SHPOs, THPOs and/or tribal officials, state and local officials, non-federal sponsors/applicants, and any other consulting parties in identifying historic properties, assessing effects, and resolving adverse effects, and provide for public involvement.

CEMVN will develop an Area of Potential Effects (APE) for each alternative in consultation with external stakeholders (consulting parties), the scope of which will include related project activities, after which CEMVN will require the obligation of funding to initiate the appropriate level of field investigations to complete Archaeological and Standing Structures Evaluation adhering to the LDOA Field Standards for Archaeological Investigation and Testing and Report Standards, and the SOI Standards for History, Archaeology, Architectural History, Architecture, or Historic Architecture (48 FR 44716). Following the completion of the aforementioned identification and evaluation, CEMVN will use the resulting technical reports to assess cultural and historic resources within the project area according to the NRHP Criteria for Evaluation (36 CFR 60.4 [a-d]). Should CEMVN determine that its programs may result in Undertakings with the potential to affect historic properties and/or sites of religious and cultural significance, CEMVN will prepare consultation letters to SHPO, Tribes, and other consulting parties describing the undertaking, the APE, the historic properties that may be affected, and CEMVN's determination of Effect. Should there be an Adverse Effect, CEMVN may elect to negotiate a traditional Memorandum of Agreement (MOA) that sets out the measures the CEMVN will implement to resolve those adverse effects through avoidance, minimization, or mitigation (36 CFR § 800.14(b)). If multiple resources will be affected, the development of individual MOAs for each adverse effect will be required.

As an alternative to the "Standard" Section 106 process described above, the agency may also defer final identification and evaluation of historic properties if specifically provided for in a Programmatic Agreement (PA) executed pursuant to § 800.14(b). A PA is likely to be more appropriate when the undertaking is complex, the undertaking will adversely affect a significant historic property, the extent of effects is unknown, there is public controversy, the parties involved overwhelmingly prefer it, or at the feasibility level there is insufficient funding and time to fully conduct all required NHPA cultural resources identification and evaluation and to determine any necessary avoidance, minimization, or mitigation measures in consultation with stakeholders and the agency is mandated by law to make a final decision on this undertaking within a timeframe that simply cannot accommodate the standard Section 106 process. The process should establish the likely presence of historic properties within the APE for each alternative, taking into account the number of alternatives under consideration, the magnitude of the undertaking and its likely effects, and the views of the SHPO/THPO and any other consulting parties. Furthermore, CEMVN's Section 106 compliance requirements may be more effectively and efficiently implemented if a programmatic approach is used to stipulate roles and responsibilities, exempt certain actions from Section 106 review, establish protocols for continuing consultation, facilitate identification and evaluation of historic properties, and streamline the assessment and resolution of adverse effects. Following the successful execution of the PA, CEMVN may proceed with issuing a ROD in compliance with Section 106 of the NHPA and in coordination with NEPA.

## 3.6 AESTHETICS

The majority of the study area is within the ARB, which constitutes a mosaic of forest, pine plantations, pasture, and cropland. The primary land-use in the area is agriculture. The Amite River flows South from the Mississippi Valley Loess Plains Ecoregion and into the Mississippi Alluvial Ecoregion. The dominant natural vegetation in the northeast consists of upland forests dominated by oak, hickory, and both loblolly and shortleaf pine. The dominant natural vegetation in the northwest consists of forests characterized by beech, southern magnolia, and American holly. The dominant natural vegetation in the south consists of inland swamps and ridges (according to the State of Louisiana Eco-Region Map, ref. "Louisiana Speaks" and "USGS Eco-Region Map", Daigle, J.J., Griffith, G.E. Omernik, J.M., Faulker, P.L., McCulloh, R.P., Handley, L.R., Smith, L.M., and Chapman, S.S., 2006, Ecoregions of Louisiana color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,000,00)."

From an aesthetic perspective, the inland swamps in the south have a fairly dense canopy constituted by bald cypress and water tupelo trees. The majority of the bald cypress are rarely the mature and majestic specimens as they once were due to logging operations in the early 1900s. The heavily shaded swamp understory is composed primarily of red maple and green ash. The ground is hard bottom. The tranquil swamps are perennially wet and the water is clear. These swamp areas are often difficult to access and are generally viewed into from roadway edges, waterways, and natural ridges. The ridges are small rises in the inland swamp and are typically occupied by Water Oak, Diamond Oak, Sweetgum, Ash, Wax Myrtle, Black Willow, Chinese Tallow, and Privet. The ridges provide a dryer and slightly more accessible setting in contrast to the surrounding darkness and wetness of the inland swamps for hunters, nature observers, bird watchers, and ecologists.

Numerous efforts have been made to protect and promote visual resources within the ARB that are known for their unique culture and natural identity. One of these efforts, made by the Louisiana Department of Culture, Recreation & Tourism, is for marketing scenic byways thru rural landscape and culturally significant communities. There is a Scenic Byway bordering the study area on the south and east which includes the Great River Road. This is but one segment to an overall scenic byway that stretches on multiple thoroughfares from Canada to the Gulf of Mexico. It is state and federally designated and has an “All American Road” status, making it significant in culture, history, recreation, archeology, aesthetics and tourism.

In 1970, the Louisiana Legislature created the Louisiana Natural and Scenic Rivers System. The System was developed for the purpose of preserving, protecting, developing, reclaiming, and enhancing the wilderness qualities, scenic beauties, and ecological regimes of certain free-flowing Louisiana streams. These rivers, streams and bayous, and segments thereof, are located throughout the state and offer a unique opportunity for individuals and communities to become involved in the protection, conservation and preservation of two of Louisiana's greatest natural resources; its wilderness and its water. Within the study area, there are four designated Louisiana Natural and Scenic Rivers (RS 56:1857). The Amite River from the Louisiana-Mississippi state line to La. Hwy. 37 in East Feliciana Parish; the Blind River from its origin in St. James Parish to its entrance into Lake Maurepas; the Comite River from the Wilson-Clinton Hwy in East Feliciana Parish to the entrance of White Bayou in East Baton Rouge Parish; and Bayou Manchac from the Amite River to the Mississippi River is designated as a Louisiana Historic and Scenic River (RS 56:1856).

## 3.7 RECREATION

Both consumptive and non-consumptive recreation activities in the study area are centered on natural resources. Consumptive recreation includes hunting, fishing for freshwater and saltwater species, and trapping alligators and nutria. Non-consumptive recreation includes wildlife viewing, sightseeing, boating, camping, and environmental education/interpretation. Opportunities for the activities listed are widespread via the waterways within and comprising the boundaries of the study area.

The following public areas, both within and in close proximity to the study area, have been set aside and provide high quality recreation opportunities: Homochito National Forest, Caston Creek Wildlife Management Area (WMA), Maurepas Swamp WMA, Waddill Outdoor Education Center, and multiple county-wide park and recreation systems (Table C1-18).

Table C1-18. Public areas within the study area

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| National Forest | | | | | | | |
| Homochito National Forest | 191,839 | Amite, Franklin, Lincoln, Wilkinson | United States Department of Agriculture Forest Service | fishing, hunting | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping, shooting range | Yes | This National Forest is just outside the project area border to the northwest and includes 5.5 mile Bushy Creek Horse Trail, Clear Springs Recreation Area, Okhissa Lake Recreation Area with boat ramps, Woodman Springs Shooting Range |
| State Wildlife Refuge | | | | | | | |
| Caston Creek WMA | 28,286 | Amite, Franklin | Mississippi Department of Wildlife, Fisheries& Parks | Fishing, hunting | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping | No | This WMA is just outside the project area border to the northwest and within Homochito National Forest. It offers scenic horseback trails as well as various hiking and biking trails for the avid outdoorsmen or the novice adventurer. |
| Maurepas Swamp WMA | 124,567 | Ascension, Livingston, St. James, St. John the Baptist | Louisiana Department of Wildlife and Fisheries | fishing, hunting, trapping | Boating, camping, birding, wildlife viewing | No | Bald eagles and osprey nest in and around the WMA. Numerous species of neotropical migrant birds use this coastal forest habitat during fall and spring migrations. Resident birds, including wood ducks, black-bellied whistling ducks, egrets, and herons can be found on the WMA year-round. |
| Waddill Outdoor Education Center | 237 | East Baton Rouge | Louisiana Department of Wildlife and Fisheries | fishing, | Nature trails, birding, shooting range, archery range, picnic facilities | No | Accessible via North Flannery Road or by boat from the Comite River. LDWF initiated a Summer Day Camp for children ages 12 to 16 in the summer of 2011. The camp is free and open for 5 days allowing participants to receive official boater and hunter education certifications. The camp also offers a fish identification class, fishing and canoeing, skeet shooting, and other outdoor-related activities. |
| Parish / County Park System | | | | | | | |
| Ascension Parish Parks | N/A | Ascension | Ascension | N/A | Ballfields, courts, playgrounds, leisure paths, swimming pools, picnic | Yes | The Parish has 13 parks within the study area in communities including St. Amant, Gonzales, Prairieville, and Geismer |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | areas | | |
| Recreation and Park Commission for the Parish of East Baton Rouge (BREC) | N/A | East Baton Rouge | BREC | N/A | Horseback riding, hiking, picnicking, mountain biking, birding, photography, camping, shooting range | Yes | BREC has more than 180 parks including a unique mix of facilities, which mirror the history and rich natural resources in the region; including a state-of-the-art observatory, a swamp nature center and conservation areas, a performing arts theatre, an equestrian park, an art gallery, an arboretum, an accredited zoo, seven golf courses and an extreme sports park with a 30,000-foot concrete skate park, rock-climbing wall, BMX track and velodrome. |
| Livingston Parish Parks | N/A | Livingston | Livingston | N/A | Ball field, courts, pools, leisure paths, picnic areas | No | The Parish has parks within the study area in communities including Greenwell Springs, Walker, Parks and Recreation of Denham Springs (PARDS), and Livingston Parks and Recreation (LPR). |
| St. James Parish Parks | N/A | St. James | St. James Parish Parks and Recreation | N/A | Ball fields, courts, playgrounds, leisure paths, swimming pools | No | The Parish has 4 parks within the study area including Gramercy Park, Lutcher Park, Paulina Park, and Romeville Park |
| St. John Parish Parks | N/A | St. John the Baptist | St. John the Baptist | N/A | Ball fields, courts, playgrounds, leisure paths, swimming pools, picnic areas | No | The Parish has 8 parks within the study area: Ezekiel Jackson, Regala, Belle Pointe, Emily C. Watkins, Greenwood, Cambridge, Stephanie Wilking, and Hwy. 51 Park |

According to the United States Department of the Interior National Park Service Land & Water Conservation Fund (LWCF), nearly 100 recreation projects within the study area have been supported between 1965 and 2011. Section 6(f)(3) of the LWCF Act assures that once an area  has been funded with LWCF assistance, it is continually maintained in public recreation use unless National Park Service (NPS) approves substitution property of reasonably equivalent usefulness and location and of at least equal fair market value. Table C1-19 below illustrates funding from the LWCF within the study area.

*Table C1-19 LWCF funding within study area*

| Parish | Grants | Amount |
|---|---|---|
| Ascension | 19 | $1,249,286.86 |
| East Baton Rouge | 58 | $3,729,989.60 |
| Livingston | 16 | $1,538,956.14 |
| St. James | 5 | $539,740.17 |
| St. John the Baptist | 1 | $128,026.56 |
| **Total:** | **99** | **$7,185,999.33** |

### 3.8 ENVIRONMENTAL JUSTICE

Five of the twelve parishes or counties in the study area including East Baton Rouge, Iberville, St. James and St. John the Baptist Parishes as well as Wilkinson County, MS, have a majority of their population identifying as minority (Table C1-20).

*Table C1-20. Total Population and Racial/Ethnic Composition*

| Geography | Total Population Estimate | White | Black or African American | American Indian and Alaska Native | Asian | Native Hawaiian and Other Pacific Islander | Some other race | Two or more races | Percent Minority | Hispanic or Latino (of any race) | Percent Hispanic or Latino (of any race) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ascension Parish, LA | 119,129 | 87,674 | 26,036 | 47 | 1,072 | - | 965 | 3,335 | 26.4% | 6,261 | 5.3% |
| East Baton Rouge Parish, LA | 446,167 | 212,859 | 204,078 | 944 | 15,146 | 123 | 5,832 | 7,185 | 52.3% | 17,825 | 4.0% |
| East Feliciana Parish, LA | 19,553 | 10,508 | 8,734 | 57 | 31 | - | 59 | 164 | 46.3% | 296 | 1.5% |
| Iberville Parish, LA | 33,122 | 16,392 | 16,195 | 83 | 20 | - | 165 | 267 | 50.5% | 837 | 2.5% |
| Livingston Parish, LA | 137,096 | 124,798 | 8,191 | 330 | 655 | 17 | 957 | 2,148 | 9.0% | 4,741 | 3.5% |
| St. Helena Parish, LA | 10,509 | 4,632 | 5,671 | 79 | 23 | - | 25 | 79 | 55.9% | 24 | 0.2% |
| St. James Parish, LA | 21,485 | 10,420 | 10,692 | 21 | 51 | - | 132 | 169 | 51.5% | 336 | 1.6% |
| St. John the Baptist Parish, LA | 43,565 | 17,716 | 24,175 | - | 391 | - | 438 | 845 | 59.3% | 2,524 | 5.8% |
| Amite County, MS | 12,574 | 7,237 | 5,277 | 3 | 34 | - | - | 23 | 42.4% | 29 | 0.2% |
| Franklin County, MS | 7,772 | 4,949 | 2,795 | - | 2 | - | - | 26 | 36.3% | 65 | 0.8% |
| Lincoln County, MS | 34,542 | 23,567 | 10,641 | 4 | 254 | - | - | 76 | 31.8% | 369 | 1.1% |
| Wilkinson County, MS | 9,084 | 2,537 | 6,477 | - | 6 | - | 39 | 25 | 72.1% | 26 | 0.3% |

Source: U.S. Census Bureau 2017 ACS.

Four of the twelve Parishes/Counties in the study area, including St. Helena Parish in Louisiana and Amite, Lincoln and Wilkinson Counties in Mississippi have 20 percent or more of individuals living below poverty, which in 2017 is $25,094 for a family of four (Table C1-21).

*Table C1-21: Persons Living Below Poverty Level*

| Geography | Population Estimate* | Below Poverty Level | Percent Below Poverty Level |
|---|---|---|---|
| Ascension Parish, LA | 118,199 | 13,824 | 11.7 |
| East Baton Rouge Parish, LA | 436,841 | 83,483 | 19.1 |
| East Feliciana Parish, LA | 16,329 | 2,928 | 17.9 |
| Iberville Parish, LA | 29,598 | 5,708 | 19.3 |
| Livingston Parish, LA | 135,933 | 17,959 | 13.2 |
| St. Helena Parish, LA | 10,280 | 2,719 | 26.4 |
| St. James Parish, LA | 21,275 | 3,316 | 15.6 |
| St. John the Baptist Parish, LA | 42,804 | 7,643 | 17.9 |
| Amite County, MS | 12,464 | 2,846 | 22.8 |
| Franklin County, MS | 7,666 | 1,369 | 17.9 |
| Lincoln County, MS | 33,986 | 8,007 | 23.6 |
| Wilkinson County, MS | 8,023 | 3,107 | 38.7 |
| * For Whom Poverty Status is Determined | | | |

Source: U.S. Census Bureau 2017 ACS.

The Environmental Indicators for the Darlington Dam, presented in Table C1-22, are all below the 80th percentile in the State or USA, which is according to EPA, the percentile where one would not expect EJ concerns. The Environmental Indicators do not highlight EJ concerns. However, the demographic indicator, Minority Population (Table C1-20), shows the area well over 50 percent minority, both for communities within the Darlington Dam footprint and communities in the 25-year floodplain. The community within the dam footprint is considered an EJ community based upon minority criteria with over 50 percent of population identifying as minority.

*Table C1-22. Darlington Dam Selected Environmental and Demographic Indicators*

| Selected Variables | Study Area Value | State Avg | Percentile in State | EPA Region Avg | Percen-tile in EPA Region | USA Avg | Percen-tile in USA |
|---|---|---|---|---|---|---|---|
| Environmental Indicators | | | | | | | |
| Particulate Matter (PM 2.5 in µg/m³) | 8.68 | 9.03 | 30 | 9.55 | 18 | 9.53 | 31 |
| Ozone (ppb) | 36.4 | 37.4 | 33 | 40.4 | 24 | 42.5 | 14 |
| NATA* Diesel PM (µg/m³) | 0.232 | 0.891 | 11 | 0.721 | <50th | 0.938 | <50th |
| NATA* Air Toxics Cancer Risk (risk per MM) | 44 | 49 | 37 | 42 | 60-70th | 40 | 60-70th |
| NATA* Respiratory Hazard Index | 1.3 | 1.9 | 6 | 1.8 | <50th | 1.8 | <50th |
| Traffic Proximity and Volume (daily traffic count/distance to road) | 2.4 | 250 | 13 | 320 | 7 | 600 | 7 |
| Lead Paint Indicator (% pre-1960s housing) | 0.038 | 0.21 | 21 | 0.18 | 39 | 0.29 | 23 |
| Superfund Proximity (site count/km distance) | 0.012 | 0.067 | 21 | 0.07 | 20 | 0.12 | 12 |
| RMP Proximity (facility count/km distance) | 0.066 | 0.88 | 18 | 0.8 | 14 | 0.72 | 15 |
| Hazardous Waste Proximity (facility count/km distance) | 0.029 | 0.74 | 4 | 0.86 | 8 | 4.3 | 6 |
| Wastewater Discharge Indicator (toxicity-weighted concentration/m distance) | 0 | 0.49 | N/A | 0.38 | 36 | 30 | 40 |
| Demographic Indicators | | | | | | | |
| Demographic Index | 59% | 40% | 76 | 44% | 71 | 36% | 81 |
| Minority Population | 73% | 41% | 80 | 51% | 70 | 38% | 80 |
| Linguistically Isolated Population | 1% | 2% | 66 | 6% | 39 | 4% | 48 |
| Population with Less Than High School Education | 20% | 16% | 66 | 17% | 66 | 13% | 77 |
| Population under Age 5 | 9% | 7% | 73 | 7% | 69 | 6% | 77 |
| Population over Age 64 | 16% | 14% | 66 | 13% | 71 | 14% | 63 |

*The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

Note: This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports. For additional information, see: www.epa.gov/environmentaljustice

Additonally, 20% or more of households in three of four block groups comprising the dam have incomes below the poverty level (Table C-23). The community within the footprint of the dam is considered an EJ community based upon the low-income criteria with over 20 percent of households living below poverty level.

*Table C1-23. Darlington Dam Households Below Poverty*

| Census Tract/BG | Total Population in Census Block Group | Households | Number of Households below Poverty Level | % HHLDS below Poverty |
|---|---|---|---|---|
| 220919511/002 | 765 | 291 | 70 | 24% |
| 220379513/001 | 850 | 323 | 59 | 18% |
| 220919511/003 | 1,047 | 398 | 100 | 25% |
| 220379516/001 | 1,613 | 613 | 141 | 23% |
| Total | 4,275 | 1,625 | 370 | 23% |

Source: EPA EJSCREEN and the U.S. Census Bureau.
Note: The data shown represents large census block groups and the percent of households below poverty. The structures within the Darlington Dam footprint are part of large census block groups.

# References and Resources

**Project References**

Couvillion, B.R. 2011. Land Area Change in Coastal Louisiana from 1932 to 2010. https://pubs.usgs.gov/sim/3164/downloads/SIM3164_Pamphlet.pdf

Couvillion, B.R. 2017. Land area change in coastal Louisiana (1932 to 2016). https://pubs.er.usgs.gov/publication/sim3381

Hieb, E.E. et al. 2017. Sighting demographics of the West Indian manatee Trichechus manatus in the north-central Gulf of Mexico supported by citizen-sourced data. *Endangered Species Research.*

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Amite River and Tributaries Study East of the Mississippi River, Louisiana


# Appendix C-2: Environmental Impact Statement Final Scoping Report

## November 2019

# CONTENTS



# TABLES



# APPENDICES

(located at https://www.mvn.usace.army.mil/Amite-River-and-Tributaries/)

# Section 1 Introduction

The National Environmental Policy Act (NEPA) of 1969 established a nationwide policy to include a detailed statement of the environmental impact in every recommendation or report on proposals for major Federal actions significantly affecting the environment. This detailed statement is the environmental impact statement (EIS).

On April 2, 2019, the Federal Register (Vol. 84, No. 63) published a notice of intent (NOI) for the U.S. Army Corps of Engineers, New Orleans District (CEMVN) to prepare a Draft Integrated Feasibility Report (IFR) and Environmental Impact Statement (DEIS) for the Amite River and Tributaries Study East of the Mississippi River, Louisiana. The purpose of the NOI was to announce the U.S. Army Corps of Engineers' (USACE) intention to prepare a draft EIS for this flood risk management study. Scoping meeting announcements were advertised in the local newspapers and CEMVN websites leading up to the scoping meetings. These meetings were held in Denham Springs, LA and Clinton, LA on April 24, 2019 and Prairieville on April 25, 2019.

The purpose of the study is to determine the feasibility of flood risk management measures (structural and non-structural) in the Amite River Basin. The IFR and DEIS will document the existing conditions of environmental resources in and around areas considered for construction, and potential impacts on those resources as a result of implementing the alternatives.

NEPA provides for an early and open public process for determining the scope of issues, resources, impacts, and alternatives to be addressed in an EIS (referred to as scoping). This scoping report outlines the project background and scoping process to date, and summarizes the key issues identified by members of the public during the initial scoping period.

# Section 2 Study Authority

The study is being performed in response to the standing authority of Bipartisan Budget Act of 2018, H. R. 1892—13, Title IV, Corps Of Engineers—Civil, Department Of The Army, Investigations, where funds are being made available for the expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection studies, which are currently authorized or which are authorized after the date of enactment of this the act, to reduce risk from future floods and hurricanes.

# Section 3 Proposed Action

The USACE will serve as the lead Federal agency in the preparation of the EIS. Other federal and/or state agencies may participate as cooperating and/or commenting agencies throughout the EIS process. In accordance with Executive order, 1307, referred to as One Federal Decision (OFD), the USACE and other agencies with environmental review, authorization, or consultation responsibilities for major infrastructure projects should develop a single EIS for such projects, sign a single Record of Decision (ROD) and issue all necessary authorizations within 90 days thereafter, subject to limited exceptions. Participating cooperating agencies include the US Fish and Wildlife Service (USFWS), Natural Resource Conservation Service (NRCS), and the US Environmental Protection Agency (USEPA).

The USACE will focus their analysis on the following resources as applicable: Aesthetics, water quality, aquatic resources and fisheries, wetlands, wildlife, threatened, endangered, and protected species, cultural, historic, and Tribal trust resources, socioeconomics, environmental justice, upland, air quality, noise and vibration, recreation, and geology, soils and water bottoms, and prime and unique farmland.

The USACE will evaluate a range of alternatives for the proposed action including structural and nonstructural measures. For the reasonable and practicable alternatives, the USACE will fully evaluate them, including the no action alternative. Alternatives may result in avoidance, minimization, and mitigation measures of impacts to reduce or offset any impacts.

The U.S. Fish and Wildlife Service will assist in documenting existing conditions and assessing effects of project alternatives through the Fish and Wildlife Start Coordination Act consultation procedures. Other environmental review and consultation requirements for the proposed project include the need for Louisiana Department of Environmental Quality Clean Water Act Section 401 water quality permit, as well as a 404(b)(1) permit. In addition, because the proposed project may affect federally listed species, the USACE will consult with the USFWS and the National Marine Fisheries Service (NMFS) in accordance with Endangered Species Act, Section 7. The NMFS will be consulted regarding the effects of this proposed project on Essential Fish Habitat per the Magnuson– Stevens Act. The USACE will also be consulting with the State Historic Preservation Officer under Section 106 of the National Historic Preservation Act concerning properties listed, or potentially eligible for listing.

# Section 4 Scoping Process

NEPA affords all persons, organizations, and government agencies the right to review and comment on proposed major Federal actions that are evaluated in a NEPA document. Known as the scoping process, this is the initial step in the preparation of the EIS and helps identify: (1) the range of actions (project and procedural changes), (2) alternatives (those to be explored rigorously and evaluated, and those that may be eliminated), and (3) the range of environmental resources considered in the evaluation of environmental impacts.

## A Public Notification

The public was notified of both public meetings using the following communication mechanisms: local newspaper and the project website, https:// www.mvn.usace.army.mil/About/ Projects/BBA-2018/studies/.

## B Scoping Meetings

The public scoping meetings were held as follows:

Wednesday, April 24, 2019
Denham Springs - Walker Branch Library
Office West Meeting Room
8101 Florida BLVD, Denham Springs, LA 70726
70722 6 to 8 p.m.

Wednesday, April 24, 2019
East Feliciana Police Jury
12064 Marston Street
Clinton, LA
6 to 8 p.m.

Thursday April 25, 2019
Galvez Branch Library, Meeting Room 2 40300
Highway 42 at Autumn Leaves Drive,
Prairieville, LA 70769
5:30 to 7:30 p.m.

The open house style meetings provided attendees with an opportunity to visit a series of poster stations staffed by project team members and subject matter experts regarding the following topics: Plan Formulation, Environmental, and Project Management. For all scoping meetings, the general public also had the opportunity to view a live-stream video on the USACE Facebook page.

The April 25, 2019 Prairieville, LA scoping meeting presentation can be viewed from the CEMVN Youtube link: https://www.youtube.com/watch?v=bRGNvbhAyJw.

This Scoping Report presents and summarizes the scoping comments expressed at the public scoping meetings, as well as all other scoping comments received during the scoping period beginning 2 April 2019, and ending 8 July 2019. This Scoping Report indicates where in the draft EIS individual comments will be addressed. The report will be provided to all scoping participants who provided their address, and has been published on the project website, https://www.mvn.usace.army.mil/About/Projects/BBA-2018/studies/.

# Section 5 Scoping Participants

A total of at least 80 people attended the three scoping meetings, with 36 in Livingston Parish, 13 in East Feleciana Parish, and 31 in Ascension Parish. These included, but were not limited to, private citizens, stakeholders, non-governmental organizations, and political representatives.

On the Facebook live feed, there were 3,184 viewers on Wednesday; and 3,687 viewers on Thursday.

# Section 6 Scoping Meeting Comments

Scoping comments document the public's concerns about the scope of the proposed course of action, as well as identify significant resources and suggested alternatives. Scoping comments are considered during the study process and preparation of the draft EIS.

## A Scoping Comment Categorization by Theme

A total of 37 comments were collected from comment cards, emails, a slide presentation, and a letter received. These comments were categorized by concern or issue identified by the commenters. A concern or issue raised three times or more became a "theme." A total of 4 recurring themes were identified, including an "other" category. The "other" category includes issues or concerns that were raised only once, or comments that were not directly related to the proposed action, such as "The meeting needs to be earlier" or "A meeting from 6-9 p.m. is a bit much." Each comment was assigned to only one theme, if applicable. The top 4 themes are discussed in this section.

The first theme is "Flooding concerns," and this involves issues surrounding floodwater impacts, including localized and regional impacts, especially those affecting property owners. A total of 6 comments were identified with this theme (See Table C2-1), and they cover flood impacts from trees in Pretty Creek, the Amite River Diversion renovation inducing further flooding, and a college professor's hydrology study on the confluence of the Comite and Amite Rivers.

The second theme is "Dredging opportunities," which involves requests for investigating dredging along various reaches in the study area. The 3 comments cover dredging boatways for creating land for public use, dredging Bayou Manchac to address siltation, and dredging the Amite River.

The third theme "Levee concerns" pertains to levee alignments in the study area. The theme had 4 comments covering the Laurel Ridge levee extension (a non-Corps project) and a suggested alternative for a levee upriver of Lake Maurepas.

The fourth theme "Ecosystem-wide flood and storm risk reduction" involves requests for investigating habitat restoration throughout the study area and considering impacts to wildlife and species of conservation need. A total of 5 comments were identified for this theme.

1. Flooding concerns – 6
2. Dredging opportunities – 3
3. Levee concerns – 4
4. Ecosystem-wide flood and storm risk reduction – 5
5. Other – 19

Table C2-2 Consolidated comments and location in the draft report

| **Location in EIS** | | | | | | | **Consolidated Comments/ Themes** | **Number of Comments** | **Percent of Occurrence** |
|---|---|---|---|---|---|---|---|---|---|
| **PN** | **Alt** | **AE** | **EC** | **CC** | **M** | **CI** | | | |
| | | X | X | | | X | Address flooding concerns | 6 | 16% |
| | X | | | | | | Investigate dredging opportunity(s) | 3 | 8% |
| | X | | | X | | X | Consider levees | 4 | 11% |
| X | X | X | | | | | Consider ecosystem-wide flood and storm risk reduction | 5 | 14% |
| | X | X | X | X | | X | Other | 19 | 51% |
| | | | | | | | **Total** | ***37**** | **100%** |

**Location in EIS: PN** – Purpose and Needs **Alt –** Alternatives **AE –** Affected Environment **EC –** Environmental Consequences **CC –** Consultation and Coordination **M-** Mitigation **CI –** Cumulative impact. *Note: The number of occurrences is greater than the total number of comments received because a given comment can be associated with more than one theme. The percentages are based on dividing the number of occurrences of a given theme by the total number of occurrence and multiplying by 100.

# Section 7 Opportunities for Public Input

The official deadline for receipt of comments for preliminary scoping was 8 July 2019. USACE New Orleans District received comments on the proposed initial array of alternatives for this project Additionally, the draft EIS document will be available for a 45-day public review and comment period that is currently scheduled to begin 14 November 2019.

# Section 8 Resource Agency Input

A stakeholder meeting was held with the resource agencies on June 18, 2019 including both state and Federal agencies. Further concerns emerged, addressing the study with nature-based solutions, especially river and bottomland hardwoods habitat restoration. The USACE will include this in the Consultation and Coordination sections in the draft EIS.

# Section 9 Website

The following project website (https://www.mvn.usace.army.mil/About/Projects/BBA-2018/studies/) will be updated with new information as needed, including a copy of this final scoping report.

Mississippi River Valley Division

Regional Planning and Environmental Division South

# Amite River and Tributaries Study East of the Mississippi River, Louisiana


# Appendix C-3 – Wetland Value Assessment Assumptions

## November 2019

**Amite River and Tributaries East of the Mississippi River (ARB) BBA18 Study:**
**WETLAND VALUE ASSESSMENT (WVA) MODEL ASSUMPTIONS AND RELATED GUIDANCE**
Note: These WVAs will likely change and will be updated following a thorough WVA of the study area.

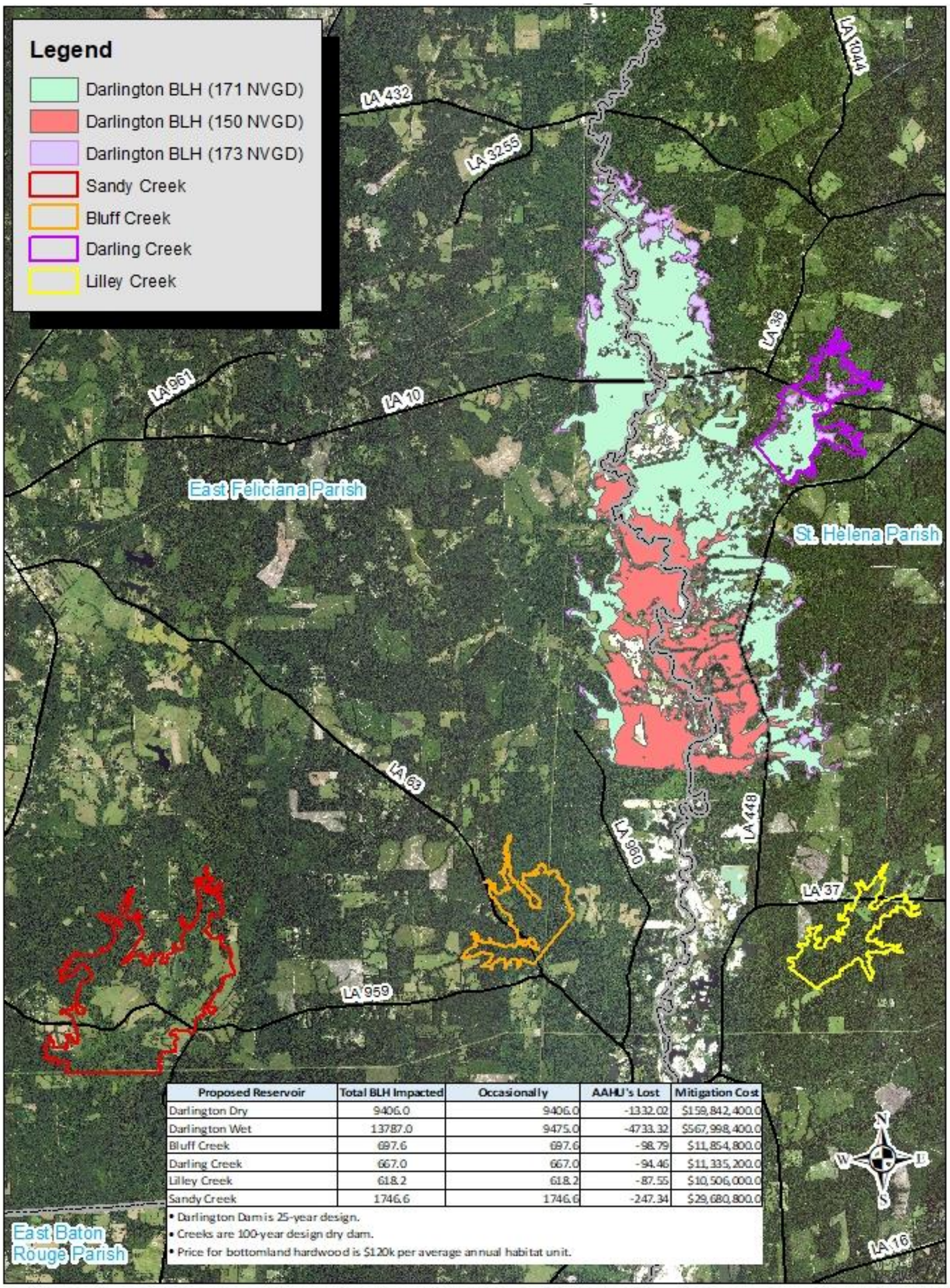
**PREFACE**

Several of the assumptions set forth in this document are based on mitigation implementation schedules. Many sections include specified WVA model target years (TYs) and calendar years applicable to assumptions, and a few sections outline anticipated mitigation construction (i.e. mitigation implementation) schedules. It is critical for the WVA analyst to understand that this document has not been revised to account for changes to the mitigation implementation/construction schedules. It is therefore imperative for the analyst to obtain the most recent mitigation implementation/construction schedule for a particular mitigation project from CEMVN prior to running WVA models. The analyst may then need to modify some of the WVA model assumptions and guidelines presented herein to account for differences between the present mitigation implementation/construction schedule and the schedule(s) that were assumed in generating this document.

Preliminary WVAs were conducted to compare the effects of each alternative to fish and wildlife resources. Roadside site assessments were used to document the existing vegetation at the four small dry dams (i.e. Lilley, Darling, Bluff, and Sandy Creek) within the final array of alternatives. Impacts to the forested communities were estimated based on anticipated flood depths and durations, and by using flood tolerances of the tree species present (U.S. Geological Survey data), growth rates of those species (U.S. Forest Service data), and aerial photography. The purpose of the preliminary WVAs is to help select the tentatively-selected plan (TSP). Once right-of-entry is obtained, final WVAs will be completed to determine mitigation requirements for the TSP. Assumptions in the preliminary WVAs during the comparison of mitigation costs indicate the Darlington Dry Dam footprint would impact approximately 1,330 average annual habitat units (AAHUs) of bottomland hardwood habitat (BLH)[1]. See Figure 1 below for the comparison of impacts (i.e. in acres and AAHUs lost). The impact to AAHUs will be further refined in the final WVA.

The USACE’s Civil Works WVA – Bottomland Hardwoods (Version 1.2) is the WVA model used to assess environmental effects for this project.

[1] There will likely be impacts associated with the staging area and for borrow sources; however, because the locations of the staging area and the borrow sources have not been determined, their impacts will be discussed in the final EIS and/or a supplemental NEPA document.




| Proposed Reservoir | Total BLH Impacted | Occasionally | AAHU's Lost | Mitigation Cost |
|---|---|---|---|---|
| Darlington Dry | 9406.0 | 9406.0 | -1332.02 | $159,842,400.0 |
| Darlington Wet | 13787.0 | 9475.0 | -4733.32 | $567,998,400.0 |
| Bluff Creek | 697.6 | 697.6 | -98.79 | $11,854,800.0 |
| Darling Creek | 667.0 | 667.0 | -94.46 | $11,335,200.0 |
| Lilley Creek | 618.2 | 618.2 | -87.55 | $10,506,000.0 |
| Sandy Creek | 1746.6 | 1746.6 | -247.34 | $29,680,800.0 |

- Darlington Dam is 25-year design.
- Creeks are 100-year design dry dam.
- Price for bottomland hardwood is $120k per average annual habitat unit.

Figure 1. Amite River and Tributaries Mitigation Areas with associated elevations of flood pools in National Geodetic Vertical Datum of 1929 (NGVD).

## 1.1 BOTTOMLAND HARDWOOD MODEL – GENERAL ASSUMPTIONS

**V1 – Tree Species Association/Composition (in canopy stratum – percentage of trees that are hard mast or other edible-seed producing trees and percentage that are soft mast, non-mast/inedible seed producing trees)**

**BLH-Wet restore, FWP scenario:**

- Of the total trees initially planted, 60% will be hard mast-producing species and 40% will be soft mast-producing species. Assume this species composition ratio (i.e. 60% of trees are hard mast-producing and 40% are soft mast-producing) will remain static over the entire period of analysis (i.e. remains the same from time of planting throughout all subsequent model target years).
- Assume Class 5 is achieved once the planted trees are 10 years old. This class remains the same thereafter (i.e. Class 5 for all subsequent target years). Note that trees will be approximately 1 year old at the time they are initially planted. Thus, Class 5 is achieved 9 years after the time of initial planting.

**General Notes:**

- Do not classify Chinese tallow as a “mast or other edible-seed producing tree”. Consider it a non-mast producing tree. Although it is an invasive species, one must still include this species regarding its contribution to percent cover in the canopy, midstory, and ground cover strata when it is present on a site (applicable to FWP scenario at TY0 and applicable to FWOP scenario for all model target years).

**V2 – Stand Maturity (average age or density breast height (dbh) of dominant and codominant canopy trees)**

**BLH-Wet and BLH-Dry restore, FWP scenario -----**

- Guidance as to how factors like subsidence and sea level rise might affect this variable (especially if the mitigation site becomes flooded for long durations, since the growth of trees may be adversely affected and certain tree species could die) -----

If the mitigation feature (polygon) is designed such that flooding at the end of the project life will not impact tree survival, i.e. flooding is <12% of the growing season (33 days) and is no more than 20% to 30% of the non-growing season, then trees should not be adversely affected. However, if the site design does not achieve this goal, then adjust the tree growth spreadsheet such that typical growth is reduced by at least 10% once flooding exceeds 20-30% of the non-growing season or is 12% or more of the growing season (Conner et al.; Francis 1983).

**General Notes:**

- Include the DBH of Chinese tallow when working with this variable (for FWOP scenario in all model target years and for FWP scenario at TY0). The same guidance would apply to other invasive species in the canopy stratum.
- For planted trees – You can use the age of the trees in lieu of their DBH when running the model (applies to all target years from time of planting throughout model run). Assume trees planted will be approximately 1 year old when they are first installed.

**V3 – Understory/Midstory (percent cover)**

**BLH-Wet and BLH-Dry restore, FWP scenario --**
Assumptions applicable to restoration features built in existing open water areas and for any restoration features that require deposition of fill to achieve target grades:

| TY | Year | Assumption |
|---|---|---|
| 0 | 2019 | Understory = 0% // Midstory = 0% Refer to Note 1 |
| 1 | 2020 | Understory = 0% // Midstory = 0% |
| 2 | 2021 | Understory = 100% // Midstory = 0% |
| 20 | 2039 | Understory = 25% // Midstory = 60% |
| 50 | 2069 | Understory = 35% // Midstory = 30% Refer to Note 2 |

Notes:
1. This assumption is applicable to restoration features built in existing open water areas. For restoration polygons built in other areas that are not open water or are only partially open water, values for cover in the understory and midstory strata must be based on site-specific conditions existing prior to the start of construction.
2. The specified values are based on the assumption that normal flooding conditions are present (i.e. desirable depth and duration of inundation). These values will need to be adjusted if sea-level rise is anticipated to increase flooding of the particular mitigation polygon to a degree whereby growth and/or survival of plant species in the understory and/or midstory strata are adversely impacted.
3. Keep in mind that canopy and midstory species will not be planted in restoration features built in open water areas until 1 year after the initial fill (borrow) has been placed in the mitigation feature. This allows 1 year of fill settlement prior to plantings.

**BLH-Wet restore and BLH-Dry restore, FWP scenario --**
Assumptions applicable to restoration features that do not require deposition of fill to achieve target grades:

| TY | Year | Assumption |
|---|---|---|
| 0 | 2019 | Refer to Note 1 |
| 1 | 2020 | Understory = 100% // Midstory = 0% |
| 20 | 2039 | Understory = 25% // Midstory = 60% |
| 50 | 2069 | Understory = 35% // Midstory = 30% Refer to Note 2 |

Notes:
1. Values for cover in the understory and midstory strata must be based on site-specific conditions existing prior to the start of construction.
2. The specified values are based on the assumption that normal flooding conditions are present (i.e. desirable depth and duration of inundation). These values will need to be adjusted if sea-level rise is anticipated to increase flooding of the particular mitigation polygon to a degree whereby growth and/or survival of plant species in the understory and/or midstory strata are adversely impacted.

**General Notes:**

- Cover accounted for by Chinese tallow and other invasive and nuisance plant species must be included in the percent cover data (applicable to FWOP scenario in all model target years and to FWP scenario at TY0).
- Changes in hydrology could result from factors such as sea-level rise and subsidence. An increase in the duration of flooding will typically decrease the understory cover and, to a lesser degree, decrease the midstory cover.

**V4 – Hydrology (flooding duration and water flow/exchange)**

**BLH-Wet restore, FWP scenario -----**
Assumptions applicable to restoration features built in existing open water areas and for restoration features that require deposition of fill to achieve target grades.

| TY | Year | Assumption |
|---|---|---|
| 0 | 2019 | Baseline conditions (score based on existing hydrology) |
| 1 | 2020 | Duration = dewatered // Exchange = none |
| 2 | 2021 | Duration = temporary Refer to Note 1 |
| 20 | 2039 | Duration = temporary Refer to Note 1 |
| 50 | 2069 | Duration = temporary Refer to Notes 1 and 2 |
| | | |

Notes:
1. Scoring of water flow/exchange component of hydrology must be based on site-specific conditions anticipated.
2. The specified value for flooding duration is based on the assumption that normal flooding conditions are present (i.e. desirable depth and duration of inundation). This value will need to be adjusted if sea-level rise is anticipated to significantly increase the duration of flooding in the particular mitigation polygon. In many cases, it is probable that the duration may shift from temporary to seasonal.

**BLH-Wet restore, FWP scenario -----**
Assumptions applicable to restoration features that do not require deposition of fill to achieve target grades and to BLH-Wet enhancement features where hydrologic enhancement is a component of the mitigation design.

| TY | Year | Assumption |
|---|---|---|
| 0 | 2019 | Baseline conditions (score based on existing hydrology) |
| 1 | 2020 | Duration = temporary Refer to Note 1 |
| 2 | 2021 | Duration = temporary Refer to Note 1 |
| 20 | 2039 | Duration = temporary Refer to Note 1 |
| 50 | 2069 | Duration = temporary Refer to Notes 1 and 2 |

Notes:
1. Scoring of water flow/exchange component of hydrology must be based on site-specific conditions anticipated.
2. The specified value for flooding duration is based on the assumption that normal flooding conditions are present (i.e. desirable depth and duration of inundation). This value will need to be adjusted if sea-level rise is anticipated to significantly increase the duration of flooding in the particular mitigation polygon. In many cases, it is probable that the duration may shift from temporary to seasonal.

3. For BLH-Wet enhancement features that do not include measures to enhance existing hydrology as part of the mitigation design, the scoring of variable V4 must be based on site-specific conditions hence no general assumptions are applicable.

**BLH-Dry restore or enhance, FWP scenario -----**

- Score flooding duration as “dewatered” during all target years used in the model.

**<u>V5 – Size of Contiguous Forested Area</u>**

**BLH-Wet & BLH-Dry restore, FWP scenario:**

- Do not consider the mitigation polygon to classify as “forested” until the planted trees are 10 years old. Remember that trees will be 1 year old when they are first installed; hence, the mitigation polygon would classify as forested 9 years following the year of initial planting. Prior to this target year, the trees initially planted in the mitigation polygon will be considered as either understory or midstory cover. For the target year when the planted trees reach 10 years old and for all model target years thereafter, the planted trees will be considered large enough for the mitigation polygon to be considered a forest. Hence at the target year planted trees reach 10 years old and all target years thereafter, the mitigation polygon can be included in the calculation of forested acreages (along with contiguous forested areas outside the mitigation polygon).

**BLH-Wet and BLH-Dry restoration, FWP and FWOP scenarios:**

- For areas outside the mitigation polygons, assume the conditions present at TY0 will remain unchanged throughout the life of the mitigation project. As used here, the term “mitigation polygons” refers to all proposed mitigation polygons regardless of the target habitat proposed. For example, a particular mitigation site could contain both a BLH-wet restoration polygon and a swamp restoration polygon. Under the FWP scenario, one would assume that the 2 restoration polygons would become forested over time but existing forested areas outside the limits of these polygons would remain forested throughout the period of analysis. Under the FWOP scenario, existing conditions would prevail in both the 2 restoration polygons and in the areas outside the limits of these polygons throughout the period of analysis.

**General Notes:**

- When scoring this variable for the FWP scenario, the area within the mitigation polygon itself as well as the adjacent “non-mitigation” areas are combined to generate the total forested acreage. However, remember the assumption that planted trees in restoration features will not be considered large enough for the feature to classify as a forest until the planted trees are 10 years old.
- When evaluating the size of contiguous forested areas, non-forested corridors <75 feet wide will not constitute a break in the forest area contiguity.

**<u>V6 – Suitability and Traversability of Surrounding Land Uses (within 0.5 mile of site perimeter)</u>**

**BLH-Wet and BLH-Dry restoration, FWP scenario:**

- When scoring a given BLH mitigation polygon, include the nearby or adjacent mitigation polygons in your assessment of land use types by assuming their land use type is the habitat type proposed (i.e. the target habitat type). However, one must consider the TY that the nearby/adjacent mitigation polygon will actually shift from its existing habitat type to the target habitat type. For example, if the adjacent mitigation polygon is a marsh restoration feature then the change from the existing habitat type (open water typically) to the target marsh habitat would not occur until TY2 (2020).

**BLH-Wet and BLH-Dry restoration, FWP and FWOP scenarios:**

- When evaluating this variable, typically assume that land uses in lands outside the mitigation polygons will score the same under the FWP and FWOP scenarios. In other words, typically assume that the existing conditions present in TY0 will remain unchanged over the life of the mitigation project. One would typically not consider potential future land development rates when scoring this variable due to the uncertainty of long-term development trends. Exceptions to this general approach would include:
  - Situations where there is a high level of confidence that a particular area is slated for a significant change in land use (e.g. construction of I-49 through the Dufrene Ponds mitigation site).
  - Situations where it is anticipated that the “land use” (habitat type) will significantly change over time due to the effects of sea-level rise and land loss (e.g. existing adjacent marsh lands rated as highly suitable/traversable changing to open water, a much lower score, due to shoreline erosion or other land loss factors).

**<u>V7 – Disturbance (sources of disturbance vs. distance from site perimeter to disturbance source)</u>**

**BLH-Wet and BLH-Dry restoration, FWP and FWOP scenarios:**
For consistency purposes, assume baseline conditions affecting the scoring of this variable will not change over time. In other words, typically assume that the existing conditions present in TY0 will remain unchanged over the life of the mitigation project.
**General Notes:**

- When scoring this variable, all distances are measured from the perimeter of the BLH mitigation polygon itself.

# APPENDIX C-4

# AGENCY COORDINATION

**Public Notice NHPA/NEPA[1]**
**Notice of Intent to Prepare Programmatic Agreement Regarding Amite River and Tributaries-East of the Mississippi River, Louisiana, Flood Risk Management Feasibility Study**

The United States Army Corps of Engineers (USACE), New Orleans District (CEMVN), is initiating the process to develop a Programmatic Agreement (PA) for the Amite River and Tributaries-East of the Mississippi River, Louisiana (ART), Flood Risk Management Feasibility Study pursuant to Section 106 of the National Historic Preservation Act (NHPA), as amended (54 U.S.C. § 300101 et seq.), and Section 110 of the NHPA, that require Federal agencies to take into account the effect of their undertakings on historic properties during the planning process and consult with stakeholders regarding these effects.


The study area, which includes the Amite River Basin, encompasses an area of approximately 3,450 square miles consisting of eight Louisiana parishes (East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, Ascension, St. James, and St. John the Baptist) and four Mississippi counties (Amite, Wilkinson, Franklin, and Lincoln). None of the initial array of alternates being considered are located within the state of Mississippi. Proposed measures are intended to provide the best comprehensive solutions to the Amite River Basin that meet the study objective: to reduce flood damages along the main channel and tributary streams of the Amite River, Bayou Manchac, and Comite Rivers. USACE began providing to the public NEPA compliance documentation on the designated project website at https://www.mvn.usace.army.mil/Amite-River-and-Tributaries/. CEMVN intends to continue to use this website to post additional project information.

CEMVN has determined that the proposed action constitutes an Undertaking as defined in 36 CFR § 800.16(y) and has the potential to cause effects on historic properties. Accordingly, CEVMN proposes to develop a project-specific PA pursuant to 36 CFR § 800.14(b)(3) to provide a framework for addressing this complex Undertaking and establish protocols for continuing consultation with the LA State Historic Preservation Officer (LA SHPO), Tribal Governments, and other stakeholders. The PA would identify consulting parties, define applicability, establish review timeframes, stipulate roles and responsibilities of stakeholders, summarize Tribal consultation procedures, consider the views of the SHPO/ Tribal Historic Preservation Officer and other consulting parties, afford for public participation, develop programmatic allowances to exempt certain actions from Section 106 review, provide the measures CEMVN will implement to develop an Area of Potential Effects (APE) in consultation with external stakeholders, outline a standard review process for plans and specifications as they are developed, determine an appropriate level of field investigation to identify and evaluate historic properties and/or sites of religious and cultural significance within the APE, streamline the assessment and resolution of Adverse Effects through avoidance, minimization, and programmatic treatment approaches for mitigation, establish reporting frequency and schedule, provide provisions for post-review unexpected discoveries and unmarked burials, and incorporate the procedures for amendments, duration, termination, dispute resolution, and implementation.

To help further develop a course of action for this project CEMVN is requesting your input by June 29, 2019, concerning the proposed Undertaking and its potential to significantly affect historic properties and/or of relevant parties who may have an interest in participating in this consultation. Comments can be sent electronically to: AMITEFS@usace.army.mil, or, mail comments to: Cultural & Social Resources Section (CEMVN-PDP-CSR), USACE, Room 140, 7400 Leake Ave., New Orleans, LA 70118-3651.

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[1] CEMVN is issuing this public notice as part of its responsibilities under the Advisory Council on Historic Preservation's regulations, 36 CFR Part 800, implementing Section 106 of the National Historic Preservation Act of 1966, as amended (54 U.S.C. § 306108). This notice applies to activities carried out under the Congressional authority for the ART Flood Risk Management Feasibility Study under the standing authority of The Bipartisan Budget Act of 2018 (Pub. L. 115-123), Division B, Subdivision 1, H. R. 1892-13, Title IV, Corps of Engineers-Civil, Department of the Army, Investigations, for flood and storm damage risk reduction. CEMVN is also required to fulfill the Council of Environmental Quality regulations (NEPA regulations, 43 FR 55978 (1978)) that provide policy and procedures to enable CEMVN officials to be informed and to take into account environmental considerations when authorizing or approving CEMVN actions that may significantly affect the environment of the United States. It is the intent of NEPA that federal agencies encourage and facilitate public involvement to the extent practicable in decisions that may affect the quality of the environment.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NEW ORLEANS DISTRICT
7400 LEAKE AVE
NEW ORLEANS LA 70118-3651

JUN 10 2019

Regional Planning and
Environment Division, South
Environmental Planning Branch
Attn: CEMVN-PDS-N

Kristin Sanders, SHPO
LA State Historic Preservation Officer
P.O. Box 44247
Baton Rouge, LA 70804-4241

**RE: Notice of Intent to Prepare Programmatic Agreement Regarding "Amite River and Tributaries-East of the Mississippi River, Louisiana, Flood Risk Management Feasibility Study."**

Dear Ms. Sanders:

The United States Army Corps of Engineers (USACE), New Orleans District (CEMVN), is initiating the process to develop a Programmatic Agreement (PA) for the Amite River and Tributaries-East of the Mississippi River, Louisiana (ART), Flood Risk Management Feasibility Study pursuant to Section 106 of the National Historic Preservation Act (NHPA), as amended (54 U.S.C. § 300101 et seq.), and Section 110 of the NHPA, that require Federal agencies to take into account the effect of their undertakings on historic properties during the planning process and consult with stakeholders regarding these effects. This letter is intended to notify the LA State Historic Preservation Officer (LA SHPO) pursuant to 36 CFR Part 800.14(b) of our plan to develop a project-specific PA that establishes procedures to satisfy the CEMVN's Section 106 responsibilities with regard to the programmatic review of this feasibility study and allows CEMVN to coordinate Section 106 reviews with its evaluation of the proposed action's potential for significant impacts to the human and natural environment required by the National Environmental Policy Act (NEPA), as amended (42 U.S.C. § 4321 et seq.). The PA will address the potential to effect historic properties that are eligible for or listed on the National Register of Historic Places (NRHP), including archaeological sites, districts, buildings, structures, and objects that are significant in American history, architecture, archaeology, engineering, and/or sites of religious and cultural significance on or off Tribal Lands [as defined in 36 CFR § 800.16(x)] that may be affected by this undertaking. We invite the LA SHPO to participate in this consultation since it may involve important questions of policy or interpretation and will result in the development of a PA that governs the application of the Section 106 process with regards to the proposed Undertaking.

**Study Authority**
The ART Flood Risk Management Feasibility Study was initiated by a resolution of the committee on Public Works of the United States Senate, adopted on April 14, 1967. CEMVN is conducting the present ART Flood Risk Management Feasibility Study under the standing authority of *The Bipartisan Budget Act of 2018 (Pub. L. 115-123), Division B, Subdivision 1, H.*

*R. 1892-13, Title IV, Corps of Engineers-Civil, Department of the Army, Investigations*, for flood and storm damage risk reduction. The lead Federal agency for this proposed action is the USACE. The Louisiana Department of Transportation and Development (LA DOTD) is the non-Federal sponsor. The feasibility study phase is 100% federally funded. Due to the limits set under the Bipartisan Budget Act of 2018, only flood control measures are being investigated in this study.

**Study Area**

The study area, which includes the Amite River Basin, encompasses an area of approximately 3,450 square miles consisting of eight (8) Louisiana parishes (East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, Ascension, St. James, and St. John the Baptist), Maurepas Lake, and four (4) Mississippi counties (Amite, Wilkinson, Franklin, and Lincoln). Over three-fourths of the study area is located within the parishes of southeastern Louisiana, east of the Mississippi River and north of Lake Maurepas. The upper one-fourth of the study area's drainage area is located in the southwestern Mississippi counties. However, none of the initial array of alternates presently being considered are located within the state of Mississippi. A map depicting the study area is included as Figure 1.

**Study Purpose and Background**

Rainfall from hurricanes, tropical storm events, and local storms pose a significant risk to the communities, ecosystems, and industries of the Amite River Basin. Flooding stemming from the Amite River and its tributaries has caused significant repetitive flood damages to residential and non-residential structures as well as industrial, commercial, and agricultural facilities within the present study area. Flooding within the Amite River Basin is typically derived from two (2) primary sources. Upper basin inundation is caused from headwater flooding from rainfall events. Lower basin inundation is caused by a combination of drainage from headwaters and backwater flooding. As recently as August 2016, the Amite basin saw significant flooding well outside of normal stages causing impacts to thousands of homes and businesses and to the Nation's critical infrastructure including to lengthy closures of the I-10 and I-12 transportation system. Furthermore, the flood was responsible for at least 13 deaths and the rescue of over 19,000 people prompting presidentially-declared disaster declarations to be issued for multiple parishes in the Amite River basin.

In accordance with the 1967 study authority, a feasibility-level study was initiated by USACE during the early 1990's which led to construction recommendations that are currently being implemented such as the Comite River Diversion and the East Baton Rouge Flood Control Project. In response to the August 2016 flooding, the entire ART study area is now being reevaluated to determine whether additional improvements for flood control are recommended with particular reference to the Amite River, Bayou Manchac, Comite River, and their tributaries. The present study will reevaluate previously proposed alternates that were not carried forward at the time of the 1990's study as well as consider new alternatives not previously assessed.

**SMART Planning Framework**

CEMVN is conducting this study according to the Specific, Measurable, Attainable, Risk Informed, Timely (SMART) planning framework for civil works feasibility studies for water resources development projects. The SMART planning process is intended to improve and streamline feasibility studies, reduce their cost, and expedite their completion. The study works progressively through a six-step planning process: 1) identifying problems and opportunities, 2) inventorying and forecasting conditions, 3) formulating alternative plans, 4) evaluating alternative plans, 5) comparing alternative plans, and 6) selecting a plan. From a NHPA/NEPA perspective, the SMART planning process is broken out into four (4) separate phases over the course of the study (Figure 2): Scoping; Alternative Evaluation and Analysis; Feasibility-Level Analysis; and Integrated Feasibility Report (IFR)/Environmental Impact Statement (EIS) development. On April 02, 2019, CEMVN published a Notice of Intent to Prepare a Draft Environmental Impact Statement for the ART Feasibility Study in the Federal Register (Vol. 84, No. 63) and USACE began providing to the public NEPA compliance documentation on the designated project website at https://www.mvn.usace.army.mil/Amite-River-and-Tributaries/. CEMVN intends to continue to use this website to post additional project information throughout the development of the IFR/EIS. The IFR/EIS examines the existing condition of environmental and cultural resources within the study area and analyzes potential impacts to those resources as a result of implementing the alternatives. At the feasibility level, there may be insufficient funding and time to conduct required NHPA cultural resources studies and/or mitigation and typically additional feasibility work still remains to be completed on the cultural, environmental, engineering, cost estimating, economic, real estate, and construction elements of the plan. Therefore, prior to approving the Undertaking, the agency may propose to develop a project-specific PA in consultation with stakeholders when the federal agency cannot fully determine how the Undertaking may affect historic properties or the location of historic properties and their significance and character.

There are five (5) key milestones that mark significant decisions in the SMART planning process (Figure 2): Alternatives Milestone; Tentatively Selected Plan (TSP) Milestone; Agency Decision Milestone; Civil Works Review Board; and Chief's Report Milestone. Table 1 (below) provides a schedule of proposed milestone dates for the ART Flood Risk Management Feasibility Study:

Table 1. Proposed Study Milestone Schedule

| Milestone | Scheduled | Actual | Complete |
|---|---|---|---|
| Alternate Milestone | Feb 7, 2019 | Feb 7, 2019 | Yes |
| Tentatively Selected Plan | Oct 3, 2019 | TBD | No |
| Release Draft Report to Public | Dec 4, 2019 | TBD | No |
| Agency Decision Milestone | Apr 3, 2020 | TBD | No |
| Final Report Transmittal | Apr 14, 2021 | TBD | No |
| Chief's Report | Oct 1, 2021 | TBD | No |

Upon the completion of the Draft IFR/EIS a stakeholder/public comment period will be initiated in conjunction with technical, peer, and policy reviews. Subsequently, results of the reviews and additional feasibility work will be incorporated into the final Chief's Report, which will again be made available for stakeholder/public review. Following the execution of a PA, the Chief of Engineers may then proceed with making a final recommendation on the project and issuing a Record of Decision (ROD) in compliance with NHPA and NEPA.

**Consideration of Alternates**

Proposed measures for the ART Flood Risk Management Feasibility Study are intended to provide the best comprehensive solutions to the Amite River Basin that meet the study objective: to reduce flood damages along the main channel and tributary streams of the Amite River, Bayou Manchac, and Comite Rivers. Other objective considerations include:

- Reduce flood damages in the Amite River Basin to business, residents and infrastructure;
- Reduce risk to human life from flooding from rainfall events;
- Reduce interruption to the nation's transportation corridors;
- Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.);
- Enhance functionality of existing flood risk reduction systems (locally and federally constructed), including evaluation of impacts due to an increase in frequency of rainfall events.

The alternatives will be further developed in the IFR/EIS. A map displaying the initial array of alternatives under consideration is included as Figure 3.

**Section 106 Consultation**
CEMVN has determined that the proposed action constitutes an Undertaking as defined in 36 CFR § 800.16(y) and has the potential to cause effects on historic properties. This letter initiates formal Section 106 consultation pursuant to 36 CFR § 800.3(c). Due to time and budget constraints for this Undertaking associated with the SMART Planning framework, CEVMN proposes to develop a project-specific PA pursuant to 36 CFR § 800.14(b)(3).The goal of this Section 106 consultation is to provide a project-specific framework for addressing this complex Undertaking and establish protocols for continuing consultation with the LA SHPO, Tribal Governments, and other stakeholders. The PA would identify consulting parties, define applicability, establish review timeframes, stipulate roles and responsibilities of stakeholders, summarize Tribal consultation procedures, consider the views of the SHPO/THPO and any other consulting parties, afford for public participation, develop programmatic allowances to exempt certain actions from Section 106 review, provide the measures CEMVN will implement to develop an Area of Potential Effects (APE) in consultation with external stakeholders, outline a standard review process for plans and specifications as they are developed, determine an appropriate level of field investigation to identify and evaluate historic properties within the APE and the potential to affect historic properties and/or sites of religious and cultural significance, streamline the assessment and resolution of Adverse Effects through avoidance, minimization, and programmatic treatment approaches for mitigation, establish reporting frequency and schedule, provide provisions for post-review unexpected discoveries and unmarked burials, and incorporate the procedures for amendments, duration, termination, dispute resolution, and implementation.

CEMVN proposes to send future notices, draft agreements, and other background information to consulting parties by e-mail to minimize communication delays and expedite the development of the PA. Please let CEMVN know if this is impractical, so we can make alternative arrangements.

A date and time for the initial Section 106 consultation meeting has not been set. Upon selection of a TSP, CEMVN will schedule a teleconference with consulting parties. The purpose of the initial meeting will be to discuss the proposed Undertaking, the APE, and determine the appropriate steps to identify, evaluate, avoid, minimize, and mitigate potential adverse effects. CEMVN will notify the SHPO and other likely consulting parties regarding the meeting as soon as possible and forward information regarding the meeting location, a conference call-in number, and the Agenda.

Please do not hesitate to notify CEMVN regarding any information your office may wish to provide at this time concerning the proposed undertaking and its potential to significantly affect historic properties and/or of any other relevant parties who you feel may have an interest in participating in this consultation. Should you have any questions or need additional information regarding this undertaking or the SMART Planning Framework, please contact Jeremiah Kaplan, Archaeologist at Jeremiah.H.Kaplan @usace.army.mil or (504) 862-2004.

Sincerely,

HARPER.MARSHALL.KEVIN.1536114358 Digitally signed by HARPER.MARSHALL.KEVIN.1536114358 Date: 2019.06.07 09:36:04 -05'00'

MARSHALL K. HARPER
Chief, Environmental Planning Branch

CC:File
LA SHPO
An electronic copy of this letter with enclosures will be provided to the Section 106 Inbox, section106@crt.la.gov.

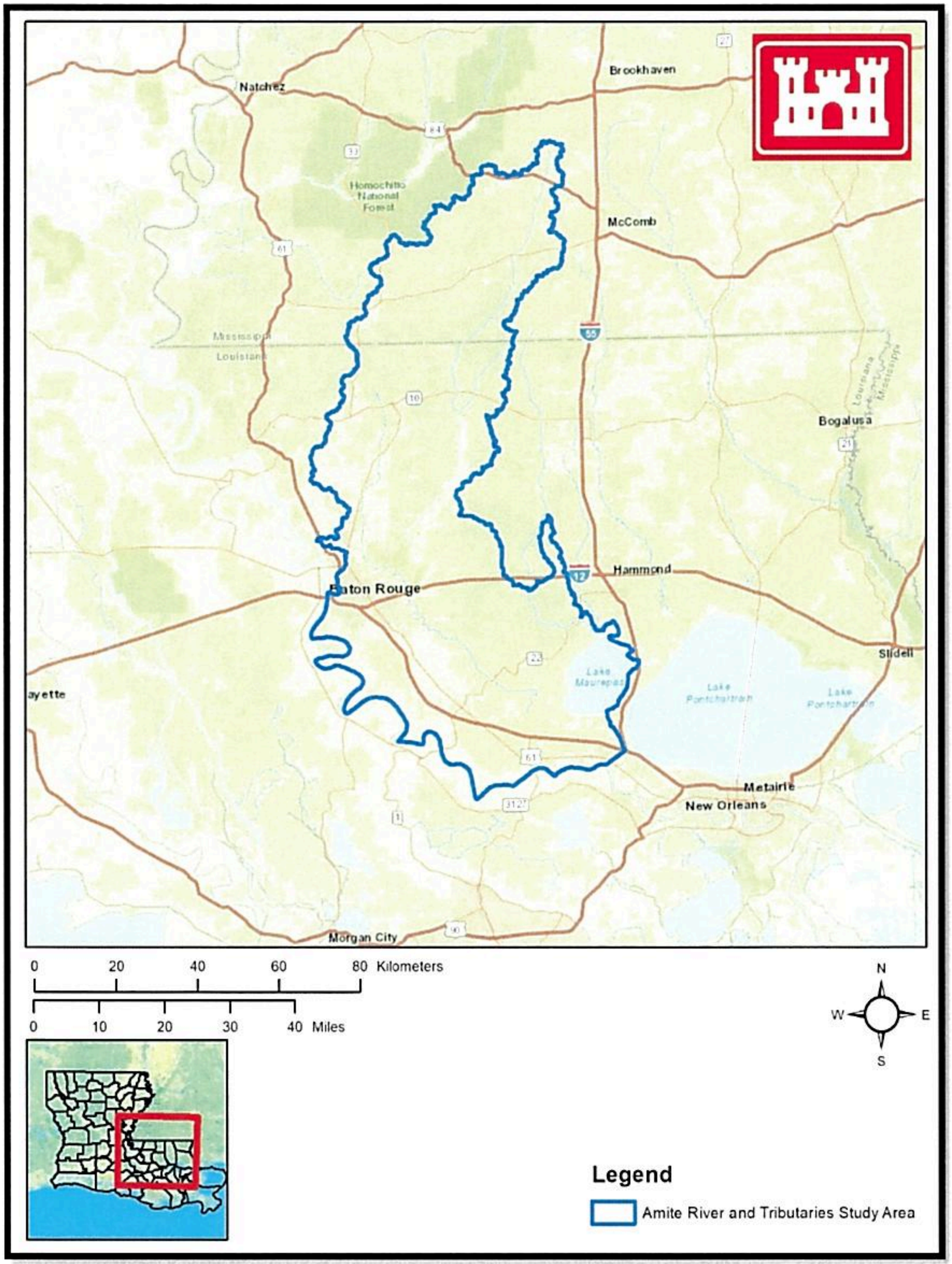


Figure 1. Transportation imagery displaying location of the ART study area.

**Section 106 Consultation, SMART Planning and NEPA Compliance Processes**

| SMART Planning<br>Phase | SMART Planning<br>Milestone | NEPA Compliance | Section 106 Consultation |
|---|---|---|---|
| 1 Scoping | Alternatives (AM) | Notice of Intent and Public Scoping | **Initiate Process**<br>- Define Undertaking<br>- Notify SHPO/THPO<br>- Identify tribes and other Consulting Parties & Involve Public<br>- Determine APE<br>- Conduct Literature & Records Searches<br>- Develop Research/Sampling strategies |
| 2 Alternatives Evaluation & Analysis | Tentatively Selected Plan (TSP) | Circulate Draft EIS with integrated FS *including 106 documentation* | **Identify Historic Properties**<br>- Phase 1 Sample Survey of APE<br>- Phase 2 National Register Eligibility Surveys/Testing for TSP<br>- Consult with SHPO/THPO, Tribes et al.<br>- Involve public<br>**Assess Effects to NRHP Eligible Sites**<br>- Apply criteria of adverse effect<br>- Consult with SHPO/THPO, Tribes et al.<br>**Resolve Adverse Effects**<br>- Avoid, minimize or mitigate<br>- Develop & coordinate draft MOA, PA and, or HPTPs<br>- Consult with SHPO/THPO et al.<br>**Draft Mitigation Plan**<br>- Develop costs for IFR/EIS |
| 3 Feasibility Level Analysis | Agency Decision Milestone on Recommended Plan (ADM) | Respond to and Address Comments; finalize EIS | **Finalize MOA or PA**<br>- Final inputs to IFR/EIS<br>- Obtain SHPO/ACHP and other signatures<br>- Obtain waiver for data recovery costs > 1% |
| 4 Complete final report | Civil Works Review Board (CWRB) | Report S&A review | **Agreement (MOA/PA) or ACHP Comment** |
| 5 File Final Report | Chief's Report | File with EPA Sign ROD | **Represent commitments in ROD** |

Figure 2. Section 106 Consultation, SMART Planning and NEPA Compliance Processes.

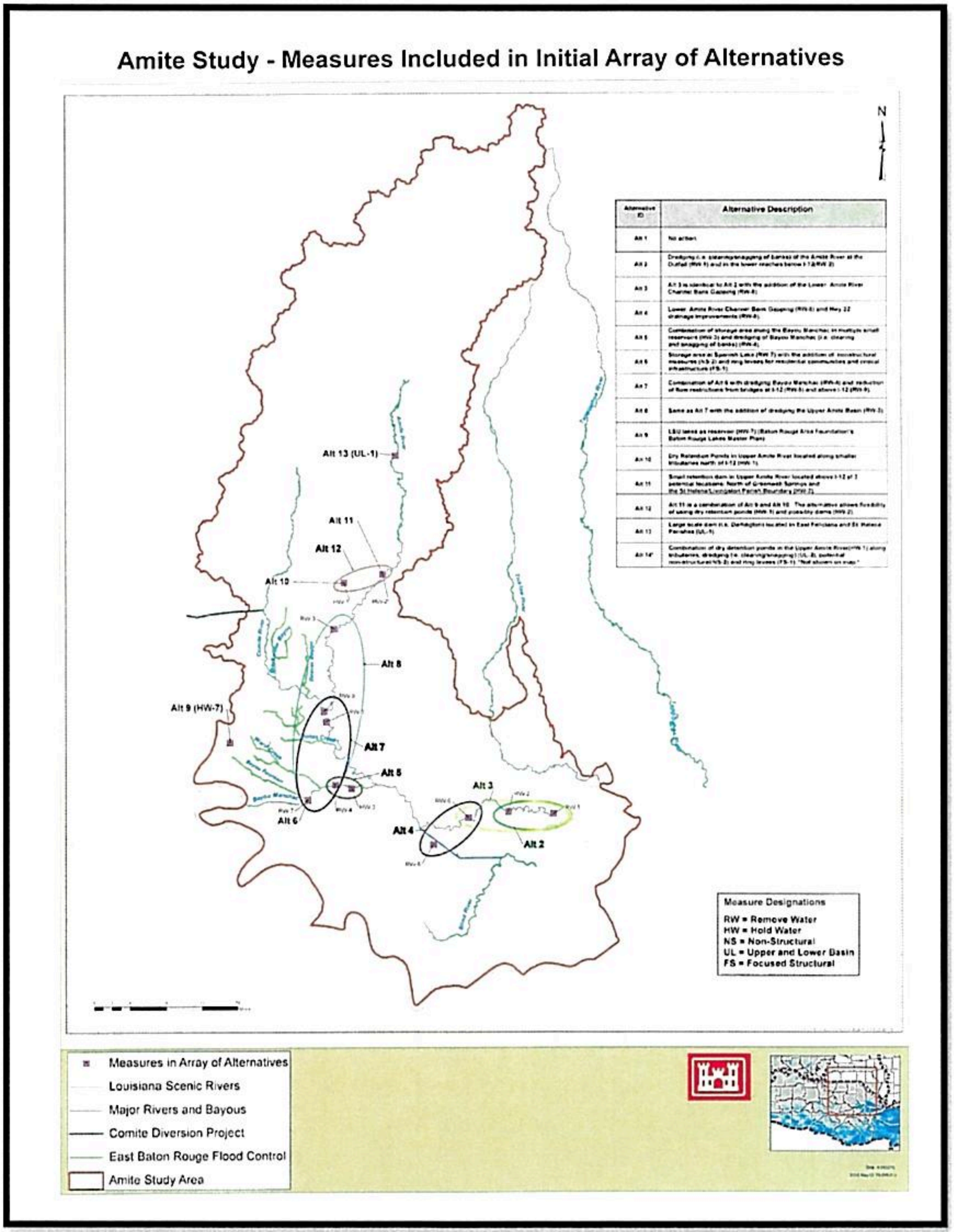


Figure 3. ART feasibility study inital array of alternates (https://www.mvn.usace.army.mil/Portals/56/docs/BBA%2018/Amite_Initial_Array_of_Alternatives_36x48_04242019.pdf).

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Louisiana Ecological Services
200 Dulles Drive
Lafayette, Louisiana 70506

March 13, 2019

Colonel Michael N. Clancy
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Clancy:

Please reference the Amite River and Tributaries Study East of the Mississippi River, LA (Flood Risk Management Feasibility Study) being conducted by the U.S. Army Corps (Corps) of Engineers (USACE) and the Louisiana Department of Transportation and Development. This study will investigate and determine the extent of Federal interest in plans that reduce flood risk along the Amite River Basin, which covers portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana.

The effects of flooding from the Amite River and its tributaries are being studied, not localized flooding in adjacent communities. The project features being evaluated to reduce flooding include retention measures, diversions, channelization (dredging downstream reaches combined with upstream detention), ring levees, drainage improvements (swales or road cuts combined with infrastructure), bridge improvements, and channel bank gapping.

The following comments are provided on a planning-aid basis to assist the Corps in developing environmentally acceptable project alternatives and features. These comments and recommendations do not constitute the final report of the Secretary of Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act ((FWCA) 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). The Service submits the following comments in accordance with provisions of the FWCA, the National Environmental Policy Act of 1969, as amended, the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 661 et seq.), the Migratory Bird Treaty Act (MBTA) (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), and the Bald and Golden Eagle Protection Act (BGEPA) (54 Stat. 250, as amended, 16 U.S.C. 668a-d).

## Threatened and Endangered Species

Within the study area, three threatened or endangered species are known to occur (Table 1). Information regarding those species and their preferred habitats are provided below.

Table 1. List of threatened and endangered species known to occur within the project area.

| Species | Species Group | Status |
|---|---|---|
| Alabama Heelsplitter Mussel | Mollusk | Threatened |
| Atlantic Sturgeon | Fish | Threatened |
| West Indian Manatee | Mammal | Endangered |

Alabama Heelsplitter

Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) was historically found in Louisiana in the Amite, Tangipahoa, and Pearl Rivers. Many life history aspects of the species are poorly understood but are likely similar to that of other members of the Unionidae family. Although the primary host fish for the species is not certain, investigation by K. Roe et al. (1997) indicates that the freshwater drum (*Aplodinotus grunniens*) is a suitable glochidial host for the species.

Based on the most recent survey data, the currently known range for the Alabama heelsplitter in Louisiana occurs only in the lower third of the Amite River along the East Baton Rouge/Livingston Parish line from Spiller's Creek, which is in the vicinity of Denham Springs downstream to the vicinity of Port Vincent. Because it has not been used widely for past or present gravel mining operations, the lower third of the Amite River (between Louisiana Highway 37 and Louisiana Highway 42) is more typical of a coastal plain river; being characterized by a silt substratum, less channelization, and slower water flow, all of which are characteristic of heelsplitter habitat. This freshwater mussel is typically found in soft, stable substrates such as sand, mud, silt, and sandy gravel, in slow to moderate currents. Heelsplitter mussels are usually found in depositional pools below sand point bars and in shallow pools between sandbars and river banks.

Major threats to this species in Louisiana are the loss of habitat resulting from sand and gravel dredging and channel modifications for flood control, as shown by the apparent local extirpation of the species in the extensively modified upper portions of the Amite River.

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine and marine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Atlantic sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain Basin, the Pearl River System, the Amite River, and adjacent estuarine and marine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Atlantic sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures and navigation projects that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

West Indian Manatee

The endangered West Indian manatee (*Trichechus manatus*) is known to regularly occur in Lakes Pontchartrain and Maurepas and their associated coastal waters and streams. It also can be found less regularly in other Louisiana coastal areas, most likely while the average water temperature is warm. Based on data maintained by the Louisiana Natural Heritage Program (LNHP), over 80 percent of reported manatee sightings (1999-2011) in Louisiana have occurred from the months of June through December. Manatee occurrences in Louisiana appear to be increasing and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of southeastern Louisiana. Cold weather and outbreaks of red tide may adversely affect these animals. However, human activity is the primary cause for declines in species number due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution.

During in-water work in areas that potentially support manatees all personnel associated with the project should be instructed about the potential presence of manatees, manatee speed zones, and the need to avoid collisions with and injury to manatees. All personnel should be advised that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973.

Additionally, personnel should be instructed not to attempt to feed or otherwise interact with the animal, although passively taking pictures or video would be acceptable. We recommend the inclusion of the following measures into construction plans and specifications to minimize potential impacts to manatees in areas where they are potentially present:

- All on-site personnel are responsible for observing water-related activities for the presence of manatee(s). We recommend the following to minimize potential impacts to manatees in areas of their potential presence:

- All work, equipment, and vessel operation should cease if a manatee is spotted within a 50-foot radius (buffer zone) of the active work area. Once the manatee has left the buffer zone on its own accord (manatees must not be herded or harassed into leaving), or after 30 minutes have passed without additional sightings of manatee(s) in the buffer zone, in-water work can resume under careful observation for manatee(s).

- If a manatee(s) is sighted in or near the project area, all vessels associated with the project should operate at “no wake/idle” speeds within the construction area and at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom. Vessels should follow routes of deep water whenever possible.

- If used, siltation or turbidity barriers should be properly secured, made of material in which manatees cannot become entangled, and be monitored to avoid manatee entrapment or impeding their movement.

- Temporary signs concerning manatees should be posted prior to and during all in-water project activities and removed upon completion. Each vessel involved in construction activities should display at the vessel control station or in a prominent location, visible to all employees operating the vessel, a temporary sign at least 8½ " X 11" reading language similar to the following: “CAUTION BOATERS: MANATEE AREA/ IDLE SPEED IS REQUIRED IN CONSRUCTION AREA AND WHERE THERE IS LESS THAN FOUR FOOT BOTTOM CLEARANCE WHEN MANATEE IS PRESENT”. A second temporary sign measuring 8½ " X 11” should be posted at a location prominently visible to all personnel engaged in water-related activities and should read language similar to the following: “CAUTION: MANATEE AREA/ EQUIPMENT MUST BE SHUTDOWN IMMEDIATELY IF A MANATEE COMES WITHIN 50 FEET OF OPERATION”.

- Collisions with, injury to, or sightings of manatees should be immediately reported to the Service’s Louisiana Ecological Services Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821). Please provide the nature of the call (i.e., report of an incident, manatee sighting, etc.); time of incident/sighting; and the approximate location, including the latitude and longitude coordinates, if possible.

The Corps is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the Service’s concurrence with that determination. If the Corps determines, and the Service concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the Endangered Species Act should be submitted to the Service. That request should also include the Corps’ rationale supporting their determination.

## At-Risk Species

The Service’s Southeast Region has defined “at-risk species” as those that are:

1. Proposed for listing under the ESA by the Service;
2. Candidates for listing under the ESA, which means the species has a "warranted but precluded 12-month finding"; or
3. Petitioned for listing under the ESA, which means a citizen or group has requested that the Service add them to the list of protected species. Petitioned species include those for which the Service has made a substantial 90-day finding as well as those that are under review for a 90-day finding. As the Service develops proactive conservation strategies with partners for at-risk species, the states’ Species of Greatest Conservation Need (defined as species with low or declining populations) will also be considered.

The Service’s goal is to work with private and public entities on proactive conservation to conserve these species thereby precluding the need to federally list as many at-risk species as possible. Discussed below are species currently designated as “at-risk” that may occur within the project area.

Alabama Hickorynut

The Alabama Hickorynut (*Obovaria unicolor*) is a 1.2-2 inch-long freshwater mussel with round or elliptical shape. The outer shell (periostracum) is smooth and brown to yellow brown, with rays. This species is a long term brooder that is gravid from June through August of the following year. Like other freshwater mussels, the Alabama Hickorynut releases its larvae (glochidia) into the water column, where they parasitize a fish (glochial host) in order to transform into a juvenile mussel. Once the glochidia are ready, they release from the host to find a suitable substrate. Suitable glochidial host fishes for this species include the naked sand darter (*Ammocrypta beani*), southern sand darter (*Ammocrypta meridiana*), Johnny darter (*Etheostoma nigrum*), Gulf darter (*Etheostoma swaini*), blackbanded darter (*Percina nigrofasciata*), dusky darter (*Percina sciera*), and redspot darter (*Etheostoma artesiae*).

The Alabama Hickorynut inhabits sand and gravel substrates in moderate currents in large streams. However, the presence of moderate gradient pool and riffle habitats in a variety of stream and river sizes may contain this species. In Louisiana, the Alabama Hickorynut is known to occur in the Pearl and Amite River systems. Habitat modification and destruction due to siltation and impoundment threaten this species. It is also negatively affected by the pollution of streams and rivers.

Alligator Snapping Turtle

The alligator snapping turtle (*Macrochelys temminckii*) may be found in large rivers, canals, lakes, oxbows, and swamps adjacent to large rivers. It is most common in freshwater lakes and bayous, but also found in coastal marshes and sometimes in brackish waters near river mouths. Typical habitat is mud bottomed waterbodies having some aquatic vegetation. The alligator snapping turtle is slow growing and long lived. Sexual maturity is reached at 11 to 13 year of age (Ernst et al. 1994). Because of this and its low fecundity, loss of breeding females is thought to be the primary threat to the species.

## Migratory Birds and Other Trust Resources

Bald Eagle

The proposed project area may provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species as of August 8, 2007. However, the bald eagle remains protected under the MBTA and BGEPA.

Bald eagles typically nest in large trees located near coastlines, rivers, or lakes that support adequate foraging from October through mid-May. In southeastern Louisiana parishes, eagles typically nest in mature trees (e.g., baldcypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants. Furthermore, bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during these periods may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

The Service recommends a survey be conducted to determine if a bald eagle nest is present within or adjacent to the project area. If a bald eagle nest occurs within 660 feet of the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/birds/Eagle/tamain.html

The Service developed the National Bald Eagle Management Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles. A copy of the guidelines is available at: https://ecos.fws.gov/ServCat/DownloadFile/36458?Reference=36436

On September 11, 2009, the Service published two federal regulations establishing the authority to issue permits for non-purposeful bald eagle take (typically disturbance) and eagle nest take when recommendations of the NBEM Guidelines cannot be achieved. Permits may be issued for nest take only under the following circumstances where: 1) necessary to alleviate a safety emergency to people or eagles, 2) necessary to ensure public health and safety, 3) the nest prevents the use of a human-engineered structure, or 4) the activity or mitigation for the activity will provide a net benefit to eagles. Except in emergencies, only inactive nests may be permitted to be taken.

Should you need further assistance interpreting the guidelines, avoidance measures, or performing an on-line project evaluation, please contact Ulgonda Kirkpatrick (phone: 352/406-6780, e-mail: ulgonda_kirkpatrick@fws.gov). For assistance with the bald eagle permitting process, please contact Resee Collins (phone: 404/314-6526, e-mail: resee_collins@fws.gov).

Coastal Forest and Neotropical Migratory Songbirds

The proposed project contains features that could potentially impact (directly and/or indirectly) migratory birds and the habitats upon which they depend. Any loss of forested habitat through direct harvest or because of increased inundation is a concern to the Service. In Louisiana, the primary nesting period for forest-breeding migratory birds occurs between April 15 and August 1. The proposed project may directly impact migratory birds of conservation concern because habitat clearing that occurs during the aforementioned primary nesting period may result in unintentional take of active nests (i.e., eggs and young) in spite of all reasonable efforts to avoid such take.

In addition to the direct loss of forested habitat, the proposed water retention features could increase the amount of time adjacent forested areas are flooded. Increased flooding stress could result in tree mortality and a loss of habitat over time. Forest fragmentation (from direct or indirect habitat loss) may contribute to population declines in some avian species because fragmentation reduces avian reproductive success (Robinson et al. 1995).

Wading Bird Colonies

In accordance with the MBTA and the FWCA, please be advised that the project area includes habitats that are commonly inhabited by colonial nesting waterbirds. We recommend that a qualified biologist inspect the proposed work sites for the presence of nesting colonies (during the nesting season) prior to any work being initiated that would impact the colony.

For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period, depending on the species present. Below is the list of colonial nesting birds that may be found and the corresponding activity window during which the project may occur without affecting nesting wading bird colonies.

| **Species** | **Project Activity Window/Non-Nesting Period** |
|---|---|
| Anhinga | July 1 to March 1 |
| Cormorant | July 1 to March 1 |
| Great Blue Heron | August 1 to February 15 |
| Great Egret | August 1 to February 15 |
| Little Blue Heron | August 1 to March 1 |
| Tricolored Heron | August 1 to March 1 |
| Reddish Egret | August 1 to March 1 |
| Snowy Egret | August 1 to March 1 |
| Cattle Egret | September 1 to April 1 |
| Green Heron | September 1 to March 15 |
| Black-crowned Night-Heron | September 1 to March 1 |
| Yellow-crowned Night-Heron | September 1 to March 15 |
| Ibis | September 1 to April 1 |
| Roseate Spoonbill | August 1 to April 1 |

In addition, we recommend that on-site contract personnel including project-designated inspectors be trained to identify colonial nesting birds and their nests, and avoid affecting them during the breeding season (i.e., the time period outside the activity window). Should on-site contractors and inspectors observe potential nesting activity, coordination with the Service and the Louisiana Department of Wildlife and Fisheries should occur.

## Fish and Wildlife Conservation Measures

The President's Council on Environmental Quality regulations for implementing the National Environmental Policy Act define mitigation to include: (1) avoiding the impact; (2) minimizing the impact; (3) rectifying the impact; (4) reducing or eliminating the impact over time; and (5) compensating for impacts. The Service supports and adopts this definition and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process. Through this process, the Service strives to make the project's goals co-equal to fish and wildlife resource conservation.

The Service's Mitigation Policy (Federal Register, Vol. 46, pp. 7644-7663, January 23, 1981) has designated four resource categories which are used to ensure that the level of mitigation recommended will be consistent with the fish and wildlife resources involved. The mitigation planning goals and associated Service recommendations should be based on those four categories, as follows:

> Resource Category 1 - Habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section. The mitigation goal for this Resource Category is that there should be no loss of existing habitat value.
>
> Resource Category 2 - Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. The mitigation goal for habitat placed in this category is that there should be no net loss of in-kind habitat value.
>
> Resource Category 3 - Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis. FWS's mitigation goal here is that there be no net loss of habitat value while minimizing loss of in-kind habitat value.
>
> Resource Category 4 - Habitat to be impacted is of medium to low value for evaluation species. The mitigation goal is to minimize loss of habitat value.

Streams and wetland habitats associated with the proposed project are designated as Resource Category 2, the mitigation goal for which is no net loss of in-kind habitat value. Non-wetland forests would also be considered Resource Category 2 due to their importance to neotropical migratory songbirds. Scrub-shrub and highly altered waterbodies and wetland habitats that may be impacted are Resource Category 3 due to their reduced value to fish and wildlife and their degraded wetland functions. The mitigation goal for Resource Category 3 habitats is no net loss of habitat value.

To achieve fish and wildlife resource conservation, the Service recommends that the following planning objectives be adopted to guide future project planning efforts.

1. Any physical retention structures constructed within the river or its tributaries should be designed to allow continuous upstream and downstream fish passage. Run of the river conduit systems that allow fish passage through the base of dams should be evaluated, as well as other fish passage designs (HDR Engineering 2014).

2. Diversion structures should be constructed/modified in a "fish friendly" manner. Fish exclusion devices, barriers, and bypass systems should be thoroughly evaluated (U.S. Dept. of the Interior 2006).

3. Channelization measures such as dredging and detention features can potentially cause erosion through headcutting. This can have detrimental impacts on mussels and other aquatic organisms. Any proposed channelization measures should be modeled to determine what other morphological changes would be expected within the Amite River and its tributaries as a result of those actions.

4. Ring levee alignments should be located to avoid and minimize impacts to both herbaceous and forested wetlands as much as possible. The acreage of wetlands enclosed within ring levees also should be minimized to the maximum extent practicable. If borrow pits are needed, those features should be located in areas providing the least fish and wildlife habitat value.

5. Any drainage improvement measures that involve structures in natural tributaries should be constructed in a manner that allows aquatic organism passage (including benthic macroinvertebrates). All round and elliptical culverts should be oversized and installed approximately 20 percent below grade to allow sediment accumulation throughout the entire length of the structure. Square culverts also should be installed below grade to a depth adequate to allow sediment accumulation throughout.

6. Bridge modifications/construction and channel bank gapping should be done in a manner to minimize turbidity and downstream sedimentation.

7. Any clearing of riparian vegetation should be limited to a single bank and when possible that bank should be either the eastern or northern bank.

8. The work order for project features that require within channel excavation should begin at the most upstream reaches.

9. Important fish and wildlife habitat (emergent wetlands, forested wetlands, and non-wetland forest) should be conserved by avoiding and minimizing the acreage of those habitats directly impacted by project features. Any forest clearing associated with project features should be conducted during the fall and winter to minimize impacts to nesting migratory songbirds, when practicable.

10. Avoid impacts to threatened and endangered species, at risk species, and species of concern such as the bald eagle, and wading bird nesting colonies.

11. West Indian manatee conservation measures from the Threatened and Endangered Species section of this report should be included in all contracts, plans, and specifications for in-water work in areas where the manatee may occur.

12. For those project impacts that cannot be fully ascertained the Service recommends that adaptive management be employed post construction to correctly identify the extend of such impacts and develop appropriate mitigation. All adaptive management measures should be developed in coordination with the Service and other natural resource agencies.

13. Compensation should be provided for any unavoidable losses of stream habitat, wetland habitat, and non-wetland forest caused (directly or indirectly) by project features. All mitigation should be coordinated with the Service and other natural resource agencies.

## Additional Information Needed

The Service would like the following questions answered through modeling or other studies in order to determine the extent of potential impacts to fish and wildlife resources. These answers will be necessary to accurately access impacts to Federal trust resources, including Threatened and Endangered Species.

1. How will each of the proposed project features affect water depths locally and from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River?

2. How will each of the proposed project features affect water temperatures locally and from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River (i.e., Alabama heelsplitter habitat)?

3. How will each of the proposed project features affect dissolved oxygen levels locally and from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River?

4. How will each of the proposed project features affect turbidity levels locally and from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River? How long (duration) would any increased turbidity levels be expected?

5. How will each of the proposed projects affect bank stabilization, channel erosion, and sedimentation rates locally, throughout the Amite River and Tributaries (AR&T), and especially from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River?

6. How will each of the proposed projects affect velocity locally, throughout the AR&T, and especially from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River?

7. Will the overall project result in periodic increased storm surge penetration and result in increased river salinization?

8. How will the overall project affect ammonia levels, metals, and nitrates from approximately 1.5 miles north of Spiller's Creek to the mouth of the Amite River?

9. How will the proposed project/project features affect fish passage? Please describe in detail fish passage plans for any project feature that could restrict fish passage.

We look forward to assisting the Corps in the documentation of existing conditions, development of alternatives, and assessment of project alternatives on Federal trust resources during the feasibility study. Should you have any questions regarding our comments, please contact Seth Bordelon (337/291-3138) of this office.

Sincerely,

Joseph A. Ranson
Field Supervisor
Louisiana Ecological Services Office

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Louisiana Ecological Services
200 Dulles Drive
Lafayette, Louisiana 70506

June 25, 2019

Colonel Michael N. Clancy
District Engineer
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Clancy:

Please reference the Amite River and Tributaries Study East of the Mississippi River, LA (Flood Risk Management Feasibility Study) being conducted by the U.S. Army Corps of Engineers (USACE) and the Louisiana Department of Transportation and Development. This study will investigate and determine the extent of Federal interest in plans that reduce flood risk along the Amite River Basin, which covers portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana.

The effects of flooding from the Amite River and its tributaries are being studied, not localized flooding in adjacent communities. The USACE developed 13 action alternatives focused on four influence areas: (1) the lower Amite River basin near Lake Maurepas; (2) the central portion of the Amite River basin; (3) the upper Amite River basin; and (4) the upper and lower Amite River basin. The U.S. Fish and Wildlife Service (Service) was not involved in the development of alternatives and would like to propose an additional alternative as well as recommendations to mitigate impacts that would result from project development.

The following comments are provided on a planning-aid basis (as a supplement to our March 13, 2019, planning-aid letter) to assist the USACE in developing environmentally acceptable project alternatives and features. These comments and recommendations are submitted in accordance with the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the National Environmental Policy Act of 1969 (as amended), and the Endangered Species Act of 1973 (ESA) (87 Stat. 884, as amended; 16 U.S.C. 661 et seq.). This letter does not constitute the final report of the Secretary of Interior as required by Section 2(b) of the FWCA.

Recommended New Alternative

A stakeholders meeting was held on June 19, 2019, at the U.S. Geological Survey building in Baton Rouge, LA. The USACE presented alternatives that are being evaluated to address the risk of flood damages to industrial facilities, commercial facilities, and agricultural facilities, as well as residential and nonresidential structures within the Amite River and tributaries floodplain. At the meeting a representative from the Amite River Basin Commission indicated that the length of the Amite River within the study area has decreased substantially due to the loss of meanders (straightening) that result from sand and gravel mining operations. Our office has since reviewed a USACE's Engineer Research Development Center report (2007) that documented the shortening (due to straightening) and widening (due to erosion) of the Amite River and attributed both changes to riparian sand and gravel mining.

The Service recommends that restoration of the Amite River be evaluated as a project alternative. Restoring meanders to critical sections of the river where most of the straightening has occurred could increase the volume of water held within the main river channel and the amount of time it takes that water to flow from the upper and central portions of the Amite River to the mouth at Lake Maurepas. Shoreline stabilization would also be necessary in unstable areas where sand and gravel mining operations exist and mining pits could be captured by the river leading to further straightening and increased down river flood stages. This alternative would fully incorporate the concepts of engineering with nature.

## Mitigation for Impacts

The Service provided general mitigation comments in our March 13, 2019, planning-aid letter. That letter stated that there should be no net loss of in-kind habitat value for streams and wetland habitats associated with the proposed project. Depending on the project features selected and the anticipated impacts from those features, the Service will likely recommend forested wetland restoration on abandoned sand and gravel mining sites along the Amite River as well as in-stream river restoration.

The Service is aware of two previous forest restoration projects that have been constructed on abandoned sand and gravel mining sites along the Amite River and Comite River. In the late 1990's an Amite River Sand and Gravel Mine Reclamation Demonstration Project was constructed after recommendation from the Governor's Interagency Task Force on Flood Prevention and Mitigation. That site is located on the east bank of the Amite River, approximately 1.5 miles southwest of Grangeville, LA, in St. Helena Parish. The Comite River project (Blackwater Conservation Area) was also an abandoned sand and gravel mine that was restored as an ecosystem restoration project under Section 206 of the 1996 Water Resources Development Act. Blackwater Conservation Area was constructed in the late early 2000's under a partnership between the USACE's New Orleans District, the City of Baton Rouge/East Baton Rouge Parish, and the Parks and Recreation Commission for the Parish of East Baton Rouge (BREC). It is located at 9385 Blackwater Road, Central, LA. The Service recommends site visits to evaluate the success of these sand and gravel restoration sites and other potential mitigation sites.

River restoration could include meander creation in areas that have been straightened and shoreline stabilization features to prevent unstable areas from being captured by the river. These mitigation recommendations should be considered throughout the study as their implementation may affect the hydrologic dynamics within the river system.

## Endangered Species Act - Section 7(a)(1)

Section 7(a)(1) of the ESA is a conservation mandate that states, "All...Federal agencies shall...utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species." It is a proactive authority with a goal to recover listed species. If river restoration is performed as a means to achieve flood control or to mitigate for impacts, those activities could be considered a Section 7(a)(1) Conservation Program that benefits the Alabama heelsplitter mussel (*Potamilus inflatus*).

We look forward to continuing our work with the USACE throughout the feasibility study process. Should you have any questions regarding our comments, please contact Seth Bordelon (337/291-3138) of this office.

Sincerely,

Joseph A. Ranson
Field Supervisor
Louisiana Ecological Services Office

cc:
Louisiana Department of Wildlife and Fisheries
Louisiana Department of Environmental Quality
Amite River Basin Commission

## Literature Cited

U.S. Army Corps of Engineers. 2007. Fluvial Instability and Channel Degradation of Amite River and its Tributaries, Southwest Mississippi and Southeast Louisiana. ERDC/GSL TR-07-26.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Louisiana Ecological Services
200 Dulles Drive
Lafayette, Louisiana 70506

October 30, 2019

Colonel Stephen Murphy
District Commander
U.S. Army Corps of Engineers
7400 Leake Avenue
New Orleans, LA 70118-3651

Dear Colonel Murphy:

The U.S. Army Corps of Engineers (USACE) is preparing a Draft Feasibility Study with Integrated Environmental Impact Statement for the Amite River and Tributaries Study East of the Mississippi River, Louisiana. This study is investigating alternatives (including a no-action alternative) to reduce flood risk along the Amite River Basin, which covers portions of Amite, Lincoln, Franklin, and Wilkinson Counties in Mississippi as well as East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension Parishes in Louisiana. This draft report contains an analysis of the impacts on fish and wildlife resources that would result from project implementation and provides recommendations to minimize those impacts. This draft report has been prepared by the Fish and Wildlife Service (Service) under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and does not constitute the report of the Secretary of the Interior as required by section 2b of that act. The Service also provides comments within this report under the following authorities - the National Environmental Policy Act of 1969, as amended, the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 661 et seq.), the Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), and the Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d). A copy of this report will be provided to the Louisiana Department of Wildlife and Fisheries (LDWF) for review, and their comments will be included in our final report.

The proposed action is authorized as part of the Bipartisan Budget Act of 2018, H. R. 1892—13, Title IV, Corps of Engineers - Civil, Department of the Army, Investigations, where funds are being made available for the expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection studies which are currently authorized or which are authorized after the date of enactment of this act, to reduce risk from future floods and hurricanes. The funds are at full federal expense and are available for high-priority studies of projects in States and insular areas with more than one flood related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017.

This study area is being included based on the August 2016 flooding over southeast and south-central Louisiana, and is continuing investigation under the authorization provided by the Resolution of the Committee on Public Works of the United States Senate, adopted on April 14, 1967.

## STUDY AREA

The study area is the Amite River Basin and tributaries. The Amite River Basin begins in southwest Mississippi and flows southward crossing the state line into southeastern Louisiana. The Amite River Basin includes 2,200 square miles flowing into the Amite River and its tributaries.

The study area is similar to the 1984 Amite Rivers and Tributaries Flood Control Initial Evaluation Study by USACE; however, it has been expanded to include areas that are impacted by backwater flooding to the southeast and east since they are hydraulically connected to the Amite River Basin and tributaries. Communities along the Amite River in East Baton Rouge, Ascension, and Livingston Parishes have undergone significant development since 1984 due to their proximity to Baton Rouge. Towns such as Prairieville, Gonzales, and Denham Springs are now subject to increased flood risks. No significant flood risks associated with the Amite River Basin were identified within the state of Mississippi; therefore, modeling and development of alternatives were focused on the state of Louisiana. This was confirmed with the Mississippi Soil and Water Conservation Commission, that there are no flooding impacts in the state of Mississippi from the Amite River and Tributaries in the state of Mississippi.

## FISH AND WILDLIFE RESOURCES

The project area contains the Amite River and tributaries, sandbars, herbaceous and forested riparian wetlands, as well as upland forests. Two of the community types observed during roadside surveys were "small stream forests" and "hardwood slope forests" (LDWF 2009). Both of these communities contain yellow poplar, sweetgum, magnolia, and beech, as well as multiple species of oaks, hickories, and pines. The small stream forests also contain several species of elm and ash, as well as sycamore, cypress, cherry laurel, blackgum, and river birch. These ecosystems provide valuable habitat for a variety of freshwater fish, mussels, crustaceans, reptiles, amphibians, birds, and mammals. Many of these species (game and non-game) provide economic value to the State and local communities through hunting, fishing, bird watching, etc.

Federal trust species such as wading birds, waterfowl, and neotropical migrants all utilize the project area. Many of these (i.e., little blue heron, wood thrush, prothonotary warbler, worm-eating warbler, Louisiana waterthrush, and painted bunting) have exhibited substantial population declines over the last 30 years, primarily as the result of habitat loss and fragmentation. The Amite River itself is of particular importance to several federally threatened and at-risk species that are discussed below. Maintaining unobstructed passage for those aquatic resources will be a necessary component of the project design. Additional State-listed at-risk species found within the project area include broadstripe topminnow (*Fundulus euryzonus*), Alabama shad (*Alosa alabamae*), Rayed creekshell (*Anodontoides radiatus*), and four-toed salamander (*Hemidactylium scutatum*).

The downstream portion of the Amite River has been altered by past deepening projects and a flood control project that rerouted flows.  The middle portion of the Amit River has been impacted by sand and gravel mining.  This mining has caused instability in the river resulting in the widening and shallowing of portions of the river.  Loss of gravel bars has also contributed to this instability and the loss of that instream habitat.  Increased turbidity and sedimentation from the instability has decreased aquatic diversity within the river.  The upstream portion of the Amite River is adversely affected by incision of the channel due to the gravel mines.  This creates turbidity and sedimentation problems as well further impacting less common and/or habitat specific species.

## Threatened and Endangered Species

Within the study area, three threatened species are known to occur (Table 1).  Information regarding those species and their preferred habitats are provided below.

Table 1.  List of threatened species known to occur within the project area.

| Species | Species Group | Status |
|---|---|---|
| Alabama Heelsplitter Mussel | Mollusk | Threatened |
| Atlantic Sturgeon | Fish | Threatened |
| West Indian Manatee | Mammal | Threatened |

### Alabama Heelsplitter

Federally listed as a threatened species, the Alabama heelsplitter mussel (*Potamilus inflatus*) was historically found in Louisiana in the Amite, Tangipahoa, and Pearl Rivers.  Many life history aspects of the species are poorly understood but are likely similar to that of other members of the Unionidae family.  Although the primary host fish for the species is not certain, investigation by K. Roe et al. (1997) indicates that the freshwater drum (*Aplodinotus grunniens*) is a suitable glochidial host for the species.

Based on the most recent survey data, the currently known range for the Alabama heelsplitter in Louisiana occurs only in the lower third of the Amite River along the East Baton Rouge/Livingston Parish line from Spiller's Creek, which is in the vicinity of Denham Springs downstream to the vicinity of Port Vincent.  Because it has not been used widely for past or present gravel mining operations, the lower third of the Amite River (between Louisiana Highway 37 and Louisiana Highway 42) is more typical of a coastal plain river; being characterized by a silt substratum, less channelization, and slower water flow, all of which are characteristic of heelsplitter habitat.  This freshwater mussel is typically found in soft, stable substrates such as sand, mud, silt, and sandy gravel, in slow to moderate currents.  Heelsplitter mussels are usually found in depositional pools below sand point bars and in shallow pools between sandbars and river banks.  Impacts from sand and gravel mining are believed to be decreasing the range of the Alabama heelsplitter .

Major threats to this species in Louisiana are the loss of habitat resulting from sand and gravel dredging and channel modifications for flood control, as shown by the apparent local extirpation of the species in the extensively modified upper portions of the Amite River.

Atlantic Sturgeon

The Atlantic sturgeon (*Acipenser oxyrhynchus desotoi*), federally listed as a threatened species, is an anadromous fish that occurs in many rivers, streams, and estuarine and marine waters along the northern Gulf coast between the Mississippi River and the Suwannee River, Florida. In Louisiana, Atlantic sturgeon have been reported at Rigolets Pass, rivers and lakes of the Lake Pontchartrain Basin, the Pearl River System, the Amite River, and adjacent estuarine and marine areas. Spawning occurs in coastal rivers between late winter and early spring (i.e., March to May). Adults and sub-adults may be found in those rivers and streams until November, and in estuarine or marine waters during the remainder of the year. Atlantic sturgeon less than two years old appear to remain in riverine habitats and estuarine areas throughout the year, rather than migrate to marine waters. Habitat alterations such as those caused by water control structures and navigation projects that limit and prevent spawning, poor water quality, and over-fishing have negatively affected this species.

West Indian Manatee

The threatened West Indian manatee (*Trichechus manatus*) is known to regularly occur in Lakes Pontchartrain and Maurepas and their associated coastal waters and streams. It also can be found less regularly in other Louisiana coastal areas, most likely while the average water temperature is warm. Based on data maintained by the Louisiana Natural Heritage Program (LNHP), over 80 percent of reported manatee sightings (1999-2011) in Louisiana have occurred from the months of June through December. Manatee occurrences in Louisiana appear to be increasing and they have been regularly reported in the Amite, Blind, Tchefuncte, and Tickfaw Rivers, and in canals within the adjacent coastal marshes of southeastern Louisiana. Cold weather and outbreaks of red tide may adversely affect these animals. However, human activity is the primary cause for declines in species number due to collisions with boats and barges, entrapment in flood control structures, poaching, habitat loss, and pollution. Please see Appendix A for recommendations to minimize potential impacts to manatees during construction.

The USACE is responsible for determining whether the selected alternative is likely (or not likely) to adversely affect any listed species and/or critical habitat, and for requesting the Service's concurrence with that determination. If the USACE determines, and the Service concurs, that the selected alternative is likely to adversely affect listed species and/or critical habitat, a request for formal consultation in accordance with Section 7 of the Endangered Species Act should be submitted to the Service. That request should also include the USACE's rationale supporting their determination.

## At-Risk Species

The Service's Southeast Region has defined "at-risk species" as those that are:

1. Proposed for listing under the ESA by the Service;
2. Candidates for listing under the ESA, which means the species has a "warranted but precluded 12-month finding"; or
3. Petitioned for listing under the ESA, which means a citizen or group has requested that the Service add them to the list of protected species. Petitioned species include those for which the Service has made a substantial 90-day finding as well as those that are under

review for a 90-day finding. As the Service develops proactive conservation strategies with partners for at-risk species, the states' Species of Greatest Conservation Need (defined as species with low or declining populations) will also be considered.

The Service's goal is to work with private and public entities on proactive conservation to conserve these species thereby precluding the need to federally list as many at-risk species as possible. Discussed below are species currently designated as "at-risk" that may occur within the project area.

Alabama Hickorynut

The Alabama Hickorynut (*Obovaria unicolor*) is a 1.2-2 inch-long freshwater mussel with round or elliptical shape. The outer shell (periostracum) is smooth and brown to yellow brown, with rays. This species is a long term brooder that is gravid from June through August of the following year. Like other freshwater mussels, the Alabama Hickorynut releases its larvae (glochidia) into the water column, where they parasitize a fish (glochial host) in order to transform into a juvenile mussel. Once the glochidia are ready, they release from the host to find a suitable substrate. Suitable glochidial host fishes for this species include the naked sand darter (*Ammocrypta beani*), southern sand darter (*Ammocrypta meridiana*), Johnny darter (*Etheostoma nigrum*), Gulf darter (*Etheostoma swaini*), blackbanded darter (*Percina nigrofasciata*), dusky darter (*Percina sciera*), and redspot darter (*Etheostoma artesiae*). These are small fish that live along the bottoms of clear streams.

The Alabama Hickorynut inhabits sand and gravel substrates in moderate currents in large streams. However, the presence of moderate gradient pool and riffle habitats in a variety of stream and river sizes may contain this species. In Louisiana, the Alabama Hickorynut is known to occur in the Pearl and Amite River systems. Habitat modification and destruction due to siltation and impoundment threaten this species. It is also negatively affected by the pollution of streams and rivers.

Alligator Snapping Turtle

The alligator snapping turtle (*Macrochelys temminckii*) may be found in large rivers, canals, lakes, oxbows, and swamps adjacent to large rivers. It is most common in freshwater lakes and bayous, but also found in coastal marshes and sometimes in brackish waters near river mouths. Typical habitat is mud bottomed waterbodies having some aquatic vegetation. The alligator snapping turtle is slow growing and long lived. Sexual maturity is reached at 11 to 13 year of age (Ernst et al. 1994). Because of this and its low fecundity, loss of breeding females is thought to be the primary threat to the species.

## Migratory Birds and Other Trust Resources

Bald Eagle

The proposed project area may provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*), which was officially removed from the List of Endangered and Threatened Species as of August 8, 2007. However, the bald eagle remains protected under the MBTA and BGEPA.

Bald eagles typically nest in large trees located near coastlines, rivers, or lakes that support adequate foraging from October through mid-May. In southeastern Louisiana parishes, eagles typically nest in mature trees (e.g., baldcypress, sycamore, willow, etc.) near fresh to intermediate marshes or open water. Major threats to this species include habitat alteration, human disturbance, and environmental contaminants. Furthermore, bald eagles are vulnerable to disturbance during courtship, nest building, egg laying, incubation, and brooding. Disturbance during these periods may lead to nest abandonment, cracked and chilled eggs, and exposure of small young to the elements. Human activity near a nest late in the nesting cycle may also cause flightless birds to jump from the nest tree, thus reducing their chance of survival.

The Service recommends a survey be conducted to determine if a bald eagle nest is present within or adjacent to the project area. If a bald eagle nest occurs within 660 feet of the proposed project area, then an evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles. That evaluation may be conducted on-line at: http://www.fws.gov/southeast/birds/Eagle/tamain.html

The Service developed the National Bald Eagle Management Guidelines to provide landowners, land managers, and others with information and recommendations to minimize potential project impacts to bald eagles. A copy of the guidelines is available at: https://ecos.fws.gov/ServCat/DownloadFile/36458?Reference=36436

On September 11, 2009, the Service published two federal regulations establishing the authority to issue permits for non-purposeful bald eagle take (typically disturbance) and eagle nest take when recommendations of the NBEM Guidelines cannot be achieved. Permits may be issued for nest take only under the following circumstances where: 1) necessary to alleviate a safety emergency to people or eagles, 2) necessary to ensure public health and safety, 3) the nest prevents the use of a human-engineered structure, or 4) the activity or mitigation for the activity will provide a net benefit to eagles. Except in emergencies, only inactive nests may be permitted to be taken.

Should you need further assistance interpreting the guidelines, avoidance measures, or performing an on-line project evaluation, please contact Ulgonda Kirkpatrick (phone: 352/406-6780, e-mail: ulgonda_kirkpatrick@fws.gov). For assistance with the bald eagle permitting process, please contact Resee Collins (phone: 404/314-6526, e-mail: resee_collins@fws.gov).

Neotropical Migratory Songbirds

The proposed project contains features that could potentially impact (directly and/or indirectly) migratory birds and the habitats upon which they depend. Any loss of forested habitat through direct impacts or because of increased inundation is a concern to the Service. In Louisiana, the primary nesting period for forest-breeding migratory birds occurs between April 15 and August 1. The proposed project may directly impact migratory birds of conservation concern because habitat clearing that occurs during the aforementioned primary nesting period may result in unintentional take of active nests (i.e., eggs and young) in spite of all reasonable efforts to avoid such take.

In addition to the direct loss of forested habitat, the proposed water retention features (Darlington Dam) could increase the amount of time adjacent forested areas are flooded. Increased flooding stress could result in tree mortality and a loss of habitat over time. Forest fragmentation (from direct or indirect habitat loss) may contribute to population declines in some avian species because fragmentation reduces avian reproductive success (Robinson et al. 1995).

Wading Bird Colonies

In accordance with the MBTA and the FWCA, please be advised that the project area includes habitats that are commonly inhabited by colonial nesting waterbirds. We recommend that a qualified biologist inspect the proposed work sites for the presence of nesting colonies (during the nesting season) prior to any work being initiated that would impact the colony. For colonies containing nesting wading birds (i.e., herons, egrets, night-herons, ibis, and roseate spoonbills), anhingas, and/or cormorants, all activity occurring within 1,000 feet of a rookery should be restricted to the non-nesting period, depending on the species present.

In addition, we recommend that on-site contract personnel including project-designated inspectors be trained to identify colonial nesting birds and their nests, and avoid affecting them during the breeding season (i.e., the time period outside the activity window). Should on-site contractors and inspectors observe potential nesting activity, coordination with the Service and the Louisiana Department of Wildlife and Fisheries should occur.

DESCRIPTION OF TENTATIVELY SELECTED PLAN AND EVALUATED ALTERNATIVES

Through coordination between the USACE's Project Development Team (PDT), the non-federal sponsor (Louisiana Department of Transportation and Development), and natural resource agencies, a total of 15 alternatives were identified for evaluation to reduce the risk of flood damages. The alternatives included combinations of 34 different structural and non-structural management measures that were identified to remove water more quickly out of the basin (e.g., dredging and diversions) or hold water back temporarily until water levels drop downstream (e.g., flood gates, dams, retention ponds). Non-structural measures such as structure elevations and relocations were also evaluated, as well as focused structural measures to protect critical facilities. Two of the alternatives identified through public scoping evaluated the flood reduction potential of restoring river meanders and converting the abandoned sand and gravel mines back to forested ecosystems.

The USACE modeled the effectiveness of reducing flood risk for each of the 15 alternatives and carried forward the no-action alternative and three action alternatives as the final array for consideration. Details are provided below for each alternative from the final array.

**1) No Action Alternative**

Under the No-Action Alternative, no risk reduction would occur. The area would continue experience damages from rainfall and wind/tide induced flooding. This would be exacerbated in the Lower Amite River Basin due to relative sea level rise.

**2) Dry Dam along Sandy Creek**

A 100-year dry dam design on Sandy Creek would lower the peak stage height along the Amite River by holding back water during rain events. This alternative was eliminated because it did not provide as much flood relief benefit as the large scale 25-year dry Darlington Dam and it's benefit area overlapped with the benefit area of the Darlington Dam. It did not provide additive benefit.

**3) Large Scale 25 Year Dry Dam (Darlington Dam)**

The large scale 25 year Darlington Dam alternative consists of an earthen dam on the Amite River that will function as a dry dam. Since this alternative was previously studied, data for analyzing it was available in the "Amite River and Tributaries, Darlington Reservoir Re-evaluation Study (Reconnaissance Scope)", dated September 1997. The 1997 report analyzed Dry and Reduced-wet Darlington Dam designs. The dry dam (carried forward here as an alternative) would have a crown elevation 1 foot lower than the reduced-wet. The dam consists of a clay core with a random fill outer layer. The design section consists of a reservoir with a 24 ft wide crown at elevation 202.8 (NGVD29) and side slopes of 1 vertical on 3 horizontal from the crown to elevation 172.8 (NGVD29), the elevation of the flood control pool. On the flood side, from the flood control elevation to the conservation pool elevation, the slope is 1 vertical on 6 horizontal. The flatter slope is to reduce the chances of sudden drawdown failures that tend to occur in this zone. Below the conservation pool elevation, the slope is 1 vertical on 4 horizontal. On the protected side, from the flood pool elevation to the conservation pool, the slope is 1 vertical on 5 horizontal. The flatter slope in this area will increase stability and will resist seepage forces that may concentrate in the lower portion of the dam. Below the conservation pool, the slope is 1 vertical on 3 horizontal. The outlet structure for the dam is three 10 foot x 10 foot box culverts with an emergency spillway.

**4) Nonstructural (25 Year Floodplain)**

A nonstructural assessment was completed that looked at the effectiveness of implementing measures such as structure elevations, relocations, and flood-proofing. An inventory of residential and non-residential structures was developed using the National Structure Inventory (NSI) version 2.0 for the portions of the study area impacted by flooding from rainfall and sea-level rise associated with the future without project condition. An assessment of all structures located in the 25-year and 50-year floodplain was performed and is presented below.

The nonstructural alternatives will be further refined based on analyses of effectiveness and cost. Further refinement will include a new analysis to combine nonstructural measures with structural alternatives, revisiting of groupings to address areas of potential life safety concerns and/or geographic groupings, as well as additional surveys conducted to be applied to the structure inventory.

25 Year Floodplain (4% Annual Chance Exceedance)

- Measure to every structure receiving a flood stage at or above the first floor elevation during the base year 25 year event.

- 4,291 residential structures were raised to the future 100 year stage up to 13’.
- 387 nonresidential structures were floodproofed up to 3’.

50 Year Floodplain (2% Annual Chance Exceedance)
- Measure to every structure receiving a flood stage at or above the first floor elevation during the base year 50 year event.
- 6,774 residential structures were raised to the future 100 year stage up to 13’.
- 670 nonresidential structures were floodproofed up to 3’.

The **Tentatively Selected Plan (TSP)** identified from the final array is the **Large Scale 25 Year Dry Darlington Dam combined with nonstructural measures**. The Dry Darlington Dam scale will be optimized during the feasibility study design. Additionally, the nonstructural plan will be refined by assessing the Darlington Dam as the new base condition for the hydrology which will likely include structures in geographical regions that are not getting direct benefits from the Darlington Dam such as the Lower Reach of the Amite River Basin.

DESCRIPTION OF IMPACTS

Construction of a dry dam across the Amite River would impact the river itself (16.75 miles within the flood pool), sandbars, herbaceous and forested riparian wetlands, as well as upland forests. The footprint of the Darlington Dam would directly impact approximately 205 acres. The flood pool, which would be temporarily inundated during large rain events, encompasses approximately 9,406 acres. The impacts associated with borrow pits for the dam are undetermined at this time.

The two community types observed during roadside surveys were small stream forests and hardwood slope forests, but other bottomland hardwood forest communities associated with riverine systems are also likely present. Once Right-of-Entry (ROE) is obtained, more thorough site visits will allow better evaluation of the natural communities that will be impacted. This information is required for us to finalize our Fish and Wildlife Coordination Act Report.

EVALUATION METHODS FOR THE SELECTED PLAN

<u>Wetland Value Assessment</u>
Preliminary Wetland Value Assessments (WVA’s) were conducted to compare the effects of each alternative to fish and wildlife resources. Roadside site assessments were used to document the existing vegetation at each site within the final array of alternatives. Impacts to the forested communities were estimated based on anticipated flood depths and durations, and by using flood tolerances of the tree species present (U.S. Geological Survey data), growth rates of those species (U.S. Forest Service data), and aerial photography. The purpose of the preliminary WVA’s was to help select the TSP. Once ROE is obtained, final (more thorough) WVAs will be completed to determine mitigation requirements for the TSP.

The USACE’s Civil Works WVA – Bottomland Hardwoods (Version 1.2) will be used to assess environmental effects for this project. Implementation of the WVA requires that habitat quality and quantity (acreage) are measured for baseline conditions, and predicted for future without-project and future with-project conditions. Each WVA model utilizes an assemblage of variables considered important to the suitability of that habitat type to support a diversity of fish and wildlife species. The WVA provides a quantitative estimate of project-related impacts to fish and wildlife resources; however, the WVA is based on separate models for bottomland hardwoods, chenier/coastal ridge, fresh/intermediate marsh, brackish marsh, and saline marsh. Although, the WVA may not include every environmental or behavioral variable that could limit populations below their habitat potential, it is widely acknowledged to provide a cost-effective means of assessing restoration measures in coastal wetland communities.

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

The product of an HSI value and the acreage of available habitat for a given target year is known as the Habitat Unit (HU) and is the basic unit for measuring project effects on fish and wildlife habitat. HUs are annualized over the project life to determine the Average Annual Habitat Units (AAHUs) available for each habitat type. The change (increase or decrease) in AAHUs for each future with-project scenario, compared to future without-project conditions, provides a measure of anticipated impacts. A net gain in AAHUs indicates that the project is beneficial to the fish and wildlife community within that habitat type; a net loss of AAHUs indicates that the project would adversely impact fish and wildlife resources.

## FISH AND WILDLIFE CONSERVATION MEASURES AND RECOMMENDATIONS

The President's Council on Environmental Quality regulations for implementing the National Environmental Policy Act define mitigation to include: (1) avoiding the impact; (2) minimizing the impact; (3) rectifying the impact; (4) reducing or eliminating the impact over time; and (5) compensating for impacts. The Service supports and adopts this definition and considers the specific elements to represent the desirable sequence of steps in the mitigation planning process. Through this process, the Service strives to make the project's goals co-equal to fish and wildlife resource conservation.

The Service's Mitigation Policy (Federal Register, Vol. 46, pp. 7644-7663, January 23, 1981) has designated four resource categories which are used to ensure that the level of mitigation recommended will be consistent with the fish and wildlife resources involved. The mitigation planning goals and associated Service recommendations should be based on those four categories, as follows:

Resource Category 1 - Habitat to be impacted is of high value for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section. The mitigation goal for this Resource Category is that there should be no loss of existing habitat value.

Resource Category 2 - Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section. The mitigation goal for habitat placed in this category is that there should be no net loss of in-kind habitat value.

Resource Category 3 - Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis. FWS's mitigation goal here is that there be no net loss of habitat value while minimizing loss of in-kind habitat value.

Resource Category 4 - Habitat to be impacted is of medium to low value for evaluation species. The mitigation goal is to minimize loss of habitat value.

Streams and wetland habitats associated with the proposed project are designated as Resource Category 2, the mitigation goal for which is no net loss of in-kind habitat value. Non-wetland forests (e.g., upland hardwood) would also be considered Resource Category 2 due to their importance to neotropical migratory songbirds. Scrub-shrub, highly altered waterbodies and wetland habitats, bedded pine plantations, and any grasslands that may be impacted are Resource Category 3 due to their reduced value to fish and wildlife and/or their degraded wetland functions. The mitigation goal for Resource Category 3 habitats is no net loss of habitat value; these habitats can be mitigated out-of-kind but should be within the general habitat type (e.g., forested land).

To achieve fish and wildlife resource conservation, the Service recommends the following:

1. The Darlington Dam should be designed to allow continuous upstream and downstream fish passage. The 10' x 10' box culverts should be installed slightly below grade to prevent "perching" and provide benthic macroinvertebrates and bottom dwelling fish (including the host fish for at-risk and listed mussels) free passage. Ideally, culverts should be installed to a depth that allows sediment to accumulate in the bottom, typically 20 percent of the height. If this reduces the required volume of flow to an unacceptable level then larger or more culverts should be installed.

2. Depending on the design and configuration of culverts at the Darlington Dam, we may require a fish passage study. The USACE should coordinate culvert design and configuration with the Service.

3. If ring levees are proposed as part of the "non-structural" component of the TSP, the levee alignments should be located to avoid and minimize impacts to both herbaceous wetlands and forested communities (wet and non-wet) as much as possible. The acreage of wetlands and forested habitat enclosed within ring levees also should be minimized to the maximum extent practicable.

4. Any clearing of riparian vegetation should be limited to a single bank and when possible that bank should be either the eastern or northern bank.

5. Important fish and wildlife habitat (emergent wetlands, forested wetlands, and non-wetland forest) should be conserved by avoiding and minimizing the acreage of those habitats directly impacted by project features.

6. Any forest clearing associated with project features should be conducted during the fall and winter to minimize impacts to nesting migratory songbirds, when practicable.

7. Avoid impacts to threatened and endangered species, at risk species, and species of concern such as the bald eagle, and wading bird nesting colonies.

8. West Indian manatee conservation measures from Appendix A should be included in all contracts, plans, and specifications for in-water work in areas where the manatee may occur.

9. Consultation should continue for the Alabama heelsplitter mussel. Any conservation measures that are identified through consultation should be included in all contracts, plans, and specifications for any work that may adversely impact the heelsplitter.

10. Compensation should be provided for any unavoidable losses of stream habitat, wetland habitat, and non-wetland forest caused (directly or indirectly) by project features. All mitigation should be developed/coordinated with the Service and other natural resource agencies. Only after forest restoration opportunities along the Amite River (abandoned sand and gravel mines) have been implemented to the maximum extent practicable should other mitigation opportunities be pursued. The Service will not be able to agree to the suitability of other mitigation proposals until after ROE allows onsite evaluation of the resources to be impacted to ensure no net loss of “in-kind” habitat value.

11. Borrow material required for construction should be acquired in accordance with the Borrow Site Prioritization Criteria provided in Appendix B.

SERVICE POSITION

The Service does not object to continuation of the feasibility study provided that the above recommendations are fully addressed. However, due to the lack of information regarding the project, the Service does not offer an official position on the TSP at this time. The scale of the Darlington Dam is tentatively set for a 25-year flood event but will be optimized later during the feasibility study. Nonstructural components of the TSP have not yet been clearly identified either. Compensatory mitigation issues also need to be further evaluated before we offer an official position.

We look forward to assisting the USACE in finalizing a plan that would minimize flood risk as well as impacts to fish and wildlife resources. Should you have any questions regarding our comments, please contact Seth Bordelon (337/291-3138) of this office.

Sincerely,

Joseph A. Ranson
Field Supervisor
Louisiana Ecological Services Office

## Literature Cited


Ernst, C. H., J. E. Lovich, and R. W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC.

Louisiana Department of Wildlife and Fisheries. 2009. The Natural Communities of Louisiana. Louisiana Natural Heritage Program.

Robinson et al. 1995 Regional forest fragmentation and nesting success of migratory birds. Science. Vol. 267, Issue 5206. pp. 1987-90.

# Appendix A

## Manatee Conditions/Recommendations

During in-water work in areas that potentially support manatees all personnel associated with the project should be instructed about the potential presence of manatees, manatee speed zones, and the need to avoid collisions with and injury to manatees. All personnel should be advised that there are civil and criminal penalties for harming, harassing, or killing manatees which are protected under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973.

Additionally, personnel should be instructed not to attempt to feed or otherwise interact with the animal, although passively taking pictures or video would be acceptable. We recommend the inclusion of the following measures into construction plans and specifications to minimize potential impacts to manatees in areas where they are potentially present:

- All on-site personnel are responsible for observing water-related activities for the presence of manatee(s). We recommend the following to minimize potential impacts to manatees in areas of their potential presence:

- All work, equipment, and vessel operation should cease if a manatee is spotted within a 50-foot radius (buffer zone) of the active work area. Once the manatee has left the buffer zone on its own accord (manatees must not be herded or harassed into leaving), or after 30 minutes have passed without additional sightings of manatee(s) in the buffer zone, in-water work can resume under careful observation for manatee(s).

- If a manatee(s) is sighted in or near the project area, all vessels associated with the project should operate at “no wake/idle” speeds within the construction area and at all times while in waters where the draft of the vessel provides less than a four-foot clearance from the bottom. Vessels should follow routes of deep water whenever possible.

- If used, siltation or turbidity barriers should be properly secured, made of material in which manatees cannot become entangled, and be monitored to avoid manatee entrapment or impeding their movement.

- Temporary signs concerning manatees should be posted prior to and during all in-water project activities and removed upon completion. Each vessel involved in construction activities should display at the vessel control station or in a prominent location, visible to all employees operating the vessel, a temporary sign at least 8½ " X 11" reading language similar to the following: “CAUTION BOATERS: MANATEE AREA/ IDLE SPEED IS REQUIRED IN CONSRUCTION AREA AND WHERE THERE IS LESS THAN FOUR FOOT BOTTOM CLEARANCE WHEN MANATEE IS PRESENT”. A second temporary sign measuring 8½ " X 11” should be posted at a location prominently visible to all personnel engaged in water-related activities and should read language similar to the following: “CAUTION: MANATEE  AREA/ EQUIPMENT MUST BE SHUTDOWN IMMEDIATELY IF A MANATEE COMES WITHIN 50 FEET OF OPERATION”.

- Collisions with, injury to, or sightings of manatees should be immediately reported to the Service’s Louisiana Ecological Services Office (337/291-3100) and the Louisiana Department of Wildlife and Fisheries, Natural Heritage Program (225/765-2821).  Please provide the nature of the call (i.e., report of an incident, manatee sighting, etc.); time of incident/sighting; and the approximate location, including the latitude and longitude coordinates, if possible.

# Appendix B

## Borrow Site Prioritization Criteria

Location of borrow sites should be prioritized in the following order to avoid and minimize impacts to fish and wildlife resources, especially where multiple alternative borrow areas exist:

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;
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;
4. Areas under forced drainage that are protected from flooding by levees, and that are:
   a) wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands(e.g., wet pastures), excluding marshes;
   b) disturbed wetlands (e.g., hydrologically altered, artificially impounded).
5. Sites that are outside a forced drainage system and levees, and that are:
   a) wetland forests dominated by exotic tree species (i.e., Chinese tallow-trees) or non-forested wetlands(e.g., wet pastures), excluding marshes;
   b) disturbed wetlands (e.g., hydrologically altered, artificially impounded).

The Service recommends that immediately after the initial identification of a new borrow site the USACE should initiate informal consultation with the Service regarding potential impacts to federally listed threatened or endangered species.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NEW ORLEANS DISTRICT
7400 LEAKE AVENUE
NEW ORLEANS, LOUISIANA 70118

REPLY TO
ATTENTION OF

September 13, 2019

Regional Planning and Environment
Division South

Joseph Ranson
Field Office Supervisor
U.S. Fish and Wildlife Service
646 Cajundome Blvd - Suite 400
Lafayette, LA 70506

Dear Mr. Ranson:

During the 19 June 2019 stakeholder meeting for the Amite River and Tributaries Study East of the Mississippi River, LA (Flood Risk Management Feasibility Study), we had received your input to consider nature-based engineering solutions in our plan formulation that address flood risk management (FRM) in the Amite River Basin. This letter addresses your follow-up planning-aid letter (PAL) dated 25 June 2019 for the Recommended New Alternative of evaluating shoreline restoration and meander creation within the study area. We have considered this alternative and, per further review, we determined that there are limited benefits downstream as well as complications with restoring and protecting meanders on the Amite River Basin.

Adding meanders to the Amite River would increase the length of the river. It may be beneficial for a high frequency rainfall event (e.g. 1 or 2 year), but it would most likely induce flooding in the area of the meanders for a low frequency rainfall event (100+ year).

The abandoned mines could provide additional storage capacity as detention ponds. However, if they are saturated up to the groundwater table, these mines may not provide significant storage capacity for the incoming runoff.

One of the possible FRM benefits of the meanders is the increase of detention volume within the river. For the high frequency events, the additional storage capacity could improve flood risk reduction. This would be extremely unlikely for low frequency rainfall events.

Another possible FRM benefit of the meander is to slow down the peak runoff traveling down the river. Slowing down the water would increase the travel time, which levels out the peak flow and reduces the water depth (i.e. creating "slow down benefit"). For a low frequency event where a significant portion of the flow is out of the channel, the meanders have less effect on storage capacity. For the upper portion of the river basin, the Amite River is mostly within bank up to the 10-year high frequency event. In that region and for those flood events, re-meandering could slow down the flood water in the channel. For the lower portion of the Amite River Basin, the Amite River is out of its banks for all simulated frequency events, so the "slow down benefit" would be minimal in the region.

For a storm that moves west to east or south to north, rainfall hits the lower Amite River Basin first. In this case, it might be beneficial to slow down the flow from the upper Amite River Basin so that the lower Amite River Basin has time to drain before water flowing from the Upper Amite River Basin. If the storm moves north to south or east to west, it would not support slowing down the water flowing from the upper Amite River Basin. In those cases, water reaches the upper Amite River Basin before reaching the lower Amite River Basin. Therefore, it is more beneficial to let the upper Amite River Basin water drain out as quickly as possible before rainfall drops in the lower Amite River Basin.

If there are significant benefits to meandering other than hydraulic, then it may be worth modeling as an alternative.

While we cannot quantify an estimate of FRM benefits associated with river meander restoration, we can explain it based on existing geomorphological data. On 16 July 2019, we had solicited the USACE Engineering and Research Development Center (ERDC) for subject-matter experts, including those involved with the September 2007 geotechnical study (See Enclosure 1). This report, concerning flood impacts by proposed meander creation in sand and gravel mined reached, indicates that upstream mined reaches have not influenced downstream flood stages (page 122 of Enclosure 1).

Prior to the 2007 fluvial study, USACE completed a reconnaissance study in 2000 concerning ecosystem restoration on the Amite River and Tributaries (See Enclosure 2) with Alternative #2 involving river remeandering restoration. Such restoration would significantly increase flood stages in the vicinity and also yield decreased flood stages downstream from applied reaches.

Both of these studies indicate possibilities for mitigation for impacts to wildlife, the threatened heelsplitter mussel (*Potamilus inflatus*), and water quality. Persuant to Section 7(a)(1) of the Endangered Species Act in your PAL letter, we could include river restoration as a means to mitigate for environmental impacts. This mitigation would require a Louisiana Scenic Rivers permit for impacts to the Amite River channel (persuant LA Scenic Rivers Act of 1988).

We look forward to continuing our work with the USFWS throughout the feasibility study. Should you have any questions regarding our comments, please contact Daniel Meden (504-862-1014) or via email at daniel.c.meden@usace.army.mil.

Sincerely,

Marshall K. Harper

Marshall K. Harper
Chief, Environmental Planning Branch

Enclosure 1: Hood, D.R., Patrick, D.M., & Corcoran M.K. "Fluvial Instability and Channel Degradation of Amite River and its Tributaries, SouthwestMississippi and Southeast Louisiana." September 2007.

Enclosure 2: Amite River and Tributaries, Louisiana Ecosystem Restoration Reconnaissance Study. July 2000.

**John Bel Edwards**
GOVERNOR

**Chuck Carr Brown, Ph.D.**
SECRETARY

# State of Louisiana

**DEPARTMENT OF ENVIRONMENTAL QUALITY**
**OFFICE OF ENVIRONMENTAL ASSESSMENT**

July 2, 2019

Ms. Kaitlyn Carriere
CEMVN-PMR, Room 331
7400 Leake Avenue
New Orleans, LA 70118

RE: Amite River and Tributaries East of the Mississippi River, LA Feasibility Study

Dear Ms. Carriere:

LDEQ appreciates the opportunity to review the proposed study and provide the following recommendations and comments. We look forward to continued collaboration in this effort.

We encourage the use of nature-based solutions such as stream and floodplain restoration. Such activities may include restoring the channel and floodplain to the hydrologic, ecological and water quality conditions present before any significant man-made alterations were made. Restoring the natural functions of the channel and floodplain by restoring hydrologic characteristics such as stream sinuosity, cross sectional area, length, and slope can both reduce flood elevation and duration as well as improve water quality, ecological, and economic conditions.

When streams are realigned by "straightening", the increased slope and decreased channel length increases water velocity, which increases bank instability and erosion. The increased water volume deposited downstream in a shorter period of time also leads to increased water elevations and flooding. Alternatively, restoring the natural meanders of the Amite River and its tributaries would increase flood storage capacity of the channels by increasing the length of the channel and adjacent floodplains. By reducing the slope of the channel and increasing the time it takes water to travel downstream, more water is absorbed by the soil and vegetation, resulting in reduced downstream water levels and flooding impacts.

Alternatives that include dredging or clearing and snagging can have significant potential adverse environmental, ecological, and economic impacts while often providing insignificant benefits for flood mitigation. Both dredging and clearing and snagging can lead to bank instability, erosion, and sedimentation. The resulting sediment deposited in other sections of the river reduces flow capacity and increases concentrations of total suspended solids, turbidity and other pollutants.

While dredging increases channel cross-sectional area, stream velocities and the ability to reaerate and assimilate organic loading are reduced. The reduction in dissolved oxygen levels can cause the waterbody to be listed as impaired, resulting in discharge permit restrictions which adversely impact development and economic conditions. Low dissolved oxygen levels can also lead to septic conditions altering the quantity and diversity of macroinvertebrates, aquatic habitat, and species.

Clearing and snagging by large track-type vehicles tends to alter channel widths and depths, producing similar impacts as described for dredging. At the same time, woody debris and sawdust from the operation can be carried downstream and deposited against bridge pilings, leading to reduced stream flow capacity, lower dissolved oxygen concentrations and other impairments, and increased scouring near bridge structures. Removal of this debris and other logs, trash, and white goods from bridge crossings would aid the waterway's flow capacity and reduce detrimental flooding, infrastructure and environmental impacts.

Additionally, removal of riparian vegetation during clearing and snagging leads to increased bank instability and sedimentation as well as increased pollutant runoff, such as nutrients and fecal coliform bacteria, from adjacent land. Removal of the overhead shading provided by the tree canopy also leads to increased stream temperatures, which increases the rate of decay of organic materials and further reduces dissolved oxygen concentrations in the water column.

Please strongly consider natural channel restoration and debris maintenance to improve function of the stream and floodplain. This approach can reduce flood elevation and duration as well as improve water quality, ecological, and economic conditions. If you have any questions or comments, please contact Mr. William C. Berger, Jr. at (225) 219-3217 or by email at Chuck.Berger@la.gov.

Sincerely,

Jonathan McFarland, P.E.
Administrator
Water Planning and Assessment Division

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**July 3, 2019**

Colonel Michael N. Clancy
District Engineer
United States Army Corps of Engineers
Post Office Box 60267
New Orleans, LA 70160-0267

RE: *Amite River and Tributaries Study East of the Mississippi River, LA*

Dear Colonel Clancy:

The Louisiana Department of Wildlife and Fisheries (LDWF) attended the recent June 19, 2019, stakeholder meeting held at the U.S. Geological Survey building in Baton Rouge, LA and has reviewed other related information regarding the Amite River and Tributaries Study East of the Mississippi River, LA (Flood Risk Management Feasibility Study) being conducted by the U.S. Army Corps of Engineers (USACE) and the Louisiana Department of Transportation and Development (LA DOTD). Based on our participation and review of available information, we offer the following comments and recommendations:

Action Alternatives

We concur with the June 25, 2019, comments provided by the U.S. Fish and Wildlife Service (USFWS) regarding action alternatives to reduce flood risk. Like USFWS, we recommend that restoring meanders and floodplain connectivity to critical reaches of the Amite which have been impacted by sand and gravel mining be evaluated for inclusion in the alternatives analysis. We understand that Alt 13 considered converting existing sand and gravel pits to floodplain; however, we believe that the scope should be increased to consider other measures beyond the footprint of those pits. Measures considered should include restoration of the channel dimension, pattern and profile, removal/redistribution and stabilization of sand tailing stockpiles and their remnants, as well as bioengineering and natural channel design measures to increase stability of highly erosive, sandy streambanks and floodplains found within heavily mined reaches. Many of the streambanks and floodways associated with these reaches currently contain excessive amounts of sand tailings and often, inadequate amounts of established vegetation. In addition, many of the mining operations have significantly altered hydrology within the floodplain with the construction of large pits, levees, and other features. Modification of these abandoned features will improve natural functions and greatly increase available flood storage.

Other measures which we believe should be explored by USACE involve the reconnection of incised Amite River tributaries to their floodplains. This strategy would raise channels and utilize

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expanded floodplain area to greatly increase retention and infiltration and greatly reduce flow rates and volumes experienced downstream. Due to sand and gravel impacts, changes in land use, shortsighted channel manipulation, and other perturbations throughout the watershed, many tributaries have degraded and incised or have been disconnected from their floodplains by other means. These unstable channels currently deliver larger volumes of water at much higher flow rates. USACE should identify impacted tributaries where adjacent land use would not interfere with the acquisition of flood easements and restoration of appropriate channels and floodplain. We believe that a larger number of smaller projects, raising streambeds and reconnecting floodplains could cumulatively provide significant flood storage as well as provide needed flow regulation, which could conceivably benefit a large portion of the basin. In order to make the alternative economically viable, LDWF suggests that USACE focus on opportunities which lend themselves to the most cost effective methodologies, such as beaver dam analogues. These types of projects are most viable and cost effective on headwater and lower-order streams.

An added benefit of the approaches described above would be that subsequent restoration, rehabilitation, and enhancement of riparian habitats could aid in offsetting any impacts to wetlands and streams resulting from other, more environmentally damaging measures and alternatives currently being considered.

Mitigation Recommendations

Like USFWS, we believe that mitigation should be in-kind and there should be no net loss of habitat value for streams and wetland habitats associated with the project. We strongly believe that USACE should explore wetland and stream mitigation opportunities within the Amite River and tributaries including the Comite River and its tributaries. Numerous abandoned sand and gravel sites exist on the banks of the Amite River and several occur along the Comite River. Due to the degraded state of the habitat, altered hydrology, and loss of function, the mitigation potential for these sites is quite high and projects on these sites could provide significant lift. It may not be prudent to restore all sites to historic contours and habitats, but each could be greatly improved with regrading, capping, planting and other measures to restore function.

Many other locations throughout the watershed could provide in-channel mitigation sites. Potential mitigation projects within the Amite and Comite Rivers range from preventing or restoring gravel pit capture, planting and protecting riparian corridors, restoring appropriate channel dimensions and bedform, etc. Similarly, smaller impacted tributaries provide numerous opportunities to develop instream projects thought the watershed.

An added benefit to providing in-kind mitigation within the watershed is that the mitigation itself could be sited and developed to improve those functions which further reduce flood risk and make the most of overall project funding.

Louisiana Scenic Rivers

Bayou Manchac is a Louisiana designated Historic and Scenic River; however, its status as such was not included within the June 19, 2019, stakeholder meeting presentation slide deck. It should be noted that Bayou Manchac is a designated Historic and Scenic River from the Amite River to the Mississippi River. As noted, the Amite River is a Louisiana designated Natural and

Scenic River from the Louisiana-Mississippi state line to La. Highway 37. The Comite River is a Louisiana designated Natural and Scenic River from the Wilson-Clinton Highway in East Feliciana Parish to the entrance of White Bayou in East Baton Rouge Parish.

Although exceptions exist, several of the identified alternatives which may impact Bayou Manchac, the Amite River and the Comite River would require Scenic Rivers authorization and others may be prohibited by the Scenic Rivers Act. Please contact Scenic Rivers Coordinator Chris Davis at 225-765-2642 for additional information regarding our Scenic Rivers and associated constraints.

Wildlife Diversity Program Concerns

The Wildlife Diversity Program (WDP) requests continued involvement in the planning process of this study. We are requesting additional details on the projects proposed within the Amite River and Tributaries - East of the Mississippi River, LA Flood Risk Management Feasibility Study. Below is an initial set of comments from WDP that encompasses rare, threatened and endangered species within the Amite River, the Comite River, and Bayou Manchac.

The Inflated Heelsplitter (*Potamilus inflatus*) may be impacted by the proposed project. This species is listed as threatened under the Endangered Species Act (16 U.S. C. 1533-1544) and is considered critically imperiled in the state of Louisiana. The Inflated Heelsplitter prefers a soft, stable substrate in slow to moderate currents, and has been found in sand, mud, silt, and sandy-gravel. The degradation of water quality is one of the leading threats to this species. Erosion control measures are recommend at proposed construction sites and include silt fencing, mulching, seeding and vegetation to decrease the amount of soil eroded by rainfall and runoff. All construction waste and debris should be placed in containers and disposed offsite, and surveying 500 feet upstream and downstream of the project site for the presence of Inflated Heelsplitters is recommended. If this mussel is found, contact Keri Lejeune at 337-735-8676 with the WDP and Monica Sikes at 337-291-3118 with the USFWS to coordinate activities.

The Alabama shad (*Alosa alabamae*) may occur within the project area. This is a federal candidate species under the Endangered Species Act (16 U.S.C. 1533-1544) and is considered critically imperiled in the state of Louisiana (S1). The Alabama shad resides in large flowing rivers, spawning over sand, gravel, and rock substrates from January to April. An increase in water control structures, poor water quality and dredging of sand bars has caused a significant population decline over the last forty years. Habitat protection is recommended for this species by avoiding disturbances such as construction of dams, water pollution, siltation, and avoiding disturbance of soil / stream bottoms. If you have any questions, please contact Keri Lejeune at 337-735-8676.

Our records indicate that Broadstripe topminnow (*Fundulus euryzonus)* may be found within the project area. This species is considered imperiled in the state of Louisiana with an S2 rank. Broadstripe topminnow prefer creeks and small rivers; frequently occurring at the surface along overhanging banks, overhanging partially submerged shrubs or trees, or around stumps, snags, and living trees standing in water close to the bank. Threats include chemical pollution and channel alterations and impoundments for navigation and flood control that could alter or eliminate habitat. Effort should be made to minimize impacts to this species. If you have any questions, please contact Keri Lejeune at 337-735-8676.

The proposed project may impact the gulf sturgeon (*Acipenser oxyrhynchus desotoi*) and its designated critical habitat. The gulf sturgeon is listed as threatened on both the federal and state species list. Major population limiting factors are thought to include barriers to spawning habitats and habitat loss associated with the construction of water control structures, including dams and sills. Other threats identified include modification to habitat associated with dredged material disposal and poor water quality associated with contamination.

Our records indicate the fresh water, mussel Southern Creekmussel (*Strophitus subvexus*) occur within a mile of the project area. This species has an S1 state rank and is considered critically imperiled in Louisiana because of its extreme rarity. Habitat protection is recommended for this species by avoiding disturbances such as water pollution, siltation, and the construction of dams. In addition, it is important to avoid disturbances of the soil / stream bottoms and existing mussel beds. If you have any questions, please contact Keri Lejeune at 337-735-8676.

Manatee (*Trichechus manatus*) may occur in within the water bodies of your project area. Manatees are large mammals inhabiting both fresh and salt water. Although most manatees are year round residents of Florida or Central America, they have been known to migrate to areas along the Atlantic and Gulf coast during the summer months. Manatee is a threatened species protected under the Endangered Species Act of 1973 and the Federal Marine Mammal Protection Act of 1972. In Louisiana, taking or harassment of a manatee is in violation of state and federal law. Critical habitat for manatee includes marine submergent vascular vegetation (sea-grass beds). Areas with sea-grass beds should be avoided during project activities if possible. Report all manatee sightings to the Louisiana Department of Wildlife and Fisheries at 337-735-8676 or 1-800-442-2511.

The Suckermouth minnow (*Phenacobius mirabilis*) may occur within your project area. The Suckermouth minnow (*Phenacobius mirabilis*) is considered critically imperiled in Louisiana. This species is a benthic organism, and occurs in runs and riffles of creeks and small to medium (sometimes large) rivers with substrates ranging from sand and gravel to large boulders. We recommend protecting habitat for the Suckermouth minnow by keeping sandy-bottomed streams clean and free of silt.

WDP records indicate that the alligator snapping turtle (*Macrochelys temminckii*) occurs in your project area. Minimize disturbance and alteration of nesting habitat, particularly during nesting season (April – June). Nesting typically occurs close to river banks and lake shores. Minimize removal of log jams in streams, as woody debris provides cover and hunting areas used by this species. Stream alteration should be avoided to protect turtle habitat. If dredging is needed, material should be dumped away from potential turtle nesting sites or dumped prior to egg laying (May – early June).

Our records also indicate the presence of a Spruce Pine-hardwood Mesic Flatwoods and two Small Stream Forest adjacent to waterbodies of the proposed project. These natural communities are considered imperiled in Louisiana with a state ranking of S2. Contact WDP botanist Chris Doffitt at 318-487-5885 for more information on avoiding impacts to these rare natural communities.

Below are other rare fish and mussel species occurring within the project area:

| **Common Name** | ***Scientific Name*** | **S Rank** |
|---|---|---|
| Alabama Hickorynut | *Obovaria unicolor* | S1 |
| Clear Chub | *Notropis winchelli* | S3 |
| Elephant-ear | *Elliptio crassidens* | S3 |
| Gulf Logperch | *Percina suttkusi* | S2 |
| Mississippi Pigtoe | *Pleurobema beadleianum* | S2 |
| Rainbow Darter | *Etheostoma caeruleum* | S2 |
| Rayed Creekshell | *Strophitus pascagoulaensis* | S2 |
| Saddleback Darter | *Percina ouachitae* | S3 |
| Shoal Chub | *Macrhybopsis hyostoma* | S3 |
| Smooth Softshell | *Apalone mutica* | S3 |
| Southern Hickorynut | *Obovaria jacksoniana* | S1S2 |
| Southern Pocketbook | *Lampsilis ornata* | S3 |
| Southern Rainbow | *Villosa vibex* | S2 |

The Louisiana Department of Wildlife and Fisheries submits these recommendations to the U.S. Army Corps of Engineers in accordance with provisions of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.). Please do not hesitate to contact Habitat Section Programs Manager, Matthew Weigel at 985-543-4931 should you need further assistance.

Sincerely,

Matt Weigel for

Kyle F. Balkum
Biologist Director

mw/cm

cc:
Louisiana Department of Environmental Quality
Amite River Basin Commission
U.S. Fish and Wildlife Service

Mississippi River Valley Division,
Regional Planning and Environment Division South

# Amite River and Tributaries Study East of the Mississippi River, Louisiana (ART)


## Appendix C-5 – General Mitigation Plan
## November 2019

# Preparation and Approval of Mitigation Plans

## 1.1 COMPONENT 1. OBJECTIVES

The components of this general mitigation plan apply to Corps-constructed mitigation projects.

The objective of this mitigation plan is to evaluate potential mitigation options that could satisfy the mitigation requirement for the Combined Darlington Dam and Nonstructural Measures (TSP). This general mitigation plan is based on a site visit and preliminary habitat analysis conducted in coordination with Fish and Wildlife Service. A more detailed mitigation plan will be developed in coordination with the Interagency Team during development of the final IFR and EIS and prior to signing of the ROD.

During a preliminary aerial survey of Darlington Dam, CEMVN identified approximately 1,332 AAHUs of bottomland hardwoods within the Darlington Dam footprint of the occasionally inundated reservoir. For the embankment dam footprint, a 100-foot buffer of impacts for approximately 300 acres, CEMVN identified approximately 255 acres of bottomland hardwoods (220 AAHUs). In addition, there will likely be impacts within the staging areas and borrow excavation sites; however, because those locations have not yet been determined, their impacts will be discussed in the more detailed mitigation plan for the final IFR and EIS.

## 1.2 COMPONENT 2: SITE SELECTION

Plan selection criteria would be considered when ranking and selecting the mitigation projects. These include:

- Risk & Reliability
- Environmental
- Time
- Cost Effectiveness
- Other Cost Considerations
- Watershed & Ecological Site Considerations

**Risk & Reliability:**

**Risk** is defined as probability multiplied by consequences. An example of risk would be a calculation of the relative chance of saltwater intrusion during the 50-year period of analysis multiplied by magnitude of anticipated plant mortality. Actions can be implemented to reduce risk, but because risk can never be completely eliminated, *residual risk* will remain.

**Reliability** refers to the chance that a component of the system will fail to perform its intended purpose as a function of the forces placed upon it. Reliability is often displayed using a fragility curve which describes the probability of failure as a function of an applied force. Many separate system components can be combined in an event tree to represent the reliability of a system.

Since these two factors are similar, it is best to consider them as one criterion: Risk & Reliability.

The below risk and reliability subcriteria (see Table C5-1) would be applied to each mitigation alternative.

**Table C5-1: Risk and Reliability**

| Issue | Explanation |
| --- | --- |
| Uncertainty Relative to Achieving Ecological Success/Potential Need for Adaptive Management (Contingency) Actions | Sources of *uncertainty relative to achieving ecological success* include: (1) incomplete understanding of the system (environmental or engineering) to be managed or restored (e.g. hydroperiod, water depth, water supply, substrate, nutrient levels, toxic compounds) |

| Issue | Explanation |
|---|---|
| | (2) imprecise estimates of the outcomes of alternative management actions (e.g. proven methodology, project complexity).<br><br>*Evaluation of Potential Need for Adaptive Management (Contingency) Actions:*<br>(1) Is there sufficient flexibility within project design and operation to permit adjustments to management actions?<br>(2) Is the system (or components) to be restored or managed well understood (e.g. hydrology and ecology) and are management outcomes accurately predictable?<br>(3) Do participants generally agree on the most effective design and operation to achieve project goals and objectives?<br>(4) Are the goals and objectives for restoration understood and agreed upon by all parties? |
| Uncertainty Relative to Implementability | Includes implementability issues that are not captured under other selection criteria. Implementability means that the alternative is feasible from technical, environmental, economic, financial, political, legal, institutional, and social perspectives. If it is not feasible due to any of these factors, then it cannot be implemented, and therefore is not acceptable. An infeasible plan should not be carried forward for further consideration. However, just because a plan is not the preferred plan of a non-Federal sponsor does not make it infeasible or unacceptable *ipso facto*. |
| Adaptability | Ability to expand (or otherwise adapt) the measure to achieve/maintain ecological success |
| Long-Term Sustainability of Project Benefits | For Forested Habitat: Measured by the Habitat Suitability Index Value at TY50, which incorporates the suitability index of all WVA variables in the WVA model. |
| Self-Sustainability of Project Once Ecological Success Criteria Linked to Notice of Construction Completion are Achieved | (1) Does the project utilize active engineering features (e.g., pumps)?<br>(2) Anticipated OMRR&R Activities<br>(3) Relative difficulty of OMRR&R |

| Issue | Explanation |
|---|---|
| Risk of Exposure to Stressors/ Reliability & Resiliency of Design | (1) To what stressors will a given alternative be exposed (e.g. sea level rise, subsidence, saltwater intrusion during storm or drought, long-term salinity shift, herbivory, invasive species, inundation from storm surge, damage from storm-induced wave action, runoff from adjacent property which could alter chemical or nutrient balance of soils, altered hydrologic regime which could change habitat type or stress vegetation, non-storm wave energy)?<br>(2) How is the project, as designed, likely to perform relative to stressors and/or how well is the project expected to return to functionality after exposure to stressors? |

**Environmental:** The National Environmental Policy Act (NEPA) and other environmental laws require federal agencies to consider the environmental impacts in their decision-making, identify unavoidable environmental impacts and make this information available to the public. All evaluated alternatives should be investigated with respect to environmental consequences. The NEPA document records this investigation. However, since a recommended alternative needs to be selected prior to being released for public review and comment, the PDT must attempt to analyze the impacts qualitatively using preliminary information, for those resources which could be impacted to differing degrees by each of the alternatives, focusing only on noteworthy differences between the alternatives. This detailed analysis will be included in the final IFR and EIS.

**Time:** The PDT must analyze the likely implementation schedules for mitigation alternatives. Time metrics account for engineering and design, real estate acquisition, construction, and period to project turn-over. Time metrics include:

- Estimated time to construction contract award (measured from TSP milestone)
- Estimated time to Notice of Construction Complete milestone (measured from TSP milestone)

**Cost Effectiveness**: Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining the objective?

**Other Cost Considerations:** In most cases, a contract's Current Working Estimate

(CWE) is based on the Programmatic Cost Estimate (PCE), which includes the additional request for funds received in the President's Budget. PDTs should not expect additional appropriations. Therefore, alternatives' costs, excluding escalation and contingency, should not exceed the Current Working Estimate. Life cycle costs are a consideration when evaluating alternatives, but should not drive plan selection. Cost calculations for projects should include construction, engineering and design, construction supervision and administration, Lands, Easements, Rights-of-way, Relocations, & Disposal Areas (LERRDs), and Operation Maintenance Repair Replacement & Rehabilitation (OMRR&R). Monitoring and adaptive management costs should be added for mitigation projects. Cost containment is an important consideration and PDTs should not only analyze an alternative's ability to stay within CWE, but also determine the least-cost alternative. Cost metrics include Total Project Cost and Average Annual Cost (and components thereof).

For alternative comparison purposes, minimal OMRR&R activities are assumed for both the WVA modeling and for cost development. These are limited to: monitoring, invasive/nuisance plant eradication, maintenance/replacement of weirs and culverts, and channel maintenance. Once the TSP is identified, assumptions may be changed for the TSP elements to include adaptive management, additional OMRR&R activities, major rehabilitation, etc. in order to sustain ecological success or to address uncertainty. These new assumptions would be reflected in the advanced project design, revised WVA modeling for the TSP, and revised TSP cost estimates,

**Watershed & Ecological Site Considerations:** The PDT has added this selection criterion to address unique factors that apply to environmental mitigation projects that were not addressed in the above listed selection criteria. Guidance from 40 CFR Part 230 discusses consideration of a mitigation site's role in the larger landscape and other ecological conditions. The two items below aim to capture this guidance. These subcriteria would be considered for each alternative:

Watershed Considerations/Significance within the Watershed:

- Consistency with watershed plans (e.g. Coast 2050, LCA, LaCPR, State Master Plan 2017). 40 CFR Part 230 Compensatory Mitigation for Losses of Aquatic Resources includes guidance regarding the siting of mitigation projects. This guidance directs that mitigation should consider existing watershed plans within the project area. Therefore, the selection criteria considers how a given alternative relates to existing watershed plans within the project area. Coast 2050 is a strategic plan for coastal Louisiana, sponsored by the Louisiana State Wetlands Conservation and Restoration Authority and the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) Task Force. It was adopted in 1999 The Coast 2050 report evolved into the Louisiana Coastal Area (LCA) Ecosystem Restoration Plan of 2004. In 2007, the Corps of Engineers, in partnership with the State of Louisiana, developed a preliminary report entitled The Louisiana Coastal Protection and Restoration (LaCPR) Preliminary Technical Report, which identified a range of coastal restoration and flood control measures for South Louisiana. Also in 2017, the state officially adopted Louisiana's Comprehensive Master Plan for a Sustainable Coast, which complements the LaCPR report.

- Contiguous with or within resource managed area (i.e. Federal, state, private mitigation bank or other restoration projects considered under Future Without Project condition)
- Located in parish of impact by habitat-type
- Critical features
  - critical geomorphic structures for ecosystem stability (critical geomorphic structures in the coastal ecosystem are those above sea level that protect lower elevation features and in many instances represent the first line of defense against marine influences and tropical storm events (i.e. restoration or preservation of natural ridges, lake rims, land bridges, gulf shoreline barrier islands, barrier headlands, and Chenier ridges)
  - LaCPR critical landscape features for storm damage risk reduction identified in Figure 7-17, Louisiana Coastal Protection and Restoration Final Technical Report and Comment Addendum, August 2009
- Habitat Linkages (e.g. wildlife corridors)

Ecological Site Considerations not captured in WVA:

- Fragmentation within site boundary (swamp and marsh alternatives only)
- Site habitat connectivity to larger surrounding project area considering future land use trends (swamp and marsh alternatives only)

## 1.3 COMPONENT 3. SITE PROTECTION INSTRUMENT

In an effort to satisfy this component as well as satisfy US Fish and Wildlife concerns, in the draft Fish and Wildlife Coordination Act Report dated 30 October 2019 (Appendix C-4), the Non-Federal Sponsor would commit to fully undertaking the monitoring, operation, and maintenance responsibilities for the mitigation project. Fee interest will be acquired in the land for Corps constructed mitigation projects, thus ensuring that no human activities will be allowed that could result in adverse effects to the constructed BLH habitat.

## 1.4 COMPONENT 4. BASELINE INFORMATION

Bottomland hardwood forests (BLH) in the study area are dominated by water oak, nuttall oak, green ash, red maple, and pignut hickory. Swamps in the Lower Amite River Basin are dominated by bald cypress and water tupelo, which have regenerated since extensive logging of virgin forest more than 70 years ago. The Louisiana swamps generally lack a mature canopy as was present in the forests before logging occurred and have lower productivity where isolated from riverine influences (Shaffer et al., 2003). Economically important natural resources associated with these swamps include fisheries of crawfish, blue catfish, and channel catfish, as well as logging. The following link contains the classification of wetlands habitat from the US Fish and Wildlife National Wetlands Inventory (https://www.fws.gov/wetlands/).

## 1.5 COMPONENT 5. DETERMINATION OF CREDITS

If the project proposes to secure credits from an approved mitigation bank, the Government will include the number and resource type of credits to be secured and how these were determined. In the main report, see Section 5.3.1.1. Wetland Resources.

Approximately 1,332 AAHUs of BLH credits from mitigation banks are needed to offset impact, not including AAHUs that have not yet been calculated for impacts arising from borrow excavation and staging area.

## 1.6 COMPONENT 6. MITIGATION WORK PLAN

The following mitigation measures may be considered in the following order:

1) Purchase of BLH mitigation bank credits

At the time of screening, mitigation banks in Lake Pontchartrain Basin existed that had BLH credits available for purchase. Many of these banks also had in-kind credits that could be released in the future. It is not known which banks would be available when the decision whether to purchase bank credits or not is made: some banks may not have enough credits remaining, some banks may be closed, and additional mitigation banks may be approved. As such, a general mitigation bank for BLH habitat, including in and out of coastal zone options, was assumed for the next step of the mitigation project analysis using information obtained from existing banks in the basin and no specific banks were identified. The Regulatory In lieu fee and Bank Information Tracking System (RIBITS) (https://ribits.usace.army.mil/) has information on all currently approved banks in the basin including their credit availability.

2) Potential BLH Corps Constructed Mitigation Sites

A preliminary investigation for potential BLH mitigation sites within and outside of the Lake Pontchartrain Basin yielded approximately 3,700 acres (1,500 AAHUs). Those mitigation sites within the Lake Pontchartrain Basin would be considered before selecting mitigation sites outside of the basin.

Mitigation for the TSP could include creation and restoration and enhancement of bottomland hardwoods (BLH) habitat as compensatory mitigation for some of the BLH impacts resulting from construction of the Darlington Dam, borrow sites, and staging area. The BLH restoration and enhancement areas (mitigation areas) would be located in agriculture, scrub/shrub, pasture, and other non-forested areas of lower habitat value.

Required earthwork for each mitigation site would mainly consist of removal (excavation; scraping; degrading) of remnant spoil material (sand, sediments, gravel) in various portions of each of the mitigation sites in an effort to establish an appropriate hydroperiod for BLH plant species.

Earthwork would also include grading to ensure appropriate drainage, establishment of dirt access roads around the perimeter of the mitigation areas, establishment of dirt access roads within some of the mitigation areas, and tillage of soil in the mitigation areas. Any existing drainage features (drainage ditches, etc.) within or adjacent to the mitigation areas and within the property boundary would likely be removed to help assure appropriate site hydrology, unless doing so would adversely affect drainage on off-site lands.

Native canopy and midstory plants typical of BLH habitats would be installed in the mitigation areas following completion of the initial earthwork. Note that the planted acreage of a few mitigation areas would be reduced by the impacts of the staging areas, roadways, and borrow sites within the mitigation area.

## 1.7 COMPONENT 7. MAINTENANCE PLAN

Maintain all areas of the project area such that the total average vegetative cover accounted for by invasive and nuisance species constitute less than 5% of the total average plant cover throughout the 50-year project life.

If drainage ditches are required, they would be maintained to provide necessary hydrology for established species.

## 1.8 COMPONENT 8. PERFORMANCE STANDARDS

The Corps would ensure that the following performance standards are met:

**1. General Construction**

A. Complete all necessary initial earthwork and related construction activities in accordance with the mitigation work plan as well as the final project plans and specifications. These requirements classify as initial success criteria.

**2. Native Vegetation[1]**

A. Initial Success Criteria (at end of first growing season following the year planting meets construction requirements) –

1. Achieve a minimum average survival of 50% of planted canopy species (i.e. achieve a minimum average canopy species density of 269 seedlings/ac.).
2. The surviving plants must approximate the species composition and percentages specified in the initial plantings component of the final planting plan[2].
3. These criteria will apply to the initial plantings, as well as any subsequent re-plantings necessary to achieve this initial success requirement.

B. Intermediate Success Criteria (3 growing seasons following attainment of Native Vegetation 2.A.) –

1. Achieve a minimum average density of 269 living individuals that are native canopy species per acre (planted trees and/or naturally recruited native canopy species).
2. Achieve a minimum average density of 135 (50% of 269) living individuals that are hard-mast producing species in the canopy stratum (planted trees and/or naturally recruited native canopy species). The remaining trees in the canopy stratum must be comprised of soft-mast producing native species.
3. This hard mast criteria will thereafter remain in effect for the duration of the overall monitoring period. Modifications to these criteria could be necessary for reasons such as avoidance of tree thinning if thinning is not warranted and the long-term effects of sea level rise on tree survival. Proposed modifications must first be approved by the USACE in coordination with the Interagency Environmental Team (IET).

C. Long-Term Success Criteria (Within 6 growing seasons following attainment of 2.B. and maintained for the duration of the remaining 50-year monitoring period)[3] --

1. Attain a minimum average canopy cover of 80% by planted and/or naturally recruited native canopy species.
2. Achieve a minimum average density of 135 (50% of 269) living individuals that are hard-mast producing species in the canopy stratum (planted trees and/or naturally recruited native canopy species). The remaining trees in the canopy stratum must be comprised of soft-mast producing native species.

Notes:
[1]There are no success criteria for midstory or understory species; however, data will be collected concurrently with scheduled monitoring throughout the 50-year project life.
[2] Greater flexibility for species composition may be allotted after multiple years of not meeting initial success criteria.
[3]The requirement that the above criteria remain in effect for the duration of the overall monitoring period may need to be modified later due to factors such as the effect of sea level rise on vegetative cover. Proposed modifications must first be approved by the USACE in coordination with the IET.
If the project doesn't meet 80% canopy cover success criteria 6 Years Following Completion of 2.C, the IET would meet and discuss path forward. Greater flexibility for species composition may be allotted after multiple years of not meeting initial success criteria.

- **Invasive and Nuisance Vegetation**

A. Initial, Intermediate, and Long-term[1] Success Criteria

1. Maintain all areas of the project area such that the total average vegetative cover accounted for by invasive and nuisance species constitute less than 5% of the total average plant cover throughout the 50-year project life. The list of invasive and nuisance species is found in Appendix C-1, Wetlands and will be tailored to reflect specific site needs.

Note:
[1]Yearly inspections to determine the need for invasive/nuisance control would be conducted until the long term success criteria for vegetation is achieved. After it is achieved, the frequency of inspections to determine the need for invasive/nuisance control would be adjusted based on site conditions.

**5. Thinning of Native Vegetation (Timber Management)**

The USACE, in cooperation with the IET, may determine that thinning of the canopy and/or mid-story strata is warranted to maintain or enhance the ecological value of the site. This determination will be made approximately 15 to 20 years following successful completion of plantings. If it is decided that timber management efforts are necessary, the NFS will develop a Timber Stand Improvement/Timber Management Plan, and associated long-term success criteria, in coordination with the USACE and IET. Following approval of the plan, the NFS will perform the necessary thinning operations and demonstrate these operations have been successfully completed. Timber management activities will only be allowed for the purposes of ecological enhancement and maintenance of the mitigation site.

## 1.9 COMPONENT 9. MONITORING REQUIREMENTS

**Baseline Monitoring Report**

Within 90 days of completion of all final construction activities (e.g. eradication of invasive and nuisance plants, planting of native species, completion of earthwork, grading, surface water management system alterations/construction, etc.) associated with applicable general construction requirements, a “baseline” monitoring report will be prepared. Information provided will typically include the following items:

- A detailed discussion of all mitigation activities completed.

- A description of the various features and habitats within the mitigation site. Various qualitative observations will be made to document existing conditions and will include, but not be limited to, potential problem zones, general condition of native vegetation, and wildlife utilization as observed during monitoring.

- A plan view drawing and shapefiles of the mitigation site showing the approximate boundaries of different mitigation features including planted areas, planted rows, areas involving eradication of invasive and nuisance plant species, surface water management features, access rows, proposed monitoring transects locations, sampling plot locations, photo station locations, and if applicable, piezometer and staff gage locations.

- Initial and final construction surveys for areas having had topographic alterations, including elevations of all constructed surface water drainage features, drainage culverts, and/or water control structures. The initial and final construction surveys should also include cross-sectional surveys of topographic alterations involving the removal of existing linear features such as berms/spoil banks, or the filling of existing linear ditches or canals. The number of cross-sections must be sufficient to represent elevations of these features. The initial and final construction surveys must include areas where existing berms, spoil banks, or dikes have been breached.

- A detailed inventory of all canopy and midstory species planted, including the number of each species planted and the stock size planted. In addition, provide an itemization of the number of each species planted and correlate this itemization to the various areas depicted on the plan view drawing of the mitigation site.

- Photographs documenting conditions in the project area will be taken at the time of monitoring and at permanent photo stations within the mitigation site. At least two photos will be taken at each station with the view of each photo always oriented in the same general direction from one monitoring event to the next. The number of photo stations required and the locations of these stations will vary depending on the mitigation site. The USACE will make this determination in coordination with the IET and will specify the requirements in the project-specific Mitigation Monitoring Plan. At a minimum, there will be 4 photo stations established. For mitigation sites involving habitat enhancement/earthwork only, permanent photo stations will primarily be established in areas slated for planting of canopy and mid-story species, but some may also be located in areas where plantings are not needed.

- Multiple baseline reports may need to be submitted if additional plantings are required by the contractor to meet planting survival acceptance criteria. Each revision will be updated to incorporate information regarding the re-planting.

**Additional Monitoring Reports**

All monitoring reports generated after the Baseline Monitoring Report will be called Initial, Intermediate or Long-Term Success Criteria Monitoring Reports and shall be numbered sequentially based on the year in which the monitoring occurred (i.e. Initial Success Criteria Monitoring Report 2019). All Monitoring Reports shall provide the following information unless otherwise noted:

- All items listed for the Baseline Monitoring Report with the exception of: (a) the topographic/construction surveys, although additional topographic surveys are required for specific monitoring reports (see below); and (b) the inventory and location map for all planted species.

- A brief description of maintenance and/or management and/or mitigation work performed since the previous monitoring report along with a discussion of any other significant occurrences.

- Quantitative plant data collected from (1) permanent monitoring plots measuring approximately 90 feet X 90 feet in size or from circular plots having a radius of approximately 53 feet, or (2) permanent transects sampled using the point-centered quarter method with a minimum of 20 sampling points established along the course of each transect, or; (3) permanent belt transects approximately 50 feet wide and perpendicular to planted rows.  The number of permanent monitoring plots and transects, as well as the length of each transect will vary depending on the mitigation site. The USACE will make this determination prior to the first monitoring event in coordination with the IET and will specify the requirements in the Mitigation Monitoring Plan. Data recorded in each plot or transect will include:

<u>First monitoring report after a planting event</u>

- number of living planted canopy species (excluding recruited) present and the species composition;
- number of living planted midstory species present and the species composition
- average density of living planted canopy species (i.e., the total number of each species present per acre ) and the species composition (transect methods)
- average density of all native species in the midstory stratum, the total number of each species present, and the wetland indicator status of each species;
- average percent cover by native species in the midstory stratum;

- average percent cover accounted for by invasive plant species (all vegetative strata combined); average percent cover accounted for by nuisance plant species (all vegetative strata combined).

Subsequent monitoring reports

- number of living native canopy trees by species;
- average density of all native species in the canopy stratum, and the wetland indicator status of each species;
- average percent cover by native species in the canopy stratum;
- average diameter at breast height (DBH) for trees (measured 10 years after successful completion of plantings) in the midstory and upper strata;
- number of living  native midstory species present and the species composition
- average density of all native species in the midstory stratum, the total number of each species present,  and the wetland indicator status of each species;
- average percent cover by native species in the midstory stratum;
- average percent cover accounted for by invasive plant species (all vegetative strata combined); average percent cover accounted for by nuisance plant species (all vegetative strata combined).

- Quantitative data concerning plants in the understory (ground cover) stratum and concerning invasive and nuisance plant species will be gathered from sampling quadrats.  These sampling quadrats will be established either along the axis of the belt transects discussed above, or at sampling points established along point-centered quarter transects discussed above, depending on which sampling method is used.  Each sampling quadrat will be approximately 2 meters X 2 meters in size.  The total number of sampling quadrats needed along each sampling transect will be determined by the USACE with the IET and will be specified in the Mitigation Monitoring Plan.  Data recorded from the sampling quadrats will include:  average percent cover by native understory species; composition of native understory species and the wetland indicator status of each species; average percent cover by invasive plant species; and average percent cover by nuisance plant species.

- Photographs will be taken to document conditions at each permanent monitoring plot and along each permanent monitoring transect. Two photos at each station will be taken, one facing north and one facing south.

- In addition, various qualitative observations will be made in the mitigation site to help assess the status and success of mitigation and maintenance activities. These observations will include: general estimates of the average percent cover by native plant species in the canopy, midstory, and understory strata; general estimate of the average percent cover by invasive and nuisance plant species;

    - general estimates concerning the growth of planted canopy and mid-story species;
    - general observations concerning the colonization by volunteer native plant species;
    - general observations made during the course of monitoring will also address potential problem zones, general condition of native vegetation, trends in the composition of the plant communities, wildlife utilization as observed during monitoring, and other pertinent factors.

- A summary assessment of all data and observations along with recommendations as to actions necessary to help meet mitigation and management/maintenance goals and mitigation success criteria.

- A brief description of anticipated maintenance/management work to be conducted during the period from the current monitoring report to the next monitoring report.

**Monitoring Reports Involving Timber Management Activities**

In cases where timber management activities (thinning of trees and/or shrubs in the canopy and/or mid-story strata) have been approved by the USACE in coordination with the IET, monitoring will be required in the year immediately preceding and in the year following completion of the timber management activities (i.e. pre-timber management and post-timber management reports). These reports must include data and information that are in addition to the typical monitoring requirements. The NFS's proposed Timber Stand Improvement/Timber Management Plan must include the proposed monitoring data and information that will be included in the pre-timber management and post-timber management monitoring reports. The proposed monitoring plan must be approved by the USACE in coordination with the IET prior to the monitoring events and implementation of the timber management activities.

**Monitoring Reports Following Re-Planting Activities**

Re-planting of certain areas within the mitigation site may be necessary to ensure attainment of applicable native vegetation success criteria. Any monitoring report submitted following completion of a re-planting event must include:

- an inventory of the number of each species planted and the stock size used;
- a depiction of the areas re-planted, cross-referenced to a listing of the species and number of each species planted in each area;
- documented GPS coordinates for the perimeter of the re-planted area. If single rows are replanted, then GPS coordinates should be taken at the end of the transect; and
- all requirements listed under "Additional Monitoring Reports" of the Mitigation Monitoring Guidelines.

## 1.10 COMPONENT 10. LONG-TERM MANAGEMENT PLAN

The non-Federal Sponsor (i.e. LADOTD) shall commit to prevent damage to the mitigation site and be responsible for maintaining the mitigation site(s) in perpetuity.

## 1.11 COMPONENT 11. ADAPTIVE MANAGEMENT PLAN

### 1.11.1 Introduction

This Adaptive Management (AM) Plan is for the Amite River and Tributaries East of Mississippi River feasibility study (ART) included in the draft IFR and EIS and is designed to mitigate for bottomland hardwood impacts from the tentatively selected plan (TSP). The Water Resources Development Act (WRDA) of 2007, Section 2036(a) and U.S Army Corps of Engineers (USACE) implementation guidance for Section 2036(a) (CECW-PC Memorandum dated August 31, 2009: "Implementation Guidance for Section *2036 (a) of the Water Resources Development* Act of 2007 (WRDA 2007) – Mitigation for Fish and Wildlife and Wetland Losses") require adaptive management be included in all mitigation plans for fish and wildlife habitat and wetland losses. Full descriptions of the mitigation projects will be included in the final IFR and EIS, due to the current lack of information.

It should be noted that even though the proposed mitigation actions under the draft IFR and EIS include the potential purchase of credits from a mitigation bank, this section only details the Adaptive Management planning for constructible mitigation features for the feasibility study. In the event that mitigation bank credits are purchased the mitigation management and maintenance activities for the mitigation bank credits will be set forth in the Mitigation Banking Instrument (MBI) for each particular bank. The bank sponsor (bank permittee) will be responsible for these activities rather than the USACE and/or the local Sponsor. USACE Regulatory staff reviews mitigation bank monitoring reports and conducts periodic inspections of mitigation banks to ensure compliance with mitigation success criteria stated in the MBI.

### 1.11.2 Adaptive Management Planning

Adaptive management planning would be conducted. Adaptive management planning elements would include: 1) development of a Conceptual Ecological Model (CEM), 2) identification of key project uncertainties and associated risks, 3) evaluation of the mitigation projects as a candidate for adaptive management and 4) the identification of potential adaptive management actions (contingency plan) to better ensure the mitigation project meets identified success criteria. The adaptive management plan is a living document and will be refined as necessary as new mitigation project information becomes available.

### 1.11.3 Conceptual Ecological Model (CEM)

A conceptual CEM (Table C5-2) identify the major stressors and drivers affecting the proposed mitigation projects under ART. For BLH, these can include sea level rise, vegetative invasive species, herbivory, etc. The CEM does not attempt to explain all possible relationships of potential factors influencing the mitigation sites; rather, the CEM presents only those relationships and factors deemed most relevant to obtaining the required acres/average annual habitat units (AAHUs). Furthermore, this CEM represents the current understanding of these factors and will be updated and modified, as necessary, as new information becomes available.

**Table C5-2. Conceptual Ecological Model**

| Alternatives/Issues/Drivers | BLH Mitigation Sites | Mitigation Banks |
|---|---|---|
| Freshwater Input | + | * |
| Sea Level Change | - | * |
| Runoff | - | * |
| Vegetative Invasive Species | - | * |
| Herbivory | - | * |

Key to Cell Codes: - = Negative Impact/Decrease

+ = Positive Impact/Increase

+/- = Duration Dependent

*Issues and drivers assumed to be addressed in the Mitigation Bank Instrument

### 1.10.4 Sources of Uncertainty and Associated Risks

A fundamental tenet underlying adaptive management is decision making and achieving desired project outcomes in the face of uncertainties. There are many uncertainties associated with habitat restoration projects. The project delivery team identified the following uncertainties during the planning process.

A. Climate change, such as relative sea level rise, drought conditions, and variability of tropical storm frequency, intensity, and timing

B. Uncertainty Relative to Achieving Ecological Success:

- Water, sediment, and nutrient requirements for BLH
- Magnitude and duration of wet/dry cycles for BLH
- Nutrients required for desired productivity for BLH
- Growth curves based on hydroperiod and nutrient application for BLH
- Tree litter production based on nutrient and water levels for BLH
- Tree propagation in relation to management/regulation of hydroperiod for BLH

C. Loss rate of vegetative plantings due to herbivory

D. Long-Term Sustainability of Project Benefits

### 1.10.5 Adaptive Management Evaluation

As part of ART, the mitigation sites will be further evaluated and planned using the screening criteria to develop a project with minimal risk and uncertainty. The items listed below were incorporated into the mitigation project implementation plan and Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) plans to minimize project risks.

- Specified success criteria (i.e., mitigation targets)
- Detailed planting guidelines for BLH
- Invasive species control
- Supplementary plantings as necessary (contingency)
- Corrective actions to meet topographic and hydrologic success as required (contingency)

Subsequently, as part of the adaptive management planning effort the mitigation project features will be re-evaluated against the CEM and sources of uncertainty and risk will be identified to determine if there is any need for additional actions and costs under the adaptive management plan to ensure that the project meets the required success criteria. Based on the uncertainties and risks associated with the project implementation, contingency actions may be identified for implemention if needed to ensure the required AAHUs are met.

Potential Action #1. Additional vegetative plantings as needed to meet identified success criteria.

Uncertainties addressed (from Section 2.2): A,B,C,D, E

Potential Action #2. Additional earthwork at mitigation sites (by adding sediment or degrading) to obtain elevations necessary for BLH vegetative establishment and maintenance.

Uncertainties addressed: A,B,C,E

Potential Action #3. Invasive species control to ensure survival of native species and meet required success criteria.

Uncertainties addressed: E

Actions 1 and 3 are not recommended as separate adaptive management actions since they are already built into the mitigation plan and success criteria identified in Section 1.7. In the event that monitoring reveals the project does not meet the identified vegetation, or hydrologic success criteria, additional plantings or construction activities are already accounted for and would be conducted under the mitigation project. Specific measures to implement Action 2, if determined necessary to achieve project benefits, would be coordinated with the NFS and other agencies to determine the appropriate course of action. If it is determined that the project benefits are significantly compromised because of improper elevation, additional fill material may need to be pumped into or removed from the project area. Due to the impact the addition of fill to the mitigation projects once they have been planted would incur, lifts to the projects are not currently considered as a viable remedial action. Instead, increasing the size of the existing mitigation project or mitigating the outstanding balance of the mitigation requirement elsewhere or through the purchase of mitigation bank would be options that could be considered through additional coordination with the NFS and the IET. However, such options would have to undergo further analysis in a supplemental NEPA document.

Action 2 is potentially a very costly action. Before implementing such an action, the Corps would coordinate with the NFS and other agencies to determine if other actions, such as purchasing of credits in a mitigation bank or building additional mitigation elsewhere, would be more cost-effective options to fulfill any shortfalls in the overall project success. The USACE would be responsible for performing any necessary corrective actions subject to availability of funding, but the overall cost would be shared with the NFS according to the project cost-share agreement.

The USACE would be responsible for the proposed mitigation construction and would monitor the project until the initial success criteria are met. Initial construction and monitoring would be funded in accordance with all applicable cost-share agreements with the NFS. The USACE would monitor (on a cost-shared basis) the completed mitigation to determine whether additional construction, invasive/nuisance plant species control, and/or plantings are necessary to achieve initial mitigation success criteria. Once the USACE determines that the mitigation has met the initial success criteria, monitoring would be performed by the NFS as part of its OMRR&R obligations. If after meeting initial success criteria, the mitigation fails to meet its intermediate and/or long-term ecological success criteria, the USACE would consult with other agencies and the NFS to determine the appropriate management or remedial actions required to achieve ecological success. The USACE would retain the final decision on whether or not the project's required mitigation benefits are being achieved and whether or not remedial actions are required. If structural changes are deemed necessary to achieve ecological success, the USACE would implement appropriate adaptive management measures in accordance with the contingency plan and subject to cost-sharing requirements, availability of funding, and current budgetary and other guidance.

## 1.12 COMPONENT 12. FINANCIAL ASSURANCES

Financial assurances are required to ensure that the compensatory mitigation project would be successful. In this case, the NFS obligation would be reflected in the Project Partnership Agreement, in which the NFS must operate and maintain the mitigation project at no cost to the Government.

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Amite River and Tributaries Study East of the Mississippi River, Louisiana


## Appendix D: Real Estate Plan

**November 2019**

# CONTENTS

# LIST OF TABLES



# LIST OF FIGURES

# Section 1
# Purpose of Real Estate Plan

This Real Estate Plan (REP) sets forth the real estate requirements and costs for the implementation and construction of the Tentatively Selected Plan (TSP). The lands, easements and rights-of-way required for the project are outlined in this REP in accordance with the requirements of Engineering Regulation (ER) 405-1-12. The information contained herein is tentative and preliminary in nature and intended for planning purposes only.

## 1.1 PROJECT PURPOSE

The Amite River and Tributaries (ART) Feasibility Study is a response to the study authority to investigate and determine the extent of Federal interest in plans that reduce flood risk along the Amite River Basin. The effect of flooding from the Amite River and its tributaries was studied; localized flooding in adjacent communities was not studied. The study product is a decision document in the form of an integrated Feasibility Report and National Environmental Policy Act of 1969 (NEPA) Environmental Impact Statement (EIS).

As recently as August 2016, the President issued disaster declarations for parishes in the Amite River Basin due to impacts from “The Great Flood of 2016.” The study area experienced historic flooding to thousands of homes and businesses and impacts to the Nation's critical infrastructure because both the I-10 and I-12 transportation system were shut down for days. The project purpose is to reduce the risks to public, commercial, and residential property, real estate, infrastructure, and human life; increase the reliability of the Nation’s transportation corridor (I-10-I-12); and enhance public education and awareness of flood risks.

## 1.2 PROJECT LOCATION

The structural feature of the TSP (the Darlington Dam) is located on either side of the Amite River in East Feliciana and St. Helena Parishes. The dam would be located approximately 22 miles North of Walker, Louisiana and 30 miles Northeast of Baton Rouge, Louisiana. The constructed dam has a footprint of approximately 205 acres located north of the dam between St Helena and East Feliciana Parishes. The outlet would consist of three 10x10 ft concrete box culverts with sluice gates that would be closed to prevent flow and allow for water to pool behind the dam prior to release. An emergency spillway would be placed at the flood control pool max elevation. An easement over approximately 1,000 acres will be acquired for borrow material. The Dry Darlington Dam scale will be optimized during the feasibility study design. Figure D:1-1 shows the location of Darlington Dam.

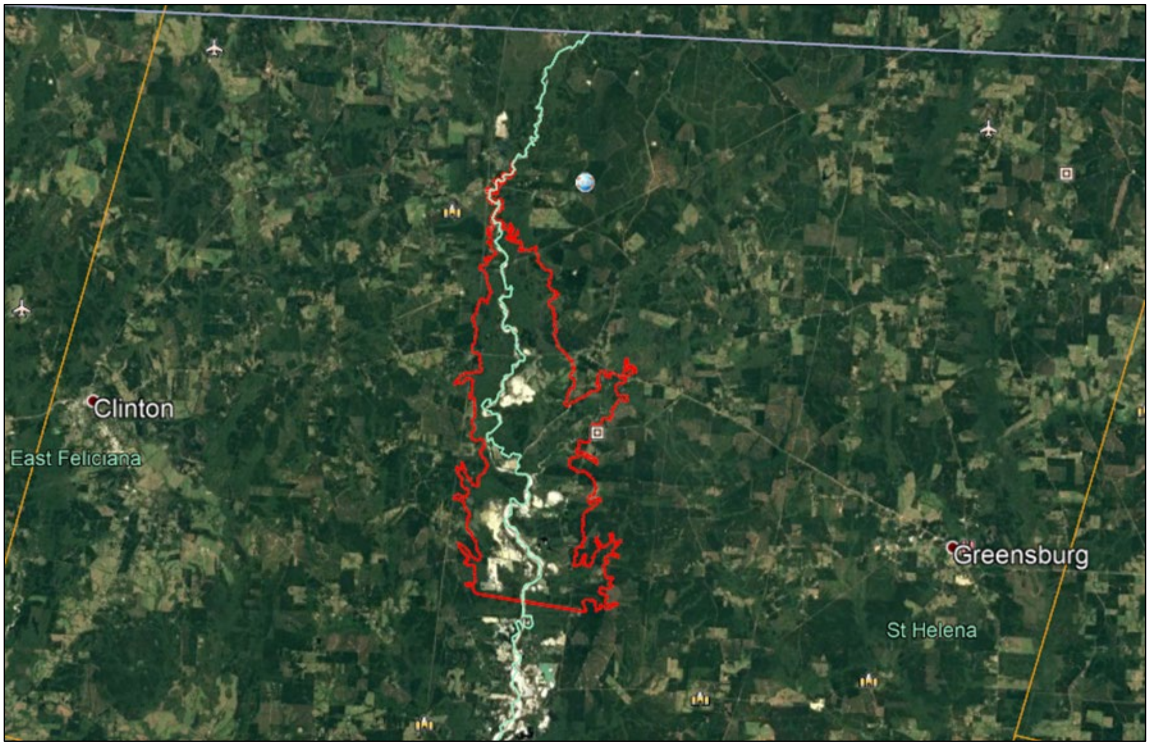

*Figure D:1-1. Location of the Darlington Dam*

The non-structural features of the TSP are located south of the proposed Darlington Dam. It encompasses residential and nonresidential structures in East Baton Rouge, East Feliciana, St. Helena, and Livingston Parishes. The Cities of Baton Rouge, Baker, Central, Denham Springs, Inniswold, and Shenandoah are all included in this area. The location and approximate location of the non-structural measures is shown on Figures D:1-2 and D:1-3.

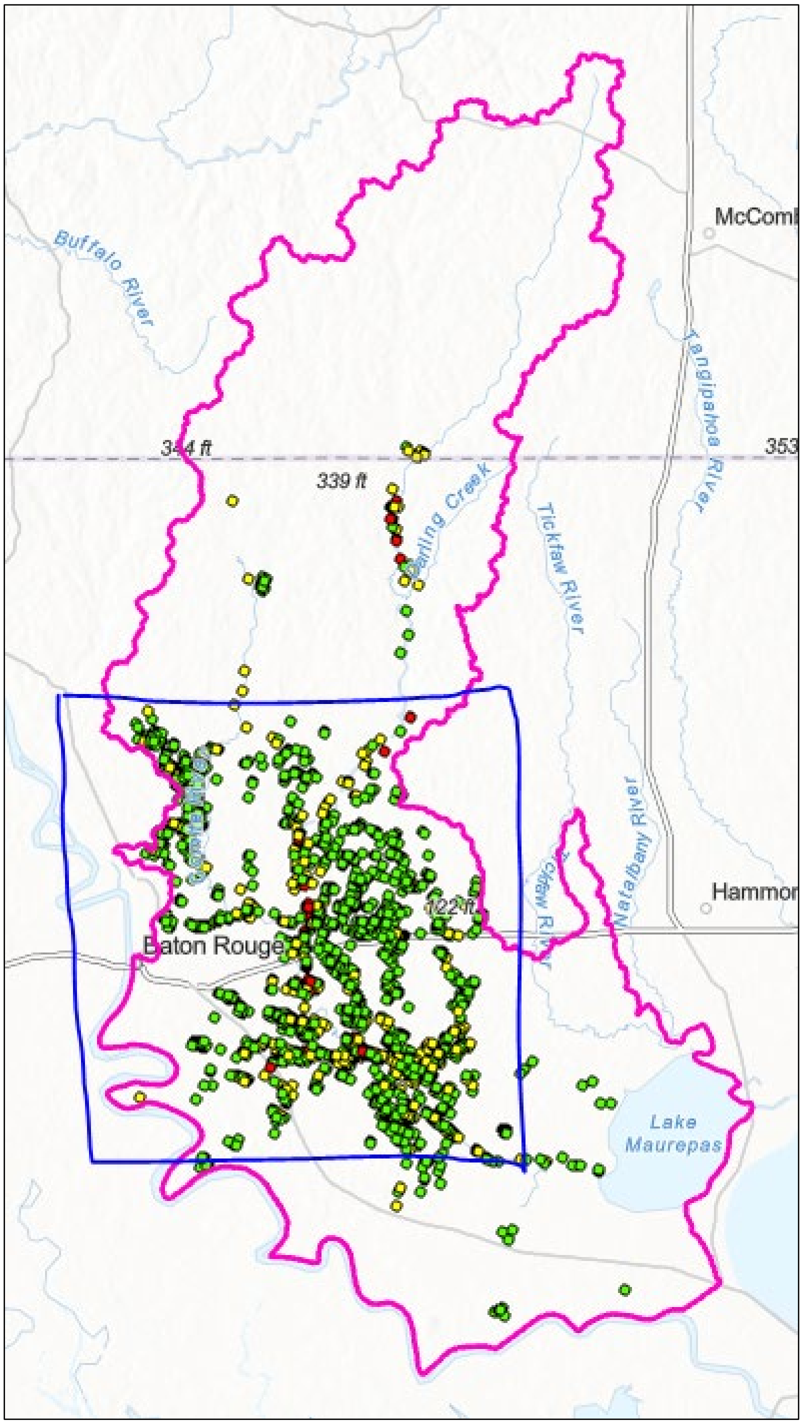


*Figure D:1-2. Location of Non-Structural Measures*

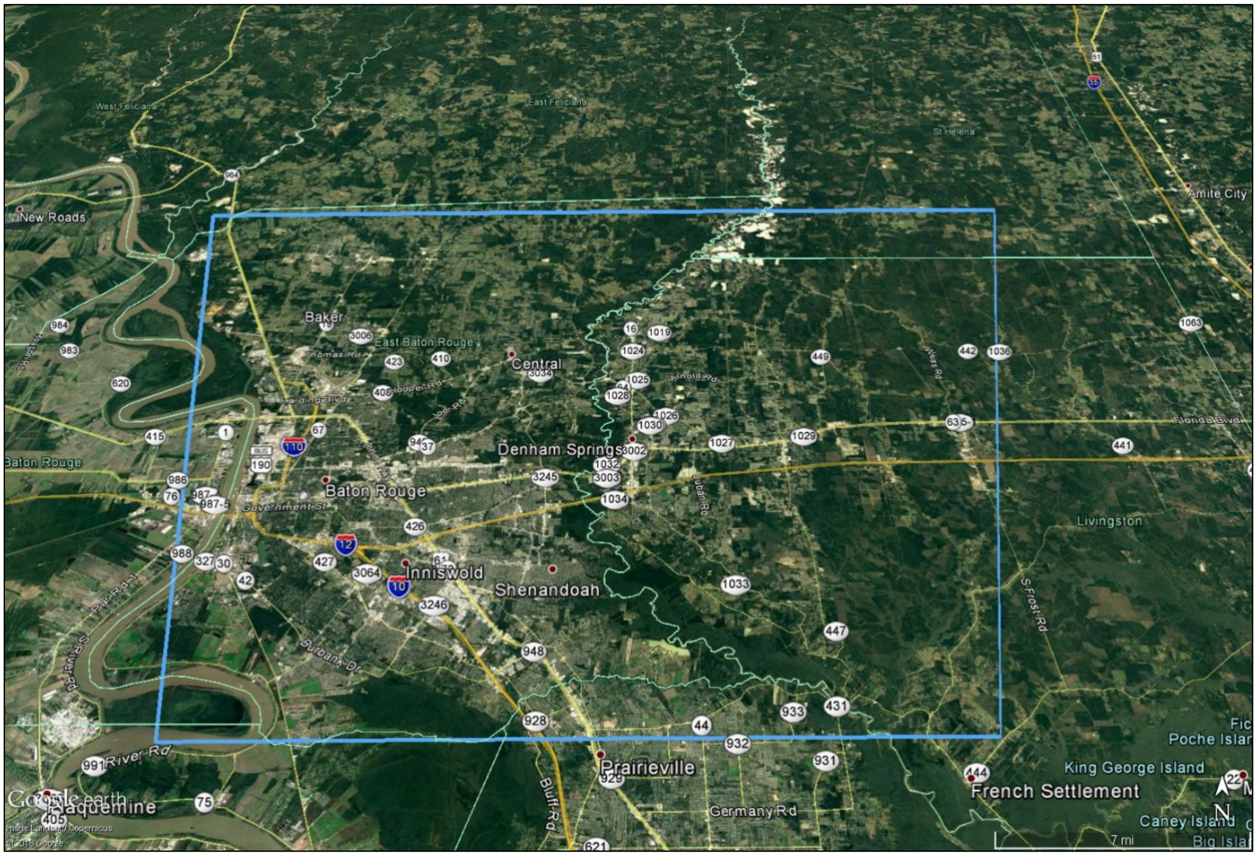


Figure D:1-3. Approximate Location of Non-Structural Measures

## 1.3 PROJECT AUTHORITY

The proposed action is authorized as part of the Bipartisan Budget Act of 2018, H. R. 1892—13, Title IV, Corps of Engineers—Civil, Department of the Army, Investigations, where funds are being made available for the expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection studies which are currently authorized or which are authorized after the date of enactment of this the act, to reduce risk from future floods and hurricanes.

This study area is being included based on the August 2016 flooding over southeast and south-central Louisiana, and is continuing investigation under the authorization provided by the Resolution of the Committee on Public Works of the United States Senate, adopted on April 14, 1967:

> *RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the chief of Engineers on Amite River and Tributaries, Louisiana, published as House Document Numbered 419, Eighty-fourth Congress. And other pertinent reports, with a view to determining whether the existing project*

*should be modified in any way at this time with particular reference to additional improvements for flood control and related purposes on Amite River, Bayou Manchac, and Comite River and their tributaries*. (US Senate Committee on Public Works, 1967).

# Section 2

# Description of the Recommended Plan and Lands, Easements, Rights-of-Way, Relocations, and Disposal (LERRD) Sites

## 2.1 STRUCTURAL

The real estate costs presented herein for the structural portion of the TSP are based on the estimated acreages and estates shown in the table below.

*Table D:2-1 Darling Dry Dam Reservoir with Flowage Area*

| | Unit | |
|---|---|---|
| **Darlington Dam and Reservoir Footprint** | | |
| **Fee, Excluding Oil and Gas** | 15,860.00 | AC |
| **Flowage Easement** | 10,309.00 | AC |
| **Land Required for Cemetery Relocation** | | |
| **Fee, Excluding Oil and Gas** | 4.00 | AC |
| **Borrow Area** | | |
| **Fee, Excluding Oil and Gas** | 1,000.00 | AC |
| **Improvements** | 365.00 | EA |

The Darlington Dam footprint is estimated to impact approximately 700 landowners. Using preliminary information, there appear to be approximately 365 structures within the footprint that would need to be relocated. Relocation assistance would need to be provided for these relocations and an estimated cost has been included in this estimate. Additionally, there are administrative costs associated with relocating a cemetery that is within the footprint. Mitigation would be required for unavoidable impacts.

It has not yet been determined if the purchase of credits from an approved mitigation bank or if US Army Corps of Engineers (USACE) constructed mitigation sites would be necessary. If Corps constructed mitigation sites are necessary, an additional 15,165 acres would need to be purchased in Fee, Excluding Oil and Gas.

For planning purposes, it is assumed that mitigation will be addressed via purchase of mitigation bank credits. The mitigation bank credit costs are included in the Environmental cost estimate for the TSP. To avoid double counting, the above table does not include acquisition costs for any Corps constructed mitigation sites.

## 2.2 NON-STRUCTURAL

The flood risk that remains in the floodplain after the proposed Darlington Dry Dam is implemented is known as the residual flood risk. Nonstructural measures can be used to reduce the residual risk associated with the TSP. The residential and nonresidential structures, damaged under the with project conditions in year 2026 that incurred flood damages by the stage associated with the 0.04 AEP event, were considered eligible for acquisition, elevation, and floodproofing based upon the below criteria.

- Elevating residential structures up to 13 feet and floodproofing non-residential structures up to 3 feet located in the 0.04 AEP floodplain and outside the FEMA floodway. Residential structures will be elevated to the 0.01 AEP base flood elevation (BFE) predicted to occur in the year 2076.
- If a structure would require elevating greater than 13 feet to meet the future year 0.01 AEP BFE, the structure may instead be acquired and removed from the floodplain. The 13’ height is based on guidance provided in the FEMA publication P-550.
- Following detailed design, it may become necessary to acquire structures for permanent evacuation of the FEMA regulated floodway. Such determination would be based on risk and performance.

During further refinement, should the Life Safety Risk Analysis indicate the need for acquisitions for permanent evacuation of the FEMA regulatory floodway or any other areas of critical concern, then eminent domain would be retained as a method of accomplishing acquisitions by the NFS, consistent with USACE Planning Bulletins 2016-01 and 2019-03.

A preliminary analysis found a total of 3,252 residential structures and an additional 314 non-residential structures in the 0.04 AEP floodplain. The nonstructural measures will be refined by assessing the Darlington Dam as the new base condition for the hydrology which will include assessment of residual flood risk.

### 2.3 ACCESS

Access to the project area would be via public roads.

### 2.4 BORROW

Locations for a borrow source are being determined and will be included in the final REP. Costs for acquiring the estimated 1,000 acres of land required for borrow are captured in the Real Estate Baseline cost estimate. An assumption was made that the borrow source will be excavated from vacant agricultural land that will be acquired in fee, excluding oil & gas.

## Section 3

# Non-Federal Sponsor Owned LERRD

The non-Federal sponsor (NFS) is the Louisiana Department of Transportation and Development (LADOTD). It appears that Highway 448, Matthews Road and Lee Lane run through the footprint of the Darlington Dam project. Per the Engineering Appendix, Appendix A, these roads and the highway will require relocation.  It will be confirmed whether LADOTD has sufficient rights in these roads and the highway for project implementation prior to submission of the final REP.  In addition, a portion of the Darlington Dam would be constructed over the Amite River, a State-owned water bottom.  However, the Amite River is a navigable waterway.  In accordance with Engineering Regulation 405-1-12, Paragraph 12-7.c., it is the policy of USACE to utilize the Navigation Servitude in all situations where available, whether or not the project is cost shared or full Federal. It is assumed that the NFS sponsor does not own any other LERRD in the project footprint.

# Section 4
# Estates

## 4.1 FEE, EXCLUDING OIL AND GAS AND FLOWAGE EASEMENT

### 4.1.1 Fee Excluding Oil and Gas (With Restriction on Use of the Surface)

*The fee simple title to the land, subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; excepting and excluding all oil and gas, in and under said land and all appurtenant rights for the exploration, development, production and removal of said oil and gas, but without the right to enter upon or over the surface of said land for the for the purpose of exploration, development, production and removal therefrom of said oil and gas.*

### 4.1.2 Flowage Easement (Permanent Flooding)

*The perpetual right, power, privilege and easement permanently to overflow, flood and submerge (the land described in Schedule A) Tracts Nos. _____, _____ and _____), in connection with the operation and maintenance of the project as authorized by the Act of Congress approved _______________, and the continuing right to clear and remove and brush, debris and natural obstructions which, in the opinion of the representative of the United States in charge of the project, may be detrimental to the project, together with all right, title and interest in and to the timber, structures and improvements situate on the land (excepting ____________________, (here identify those structures not designed for human habitation which the District Engineer determines may remain on the land)); provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the United States in charge of the project, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and/or placement of. landfill; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.*

## Section 5

# Existing Federal Projects within LERRD Required for the Project

Federal projects within the study area include:

- Bayou Manchac-Clearing and snagging on Bayou from mouth to below Ward Creek, mile 7.81
- Comite River-Channel enlargement and realignment on Comite from its mouth to Cypress Bayou at mile 10
- Blind River-Intermittent Clearing/snagging on Blind River below Lake Maurepas
- Amite River-Enlargement/realignment between Bayou Manchac (35.75) to control weir at (25.3); intermittent clearing/snagging from mouth Comite (mile 54) to Bayou Manchac (35.75)
- Amite Diversion Channel-Construct weir and diversion 19 miles long from mile 25.3 on the Amite to mile 4.8 on the Blind River. Weir org. design 1,500' at sea level divided into 1,000 & 500' sections and then modified to include 5x20' boat way.

Two authorized USACE construction projects, Comite River Diversion and the East Baton Rouge Flood Control, are located in or adjacent to the study area and will impact the hydrology of the Amite River Basin when construction is completed. The impacts of these projects will be considered during the feasibility study and the Preconstruction Engineering & Design phase of Amite River and Tributaries structural and non-structural components.

However, there are no Federal projects within the LERRD acquisition area of the project.

# Section 6

# Federally-Owned Lands within LERRD Required for the Project

There are no federally owned lands within the LERRD required for the project.

# Section 7
# Federal Navigation Servitude

The navigation servitude is the dominant right of the Government, under the Commerce Clause of the U.S. Constitution, to use, control, and regulate the navigable waters of the United States and submerged lands thereunder. A portion of the Darlington Dam will be constructed within the ordinary high water mark of the Amite River; therefore, the navigation servitude will be invoked in this area.

# Section 8
# Project Maps

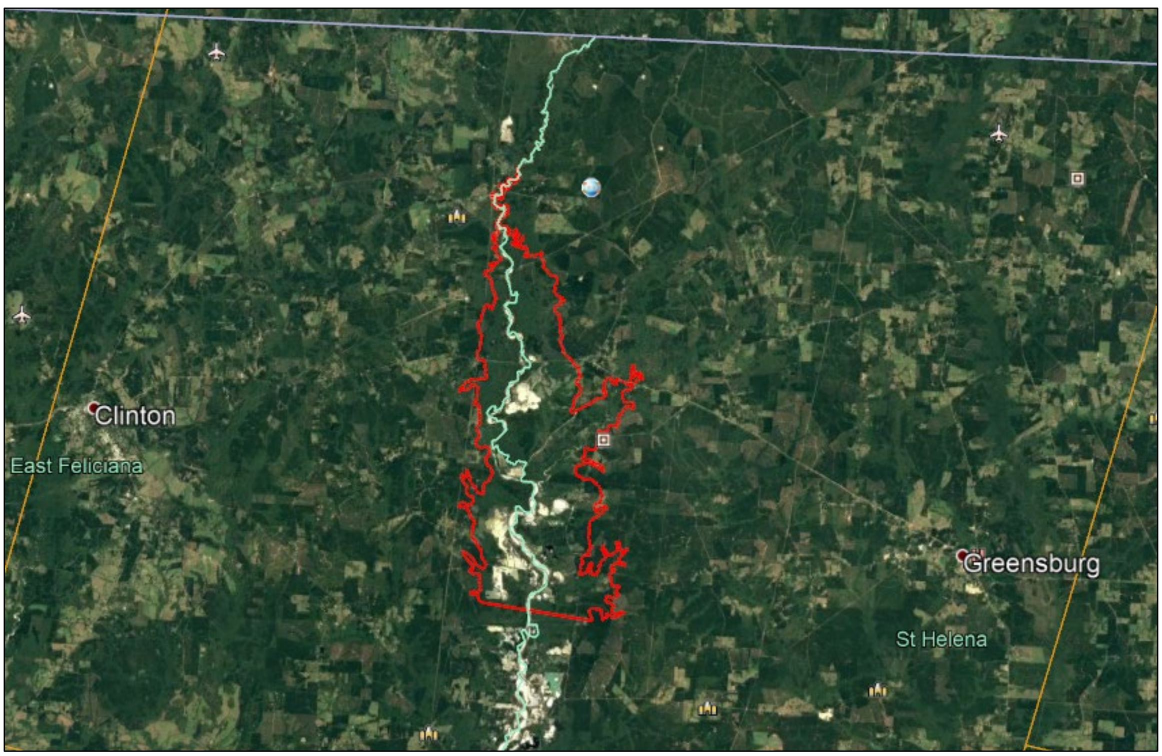


*Figure D: 8-1. Darlington Dam Area (Structural Component of the TSP)*

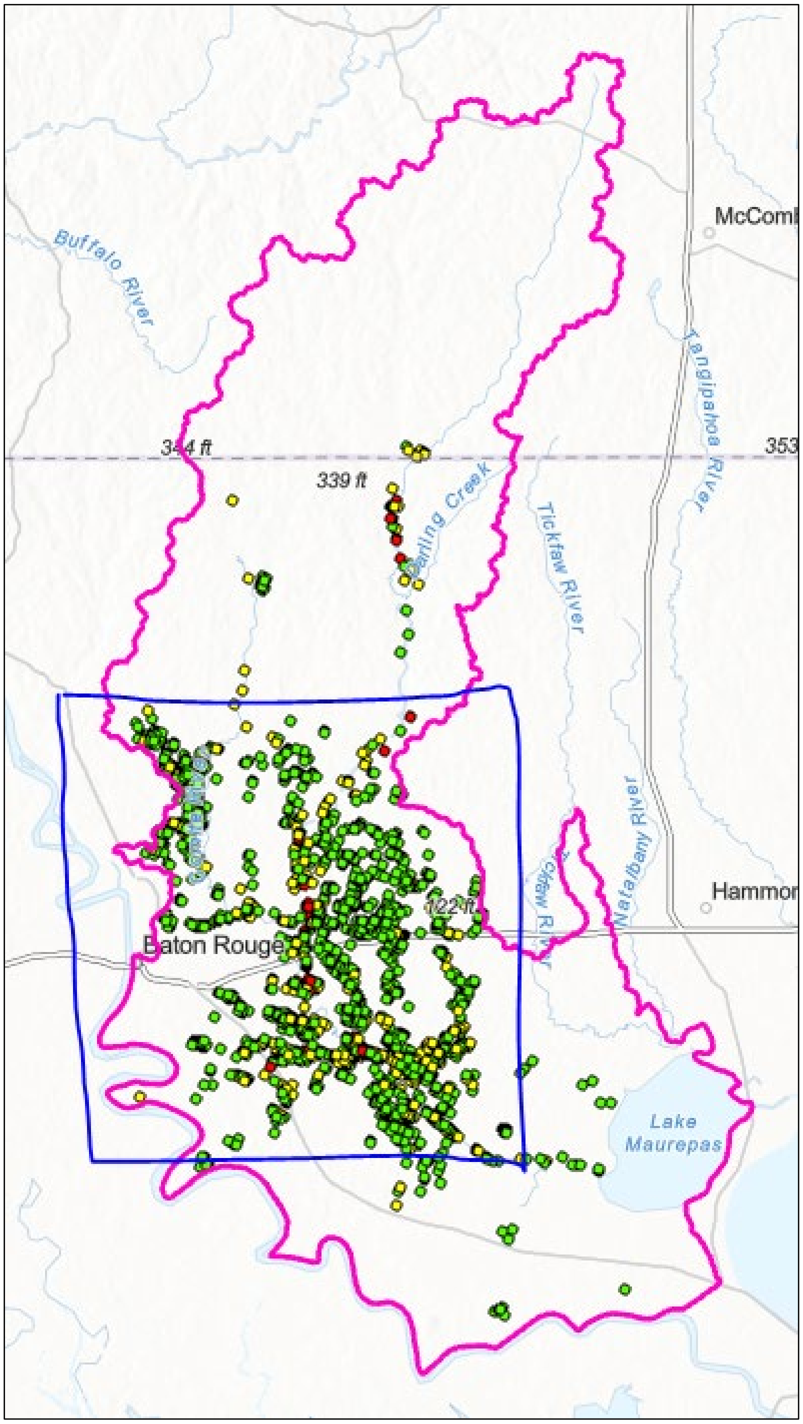


*Figure D:8-2. Nonstructural Area*

## Section 9

# Induced Flooding

It is not anticipated that there will be induced flooding, as a result of the project, outside of the project footprint. Fee, excluding oil and gas, or flowage easements would be acquired over areas within the flood pool and maximal probable flood associated with the Darlington Dam. However, further hydraulic modeling will be run during feasibility study design to determine if any induced flooding will occur outside of the project footprint.

# Section 10
# Baseline Cost Estimate

## 10.1 STRUCTURAL

Total real estate costs, excluding mitigation, for the Structural portion of the TSP are $164,021,000. This includes the cost of acquiring Fee, Excluding Oil and Gas and Perpetual Flowage Easements over the proposed Darlington Dam site and areas encompassing the flood pool and probable maximal flood. These costs include land, improvements, relocation assistance for displaced persons, acquisition costs, cemetery relocation administrative costs, and contingencies. If it is necessary to acquire lands for Government constructed mitigation sites, total real estate costs for the structural portion of the TSP are estimated to be $223,167,000. Mitigation costs have already been captured under the Environmental Costs in the event that mitigation bank credits are purchased. So as not to double count mitigation costs, these mitigation bank costs are accounted for separately.

## 10.2 NON-STRUCTURAL

Total Real Estate Costs for the Non-Structural portion of the TSP are $74,567,000. This cost includes relocation assistance for tenants, administrative costs (Flood Proofing Agreement, Title verification, etc), and contingencies for elevating 3,252 residential structures and flood proofing 314 non-residential structures.

Costs for the non-structural measures listed below, which may include mandatory acquisitions and relocation assistance to displaced persons arising from such acquisitions, have not been accounted for in any Real Estate Costs. It is unknown at this time where or how many structures would be acquired:

- If a structure would require elevating greater than 13 feet to meet the future year 0.01 AEP BFE, the structure may instead be acquired and removed from the floodplain. The 13' height is based on guidance provided in the FEMA publication P-550.
- Following detailed design, it may become necessary to acquire structures for permanent evacuation of the FEMA regulated floodway. Such determination would be based on risk and performance.

During further refinement, should the Life Safety Risk Analysis indicate the need for acquisitions for permanent evacuation of the FEMA regulatory floodway or any other areas of critical concern, then eminent domain would be retained as a method of accomplishing acquisitions by the NFS, consistent with USACE Planning Bulletins 2016-01 and 2019-03.

# Section 11

# P.L. 91-646 Relocation Assistance Benefits

## 11.1 STRUCTURAL

Relocation assistance benefits are anticipated for the structural features of the project. With the fee acquisition, residential and nonresidential structures would need to be acquired and landowners would be displaced as a result of the structural project features of the Darlington Dam footprint. Based on preliminary information and aerial photography, it is estimated that 365 structures are located within the footprint. P.L. 91-646 would be applied accordingly.

## 11.2 NON-STRUCTURAL

P.L. 91-646 Relocation Assistance Benefits would apply in two different scenarios depending on if the structure is being elevated/flood proofed based on voluntary participation or if the structure is classified as a mandatory acquisition.  Because relocation assistance benefits differ under the two scenarios, this section is broken out by “Voluntary Structure Elevating/Flood Proofing” and “Mandatory Acquisition”.

**Voluntary Structure Elevating/Flood Proofing:**

### ELEVATING RESIDENTIAL STRUCTURES

If a structure is located within the 0.04 AEP floodplain but outside of the FEMA Floodway, participation is voluntary.  If a structure would require elevating greater than 13 feet to meet the future year 0.01 AEP BFE, the structure may instead be acquired and thus removed from the floodplain.  Such an acquisition would be considered voluntary.

Because participation would be voluntary, the owner-occupants are not eligible for relocation assistance benefits, in accordance with the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs (URA), as promulgated by 49 CFR Part 24, paragraphs 24.2(a)(9)(ii)(D), (E), (H), 24.101(a)(2), and applicable sections in Appendix A - Engineering. However, if the owner of a leased residential property participates in the structure elevation, the tenant is considered displaced and is eligible for relocation assistance.

Excerpt of the applicable portions of 49 CFR Part 24 as they relate to owner-occupants:

49 CFR Part 24:

(1) Subpart A, paragraph 24.2(a)(9)(ii)(E), Persons Not Displaced definition, states that an owner-occupant who moves as a result of an acquisition of real property that will not be acquired if an agreement cannot be reached, or as a result of rehabilitation of the real property, is not a displaced person. However, the displacement of a tenant as a direct result of any acquisition, rehabilitation or demolition for a Federal or Federally-assisted project is subject to the URA as a displaced person; and (H) states that an owner-occupant who conveys his or her property...after being informed in writing that if a mutually satisfactory agreement on terms of the conveyance cannot be reached, the Agency will not acquire the property. In such cases, however, any resulting displacement of a tenant is subject to the URA as a displaced person; and

(2) Subpart B, paragraphs 24.101(a)(2), (b)(1)(iii), & (b)(2)(i), Applicability of Acquisition Requirements, states that if the agency will not acquire a property because negotiations fail to result in an agreement, the owner of such property is not a displaced person and as such, is not entitled to relocation assistance benefits. However, tenants on such properties may be eligible for relocation assistance benefits.

(Note: the above paragraph is intended to stress that if an agency will not use condemnation as an acquisition tool, then an owner-occupant is not considered a displaced person; conversely, even if an agency does not utilize condemnation as an acquisition tool, tenants may be considered displaced persons. It is understood that if an owner does not participate in the project, then a tenant would not be displaced and would not qualify for relocation assistance.)

Property owner/occupants of eligible residential structures who willingly participate in the residential elevation project are not considered displaced persons (in accordance with 49 CFR Part 24), and therefore are not entitled to receive relocations assistance benefits. However, displaced tenants of eligible residential structures to be elevated, are eligible for temporary relocations assistance benefits. Eligible tenants that temporarily relocate would be reimbursed for the cost of temporary alternate housing, meals and incidentals (such as laundry services), and the fees for disconnection and connection of utilities at the temporary residence. Alternate housing could be hotels or apartments, depending upon availability in the community. All temporary housing costs would need to be approved in advance by the NFS after first obtaining the prior written approval of USACE. Hotel costs would be reimbursed based on the General Services Administration per diem rates for Louisiana. Apartment costs would be based on market rents. All conditions of temporary relocation must be reasonable. Temporary relocation should not extend beyond one year before the person is returned to his or her previous unit or location. Any residential tenant who has been temporarily relocated for more than 1 year must be offered permanent relocation assistance, which may not be reduced by the amount of any temporary relocation assistance previously provided. At a minimum, tenants shall be provided the following: reimbursement for all reasonable out-of-pocket expenses incurred in connection with the temporary relocation, including the cost of moving to and from the temporarily occupied housing, and any increase in monthly rent or utility costs at such housing. Tenants are entitled to receive appropriate advisory services, including reasonable advance written notice of:

- Date and approximate duration of the temporary relocation;
- Address of the suitable decent, safe, and sanitary dwelling to be made available for the temporary period
- Terms and conditions under which the tenant may lease and occupy a suitable decent, safe and sanitary dwelling in the building/complex upon completion of the project; and
- Provisions of reimbursement for all reasonable out of pocket expenses incurred in connection with the temporary relocation as noted above.
- In addition to relocation advisory services, displaced tenants may be eligible for other relocation assistance including relocation payments for moving expenses and replacement housing payments for the increased costs of renting or purchasing a comparable replacement dwelling.

All temporary housing costs must be approved in advance by the NFS. In order for the NFS to receive credit towards their cost-share obligations, USACE must provide prior written approval for those expenditures.

**DRY FLOOD-PROOFING OF NON-RESIDENTIAL STRUCTURES**

It is assumed that for these measures, there will be no requirements for temporary relocation. In the event that relocations are required, in accordance with 49 CFR Part 24 (Subpart A, Section 24.2(a)(9)(ii)(D), property owner/occupants of non-residential structures who willingly participate in the project are not considered displaced, and therefore are not entitled to receive relocations assistance benefits. Additionally, businesses will not receive benefits for temporary loss of operation during construction. Business owners who are tenants of the structure, and who must relocate temporarily during construction, could receive relocation assistance advisory services and moving expenses, in accordance with 49 CFR Part 24.

**Mandatory Acquisition of Residential and Non-Residential Structures:**

Following detailed design, it may become necessary to acquire structures for permanent evacuation of the FEMA regulated floodway. Such determination would be based on risk and performance. Relocation Assistance would apply to owner-occupants as well as tenants because participation would no longer be voluntary. Owner occupants and tenants of the residential/non-residential structure would be eligible to receive relocation benefits including advisory services and moving expenses, in accordance with 49 CFR Part 24.

During further refinement, should the Life Safety Risk Analysis indicate the need for acquisitions for permanent evacuation of the FEMA regulatory floodway or any other areas of critical concern, then eminent domain would be retained as a method of accomplishing acquisitions by the NFS, consistent with USACE Planning Bulletins 2016-01 and 2019-03.

Costs for any mandatory acquisition within the non-structural measures for the TSP and any relocation costs associated with the acquisitions have not been accounted for in this REP due to insufficient information on location and number of structures.

## Section 12

# Mineral Activity/Crops

The Louisiana Department of Natural Resources provides a Strategic Online Natural Resources Information System (SONRIS), which contains up-to-date information on oil & gas activity in the state of Louisiana. Review of this information indicated that there are oil and gas wells within the project area. As more information is developed, during more detailed design, research will be conducted to verify the number and disposition of wells in the area and whether that mineral activity would be impacted by the project. The proposed fee estate as written will prohibit the use of the surface for oil & gas exploration or production. Lands within the footprint to be acquired do not appear to be used for timber or crop production. If the project were to impact such lands, the owner of the timber or crops will be allowed to harvest prior to acquisition.

## Section 13

# Non-Federal Sponsor Capability Assessment

A Capability Assessment will be completed and included as an appendix to the REP before the final REP is prepared. Based on prior USACE projects, Louisiana Department of Transportation and Development is expected to be fully capable of acquiring and providing lands, easements and rights-of-way for the construction and operation and maintenance of the project.

## Section 14

# Zoning Ordinances

No zoning ordinances are proposed in lieu of, or to facilitate, acquisition in connection with the project.

# Section 15
# Acquisition Schedule

## 15.1 DARLINGTON DAM

The following schedule shows the tasks and duration for acquisition of the LERRD required for the project, which would affect approximately 700 private landowners.  This schedule is subject to change based on project priorities and how the NFS will handle acquisitions.  This schedule is for preliminary planning purposes for schedule estimating; it is based on a worst case scenario that all 700 tracts are acquired at the same time.

| | |
|---|---|
| 1. Mapping | 6 months |
| 2. Title | 12 months |
| 3. Appraisals (begin concurrent with title) | 18 months |
| 4. Negotiations | 24 months |
| 5. Closing | 18 months |
| 6. Condemnation * | 24 months |

*Overlaps with Closing timeframe

## 15.2 NON-STRUCTURAL PORTION

The nonstructural measures may include elevations and flood proofing of structures. Such work would require execution of an agreement between the landowner and the NFS. In addition, the following administrative functions, among others, would be required: title research, HTRW analysis, and structural condition analysis, and additional property inspections to determine eligibility. Temporary rights of entry would have to be obtained from the owners in order to perform some of these administrative duties. An implementation plan will be prepared and will be included in the Final Integrated Feasibility Report and Environmental Impact Statement.

Tasks shown below would likely vary by property; therefore, the schedule shown is the overall anticipated time for the total number of structures and assumes an overlap of tasks. The schedule is dependent upon a defined nonstructural implementation plan and assumes that project funding will be available every year. Therefore, this estimated schedule is expected to be refined as more information becomes available during PED and implementation of the authorized project.

| | |
|---|---|
| Obtain Right-of-Entry for Investigations (To Determine Eligibility) | 6-12 months |
| Title research | 40-60 months |
| Preliminary Investigations (i.e. HTRW, structural, surveys, etc.) | 36-60 months |
| Execution of agreement b/w landowner & NFS & curative docs | 12-24 months |
| Filing Agreement between landowner & NFS | 12 months |
| Relocation of Displaced Tenants | 12-24 months |

# Section 16
# Facility/Utility Relocations

## 16.1 ROADWAY RELOCATIONS

Selective public roadways were chosen for evacuation routes only in the case of emergencies. All other existing highways and roads that traverse the proposed reservoir will not be considered to be relocated, rerouted or raised to accommodate a 100–year flood event in accordance with LADOTD standards. Public roads that only provide access to areas inside the reservoir limits to be acquired in fee will be considered abandoned and therefore were excluded from this study.

Louisiana Highway 10 is the only selected roadway that is above the 100 – year flood elevation for an evacuation route but was not listed as needing relocation.

Per the Engineering Appendix (Appendix A), Matthew Road, Lee Lane, and LA 448 will require relocation up and over the proposed flood protection required for continued access for local traffic. These relocations, however, will not require the acquisition of any new right of way.

## 16.2 POWER LINE AND TELEPHONE RELOCATIONS

Some power distribution lines and telephone lines along LA Highway 448, Matthew Road and Lee Lane may need to be relocated. Confirmation is required to determine what type of lines (distribution power or transmission lines) are located east of the Darlington Dam – Dry Reservoir Alternative; however, they do not appear to be impacted.

## 16.3 PIPELINE RELOCATIONS

Per the Engineering Appendix, pipelines located under the flood pool area would not be required to be relocated or weighted down to offset negative buoyancy. All pipeline crossings were buried below ground at a minimum of 3 to 5 feet in depth.

## 16.4 CEMETERY RELOCATIONS

The Church of God in Christ Cemetery has been identified in the project area and would be required to be relocated.

Preliminary investigations were conducted to identify the number of memorials at the cemetery. Twenty-six memorials were identified at Church of God in Christ Cemetery.

Historical investigations, including contact of descendants, excavations, and re-interments including grave markers and burial vaults must meet state and local guidelines and regulations.

The Church of God in Christ Church, located adjacent to its cemetery, would have to be relocated outside of limits of the Darlington reservoir. This church's structure is estimated to have a living space of 5,000 square-feet, which services the local community. It is recommended that the church, along with its cemetery, be relocated to one location. Costs associated with relocation of the church would be paid under P.L. 91-646, Relocation Assistance Benefits.

ANY CONCLUSION OR CATEGORIZATION CONTAINED IN THIS REPORT THAT AN ITEM IS A UTILITY OR FACILITY RELOCATION IS PRELIMINARY ONLY. THE GOVERNMENT WILL MAKE A FINAL DETERMINATION OF THE RELOCATIONS NECESSARY FOR THE CONSTRUCTION, OPERATION OR MAINTENANCE OF THE PROJECT AFTER FURTHER ANALYSIS AND COMPLETION AND APPROVAL OF FINAL ATTORNEY'S OPINIONS OF COMPENSABILITY FOR EACH OF THE IMPACTED UTILITIES AND FACILITIES.

## Section 17

# HTRW and Other Environmental Considerations

An HTRW environmental site assessment will be done prior to the final Integrated Feasibility Report and EIS. Please see the HTRW discussion in Section 6 of the Draft IFR and DEIS for further information.

# Section 18

# Landowner Attitude

There have been three public scoping meetings held in the Baton Rouge area. There has been mixed feelings on the support and opposition of the alternatives, but there have not yet been public meetings to address the TSP.

# Section 19

# Risk Notification

A risk notification letter has not been sent to the NFS. The NFS will be notified in writing about the risks associated with acquiring land before the execution of the Project Partnership Agreement and the Government's formal notice to proceed with acquisition. This will be sent prior to the final report.

# Section 20
# Other Real Estate Issues

It is not anticipated that there will be any other real estate issues for this project.

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# Amite River and Tributaries East of the Mississippi River, Louisiana


## Appendix E: Plan Formulation

## November 2019

# CONTENTS

# LIST OF TABLES



# LIST OF FIGURES

# Section 1
# Introduction

This appendix provides supplemental plan formulation information on the Amite River and Tributaries Comprehensive Study East of the Mississippi River, Louisiana (ART) to investigate and determine the extent of Federal interest in alternatives that reduce flood risk along the Amite River Basin (ARB). It supplements the information in Chapter 4 of the main report and includes tables and maps used in the development, screening, and evaluation of management measures and alternative plans.

The ART goals, objectives and constraints are identified in Chapter 2 of the report. They are included here as a point of reference for screening purposes (Table 1).

*Table 1Objectives and Constraints*

| OBJECTIVES | CONSTRAINTS |
|---|---|
| Reduce risk to human life from flooding. | Avoid induced development, to the maximum extent practicable, which contributes to increased life safety risk. |
| Reduce flood damages in the ARB to industrial, commercial, agricultural facilities, and residential and nonresidential structures. | |
| Reduce interruption to the nation’s transportation corridors in particularly the I-10/I-12 infrastructure. | |
| Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.). | |

Additionally, several planning considerations were identified for plan formulation that would not require the removal of an alternative plan, but were assessed as part of the plan formulation process:

- Avoid or minimize negative impacts to:
  - threatened and endangered species and protected species;
  - critical habitat, e.g., threatened and endangered species (T&E);
  - water quality;
  - cultural, historic, and Tribal resources;
  - recreation use in the basin.
- Recognition/awareness that reaches of the Amite and Comite Rivers are Scenic Rivers, which may require legislative changes in order to implement alternatives.
- Consistency with local floodplain management plans by not inducing flooding in other areas.

# Section 2
# Management Measures

Measures considered for this study are referred to in Chapter 4, Section 4.1. This section provides additional information about those measures that were evaluated and removed from further consideration during the planning process. Due to the large size of the study area, for presentation and discussion purposes the ARB was divided into three areas that have distinct geomorphology as discussed in Section 4.2 of the main report: the Upper Basin, Central Basin and Lower Basin (Figures 2-1 through 2-3).

The ARB primarily has flooding from two different sources. The upper basin flooding is caused from headwater flooding from rainfall events. The lower basin flooding is caused by a combination of drainage from headwaters and backwater flooding from tides and wind setup. Thirty four nonstructural and structural management measures of a variety of scales were identified for evaluation to reduce the risk of flood damages within the ARB (Table 2).

The management measures use one or more combinations of Concept/Formulation Strategy for Flood Risk Management (FRM) as follows:

- Remove Water (RW) = Removing water more quickly out of the basin
- Hold Water (HW) = During heavy rainfall events water would be held back from flowing down the basin until water levels drop to reduce the flood risk.
- Nonstructural (NS)= does not modify or restrict the natural flood
- Upper and Lower Basin (UL) = Alternative that likely results in reduced flood risk for the entire basin.
- FS = Focused Structural measures to protect critical Facilities

## 2.1 NONSTRUCTURAL MEASURES

Nonstructural measures (NS) reduce the human exposure or vulnerability to a flood hazard without altering the nature or extent of the flood hazard. Nonstructural alternatives could be used in conjunction with any of the structural flood mitigation alternatives to optimize the cost/benefit ratio.

- Nonphysical (NS-1): Consists of flood warning system/evacuation plans. While adequate land use and floodplain management development regulations already exist, it warranted further evaluation.
- Physical NS (NS-2): Consists of property acquisition and relocation assistance, elevation, and/or flood proofing of structures.

## 2.2 STRUCTURAL MEASURES

Structural measures are those that are physical modifications designed to reduce the frequency of damaging levels of flood inundation. Retention Structures arel large, regional, below grade structures, designed to attenuate flood peaks and release downstream at non-damaging flow rates. The following features are being considered:

- .01 Annual Exceedance Probability (AEP) dry dams along smaller Amite River Tributaries north of I-12 and/or below I-12 (HW-1).
- Large and small scale dams in the upper portion of the ARB (HW-2 and UL-1).
- Storage Area at Spanish Lake Basin (RW-7)
- Reservoirs along Bayou Manchac (HW-3)
- Diversion Structures: Diversion structure(s) located in the lower portions of the ARB that can divert flow to the Mississippi River. Gravity Fed and Pump diversions were considered as well as modifications to the Comite and Amite Rivers diversions that are presently in place RW-10 through RW-16)
- Channelization: There are numerous possible variations of this measure, including dredging channelization segments in specific downstream reaches of the river combined with upstream detention (RW-1 through RW-4, RW-18 through RW-20, and UL-2)
- Ring Levees: Ring levees, or similar, could be constructed to protect communities and other significant structures and/or lands (FS-1).
- Drainage Improvements: Numerous possibilities such as a combination of contoured swales or road cuts with traditional drainage infrastructure (culverts, catch basins, flow control structures and slotted pipe) to regulate the flow and discharge of storm water south of French Settlement (RW-17 and HW-5).
- Bridge improvements: Change in design to bridges where applicable to reduce the restriction of the flow of the Amite River and tributaries (RW-5, RW-8, RW-9).
- Dredging of Lakes: Increase the depth of the Lake Maurepas and University Lakes to increase the hold capacity of the lakes during extreme rainfall events and tide/wind backwater flooding for Lake Maurepas (RW-22 and HW-7).
- Channel Bank Gapping: Select cuts into the banks of the Amite River and Tributaries (RW-6 and RW-21).
- Floodgate: Closure of tidal pass at Lake Maurepas/Lake Pontchartrain or Hwy 61 at Blind River to reduce backwater flooding caused by tides and wind driven flooding (HW-4 and HW-6).

### 2.3 SCREENING CRITERIA

Screening is the ongoing process of eliminating measures, based on the planning criteria. The management measures were screened by using the formulation criteria as given and defined in ER- 1105-2-100 which includes the 1983 Principles and Guidelines. The criteria are effectiveness, efficiency, acceptability, and completeness.

The screening criteria were derived for the specific planning study using planning objectives, constraints and considerations and opportunities of the project area. Each measure was scored using a 4 point scale on whether it met the objective(s) or avoids constraints and considerations as discussed in Section1 by using the following criteria: Exceeds (++), Meets (+), No Change (n), or Decreases (-) (Table 2). Due to the limited ability to generate new data prior to the Alternatives Milestone, metrics relied principally upon existing data and professional judgment.

### 2.4 SCREENING OF MEASURES

The scoring results were compiled and averaged. After scoring, the PDT reviewed the results and confirmed that the highest scoring measures should be retained. The lower scoring measures were reviewed further and nineteen measures (Table 2) were carried forward for alternative development. Below is a general discussion of those measures that were screened which were limited to structural.

#### 2.4.1 Diversion Structures (RW-10, RW-11 and RW-13 thru RW-16)

The Mississippi River at the proposed locations (RW-11, RW-13 and RW-15) has a much higher elevation in comparison to the adjacent Amite River and tributaries. A negative flow would not be achievable by gravity fed means; therefore, the gravity fed diversions to the Mississippi River were screened out. The Bayou Conway (RW-10), Romeville (RW-14) and Union (RW-16) locations, proposed for a pump at the Mississippi River with a diversion, were screened but Bayou Manchac (RW-12) was carried forward due to the complexity of the area and potential benefits. The pump stations would have a limited radius of influence, the cost would be very significant due to the head losses associated with the pump distances needed and there would be limited opportunities to place a diversion due to large developed areas under forced drainage systems.

#### 2.4.2 Channelization (RW-18 thru RW-20)

Dredging the outfall at Blind River (RW-18), the Lower Blind River (RW-19) and Colyell Creek (RW-20) were screened out in part due to limited benefits. Based on the LADOTD 2018 Report on Investigation into the Potential Hydraulic Impacts of Dredging the Lower Amite River dredging near the mouth of Lake Maurepas would result in negligible amounts of water surface elevation reduction due to the flood elevations being controlled by the Lake and influenced by tides. Colyell Creek has also limited benefits due to the low density of structures along the creek.

### 2.4.3 Drainage Improvements (RW-17 thru HW-5)

Modifications to Comite Diversion (RW-17) was screened out due to the limits of the construction project authorization. Dry Retention Ponds along the Lower Amite River was screened in part because the geomorphology of the lower Amite is extremely flat which prevents the use of dry retention ponds to be feasible in the area below I-12.

### 2.4.4 Dredging of Lakes (RW-22)

Increasing the depth of the Lake Maurepas (RW-22) by dredging was screened for several reasons including: limited benefits and significant impacts to the Lake Maurepas ecosystem. Additionally, overtime the measure could be ineffective with relative sea level rise since it is hydrologically connected to Lake Pontchartrain. Dredging of University Lakes was carried forward as an alternative for further evaluation (HW-7).

### 2.4.5 Channel Bank Gapping (RW-21)

Select cuts of the bank of the Amite River at the Amite River Diversion (RW-21) was screened out in part since it would have very limited FRM benefits and would only likely affect stages directly on the Amite River diversion channel. It would also potentially impact backwater areas. Channel bank gaping along the Amite River was carried forward as an alternative for further evaluation (RW-6).

### 2.4.6 Floodgates (HW-4 and HW-6)

Floodgates at Hwy 61 at Blind River (HW-4) were screened out in part since the measure would require significant improvements to other infrastructure to make it work and there would be limited benefits. Lake Maurepas/Lake Pontchartrain (HW-6) was screened in part due to limited benefits, significant impacts to the Lake Maurepas ecosystem, and historically, there has been significant public opposition to closing off the passes.

*Table 2 Management Measures*

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obj1 | Obj2 | Obj3 | Obj4 | Obj5 | Con1 | Con2 | Con3 | Con4 | Con5 | Con6 | Con7 | Con8 |
| Measure ID | Description | Reduce flood damages | Reduce risk to human life from flooding from rainfall events | Reduce interruption to the nation's transportation corridors | Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.); | Engineering with nature | T&E | Critical Habitat | Cultural | Water Quality | Scenic Rivers | Local Flood Manag-ement Plans | BBA Author-ization limits | Not to induce develop-ment within flood plain |
| RW-1 | Dredging of Outfall @ Amite River | + | n | n | n | + | n | n | - | + | - | n | + | n |
| RW-2 | Dredging of Lower Amite River | + | n | n | n | + | n | n | - | + | - | n | + | n |
| RW-3 | Dredging of Upper Amite River | + | n | - | n | + | n | n | - | n | - | n | + | n |
| RW-4 | Dredging of Bayou Manchac | + | n | ++ | + | + | n | n | - | n | - | n | + | n |
| RW-5 | Bridge Restrictions/ Improvements for I-12 | + | n | + | + | n | n | n | - | + | - | n | + | n |
| RW-6 | Amite River Channel Bank Gapping | + | n | n | + | n | n | n | - | + | + | + | + | n |

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Obj1** | **Obj2** | **Obj3** | **Obj4** | **Obj5** | **Con1** | **Con2** | **Con3** | **Con4** | **Con5** | **Con6** | **Con7** | **Con8** |
| **Measure ID** | **Description** | **Reduce flood damages** | **Reduce risk to human life from flooding from rainfall events** | **Reduce interruption to the nation's transportati on corridors** | **Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.);** | **Engineering with nature** | **T&E** | **Critical Habitat** | **Cultural** | **Water Quality** | **Scenic Rivers** | **Local Flood Manag-ement Plans** | **BBA Author-ization limits** | **Not to induce develop-ment within flood plain** |
| RW-7 | Storage Area at Spanish Lake, Ascension/Iberville Parish | + | n | + | + | + | - | - | - | - | + | - | + | + |
| RW-8 | Hwy 22 and Port Vincent Bridge Drainage Improvements | + | n | n | n | n | - | - | n | + | + | + | - | + |
| RW-9 | Upper Amite Bridge Restrictions/ Improvements | + | n | + | + | n | n | n | - | + | - | n | + | n |
| RW-10 | Bayou Conway Pump to Mississippi River | + | n | + | + | - | n | - | - | n | + | n | n | + |
| RW-11 | Diversion Gravity Fed (Manchac) | + | n | + | + | - | n | - | - | n | - | n | + | + |
| RW-12 | Diversion Pump Station (Manchac) | + | n | + | + | - | n | - | - | n | - | n | + | + |

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obj1 | Obj2 | Obj3 | Obj4 | Obj5 | Con1 | Con2 | Con3 | Con4 | Con5 | Con6 | Con7 | Con8 |
| Measure ID | Description | Reduce flood damages | Reduce risk to human life from flooding from rainfall events | Reduce interruption to the nation's transportation corridors | Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.); | Engineering with nature | T&E | Critical Habitat | Cultural | Water Quality | Scenic Rivers | Local Flood Manag-ement Plans | BBA Author-ization limits | Not to induce develop-ment within flood plain |
| RW-13 | Diversion Gravity Fed (Union) | + | n | n | n | - | n | - | n | n | + | n | n | + |
| RW-14 | Diversion Pump Station (Union) with conveyance channel | + | n | n | n | - | n | - | n | n | + | n | n | + |
| RW-15 | Diversion Gravity Fed (Romeville) | + | n | n | n | - | n | - | n | n | + | n | n | + |
| RW-16 | Diversion Pump Station (Romeville) with conveyance channel | + | n | n | n | - | n | - | n | n | + | n | n | + |
| RW-17 | Modifications to Comite Diversion | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| RW-18 | Dredging of Outfall @ Blind River | + | n | n | n | + | n | n | - | + | - | n | + | n |
| RW-19 | Dredging of Lower Blind River | + | n | n | n | + | n | n | - | + | - | n | + | n |

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Obj1** | **Obj2** | **Obj3** | **Obj4** | **Obj5** | **Con1** | **Con2** | **Con3** | **Con4** | **Con5** | **Con6** | **Con7** | **Con8** |
| **Measure ID** | **Description** | **Reduce flood damages** | **Reduce risk to human life from flooding from rainfall events** | **Reduce interruption to the nation's transportati on corridors** | **Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.);** | **Engineering with nature** | **T&E** | **Critical Habitat** | **Cultural** | **Water Quality** | **Scenic Rivers** | **Local Flood Manag-ement Plans** | **BBA Author-ization limits** | **Not to induce develop-ment within flood plain** |
| RW-20 | Dredging of Colyell Creek | n | n | n | n | + | - | - | - | - | - | n | + | n |
| RW-21 | Amite River Diversion Channel Bank Gapping | n | n | n | n | - | n | n | n | + | + | + | n | n |
| RW-22 | Dredging of Lake Maurepas | n | n | n | n | - | - | - | - | - | - | n | + | n |
| HW-1 | .01 AEP Dry Dams-Upper Amite Tributaries | + | n | + | + | + | n | n | n | + | n | n | + | n |
| HW-2 | Small Dry Dams on Amite River - Upper Amite | ++ | + | + | + | + | n | n | - | + | - | + | + | n |
| HW-3 | Reservoirs along Bayou Manchac | + | n | + | + | + | n | n | - | n | - | n | n | n |
| HW-4 | Flood Gate at Blind River Hwy 61 | + | n | n | + | - | - | n | n | n | - | n | n | n |

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Obj1** | **Obj2** | **Obj3** | **Obj4** | **Obj5** | **Con1** | **Con2** | **Con3** | **Con4** | **Con5** | **Con6** | **Con7** | **Con8** |
| **Measure ID** | **Description** | **Reduce flood damages** | **Reduce risk to human life from flooding from rainfall events** | **Reduce interruption to the nation's transportation corridors** | **Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.);** | **Engineering with nature** | **T&E** | **Critical Habitat** | **Cultural** | **Water Quality** | **Scenic Rivers** | **Local Flood Manag-ement Plans** | **BBA Author-ization limits** | **Not to induce develop-ment within flood plain** |
| HW-5 | Dry Retention Ponds- Lower Amite | + | n | n | n | - | - | n | - | n | n | n | n | n |
| HW-6 | Closures at Tidal Passes | + | n | n | + | - | - | - | n | - | n | n | - | n |
| HW-7 | University Lakes as Reservoir | + | n | n | n | - | n | n | n | n | n | ++ | + | n |
| UL-1 | Large Scale .04 AEP Dam - Upper Amite (i.e. Darlington) | ++ | n | ++ | ++ | - | - | - | - | n | - | + | ++ | n |
| NS-1 | Flood warning/Monitoring systems | n | ++ | + | n | n | n | n | n | n | n | n | n | n |
| UL-2 | Dredging of Amite River Tributaries | + | + | + | + | + | n | n | - | n | - | n | + | n |
| NS-2 | Nonstructural Improvements for high frequency events | + | + | n | n | n | n | n | n | n | n | n | + | n |

| | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective NA were used for Measures that were strictly NER Measures | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obj1 | Obj2 | Obj3 | Obj4 | Obj5 | Con1 | Con2 | Con3 | Con4 | Con5 | Con6 | Con7 | Con8 |
| Measure ID | Description | Reduce flood damages | Reduce risk to human life from flooding from rainfall events | Reduce interruption to the nation's transportation corridors | Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.); | Engineering with nature | T&E | Critical Habitat | Cultural | Water Quality | Scenic Rivers | Local Flood Manag-ement Plans | BBA Author-ization limits | Not to induce develop-ment within flood plain |
| FS-1 | Ring Levees around Critical Facilities | + | + | n | + | - | n | n | - | n | n | n | + | n |

Note: Shaded cells are measures that were not carried forward during the screening process.
NA = Not Applicable

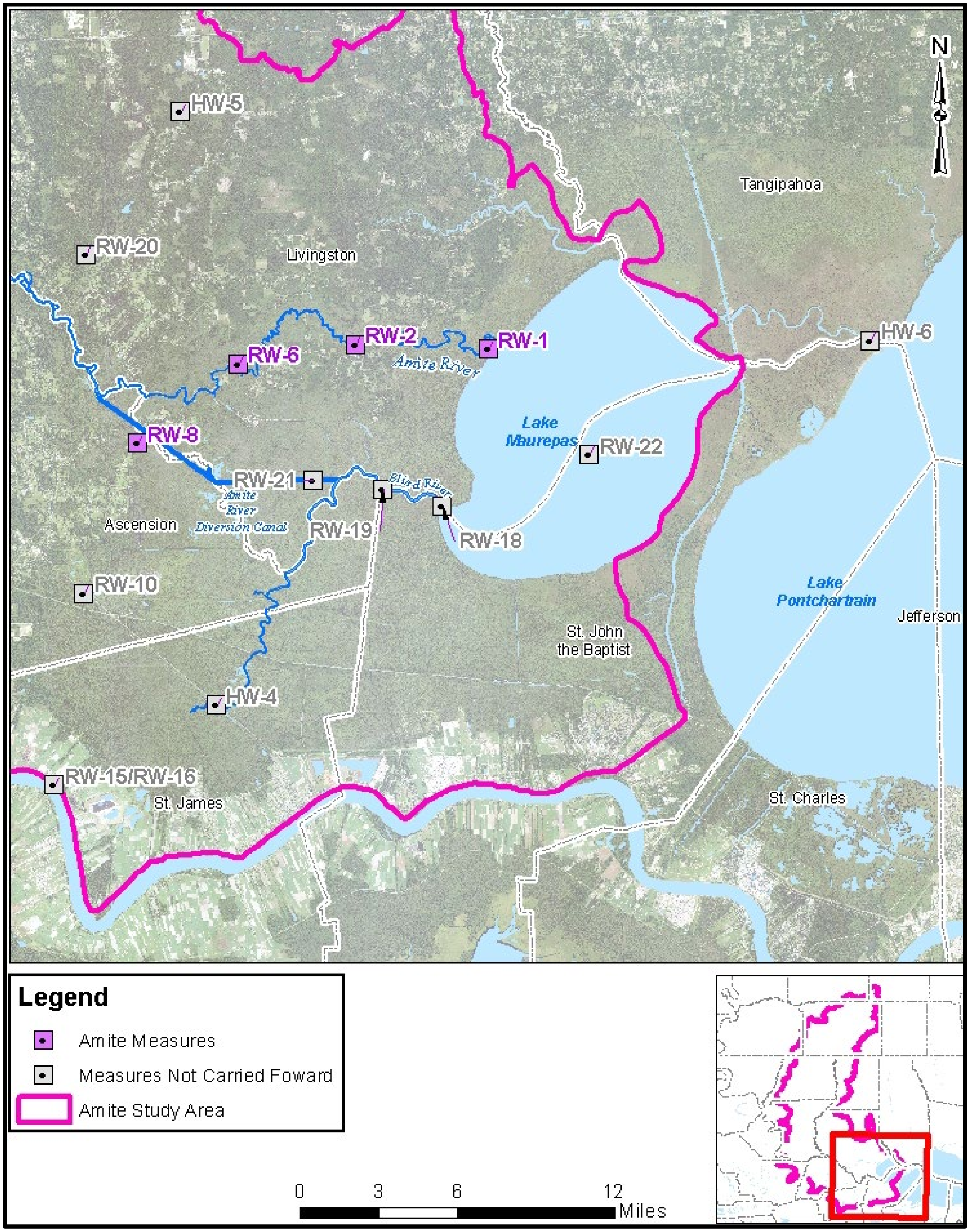



*Figure E-1. Management Measures located in the Lower ARB*

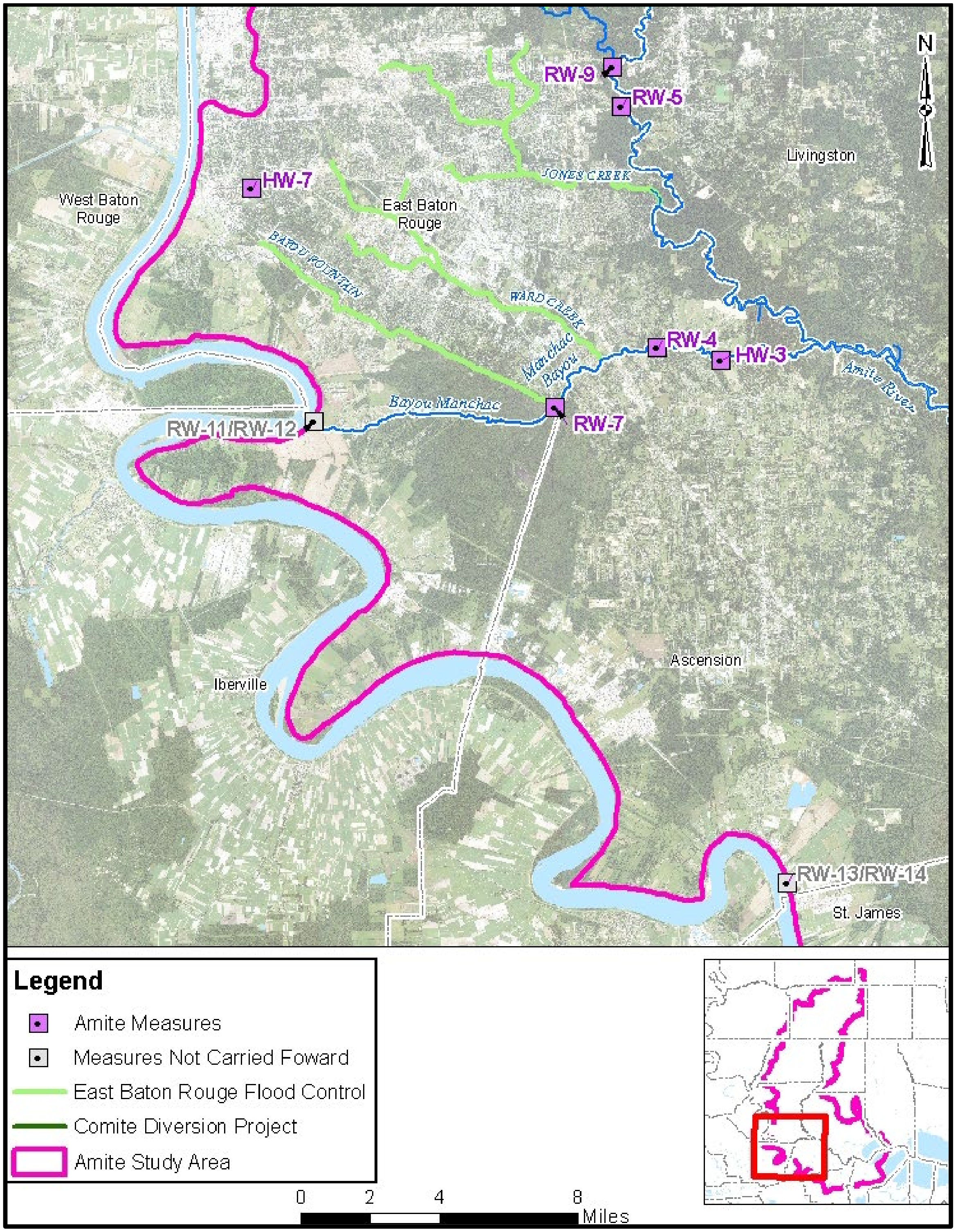



*Figure E-2. Management Measures located in the Central ARB*

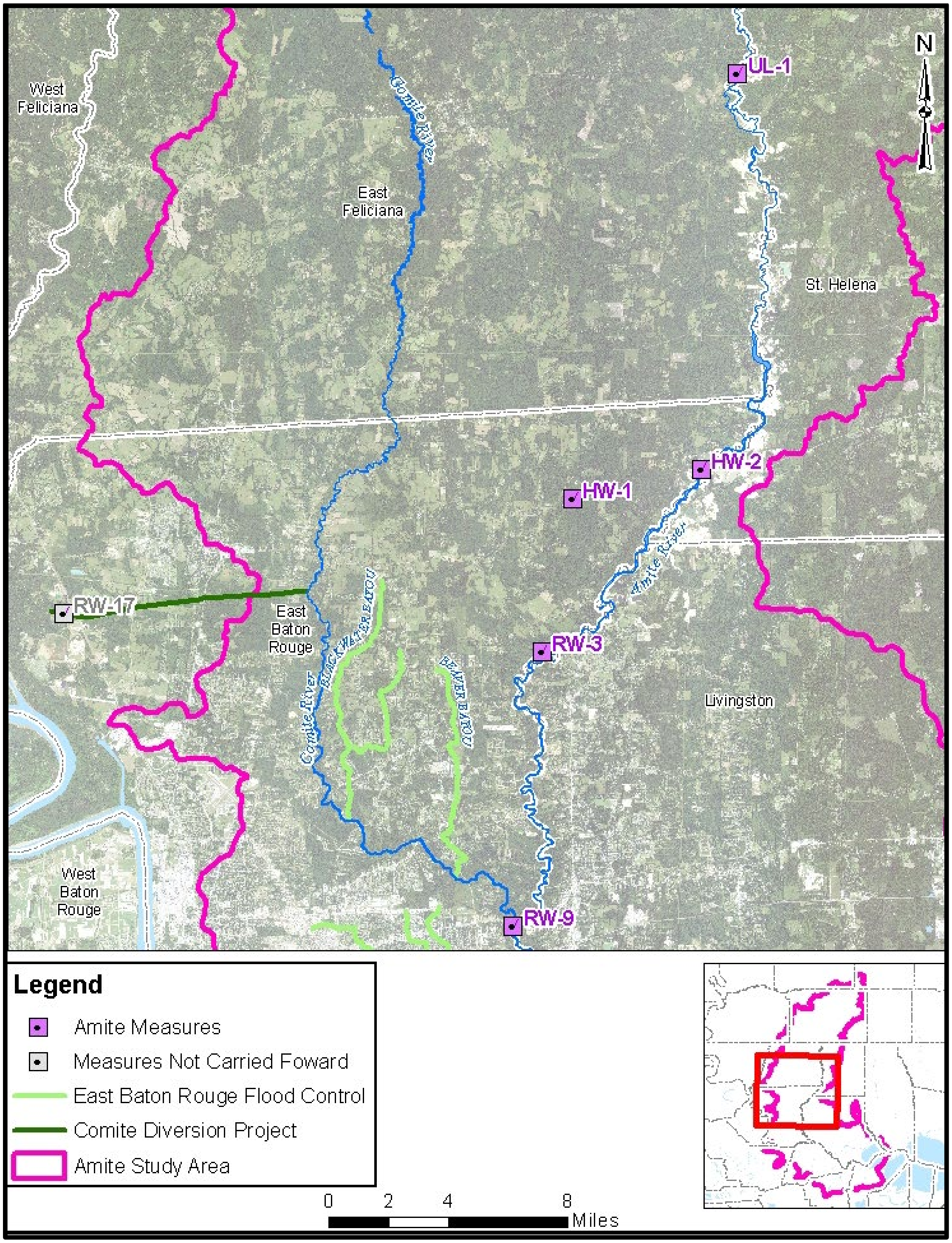



*Figure E-3. Management Measures located in the Upper ARB*

# Section 3
# INITIAL ARRAY OF ALTERNATIVES

## 3.1 DEVELOPMENT OF INITIAL ARRAY OF ALTERNATIVE

Fifteen alternatives were assembled through the plan formulation process. Thirteen alternative plans were initially identified using one or more of the nineteen management measures that were carried forward after the screening process. Two additional alternatives (Alternatives 14 and 15) were identified through public scoping as discussed in Section 2.4 of the main report. Similarly, to the development of management, for presentation and discussion purposes, the ARB was divided into areas of hydraulic influence as follows:

- Lower Basin
- Central Basin
- Upper Basin
- Upper and Lower Basin

NEPA regulations (40 CFR 1502.14(d)) requires that a No Action plan be considered as a viable alternative in the final array of plans. It represents future conditions that will likely occur if USACE takes no action. The No Action plan is included as Alternative 1. In accordance with Section 73 of the Water Resources Development Act of 1974, a minimum of one primarily nonstructural plan must be considered; therefore, Alternative 13 for nonstructural is included.

### 3.1.1 Influence Area Lower Basin

Three alternatives were identified with an influence area of the lower ARB near Lake Maurepas that use the strategy of removing water out of the basin more quickly than baseline conditions (Figure 2-1). The alternatives could be combined into several different combinations, but they focus on dredging (i.e. clearing/snagging of banks) of the Amite River in the lower reaches and outfall, channel bank gapping and Hwy 22 drainage improvements.

Alternative 2: Dredging of the Amite River outfall (RW-1) and in the lower reaches of the Amite River (RW-2). The dredging would include scraping, clearing and snagging of the banks. This potentially had an influence area from Colyell Creek to Lake Maurepas and some backwater areas.

Alternative 3: Lower Amite River Channel Bank Gapping (RW-6). This potentially had an influence area from French Settlement to Lake Maurepas.

Alternative 4: Hwy 22 and Port Vincent Bridge drainage improvements (RW-8). This potentially had an influence area from French Settlement to the River Outlet. This alternative included the assessment of the local hydrology to identify restrictions from the Port Vincent and Highway 22 bridges. Placing culverts in the area as well as the Ascension Parish proposed plan of placing a Causeway for a portion of Hwy 22 instead of the roadway and small bridge currently in place were assessed as part of this alternative.

### 3.1.2 Influence Area Central Basin

Five alternatives (Alternatives 5-9) were identified that focus on addressing flood risk in the central portion of the ARB including the area of Bayou Manchac (Figure 2-2). Alternatives 5 and 6 focus on the Bayou Manchac Area and include dredging (i.e. clearing/snagging of banks), small dry reservoirs, and operation of flood gates and pumps.

Alternatives 7 and 8 focus on the central portion of the Amite River and Alternative 9 focuses on a tributary to Bayou Manchac which flows into the Amite River.

Alternative 5: Dredging (RW-4) and storage along Bayou Manchac in multiple small reservoirs (HW-3). The dredging would include scraping, clearing and snagging of the banks. This potentially had an influence area for the entire Bayou Manchac area.

Alternative 6: Flood gate with Pump to Mississippi River along with open flood gates at Turtle/Alligator Bayous (RW-7), nonstructural (NS-2) and focused structural (FS-1). This alternative includes placing a flood gate on Bayou Manchac at Airline Hwy in order to address flooding from the Amite River. Pumping to Mississippi River with a conveyance channel along Bluebonnet was included in order to address the water in Bayou Manchac between the floodgate and the Mississippi River, along with the flood gates at Turtle and Alligator Bayous to remain open so the water would flow into the natural retention area, Spanish Lake. Additionally, the alternative included nonstructural measures to address potential impacts as well and focused nonstructural such as ring levees for residential communities and critical infrastructure in the area.

Alternative 7: Reduction of flow restrictions from bridges at I-12 (RW-5) and above I-12 (RW-9). Public feedback has expressed concern over the I-12 and Hwy 190 Bridges contributing to flooding.

Alternative 8: Dredging of the Upper and Central Amite Basin, above I-12 (RW-3). The dredging would include scraping, clearing and snagging of the banks. This potentially had an influence area for the Upper and Central portions of the Amite River.

Alternative 9: University Lakes as reservoirs (HW-7). This alternative is part of the Baton Rouge Area Foundation's Baton Rouge Lakes Master Plan with a potential influence of the Bayou Duplanier area. The plan includes changing the local hydrology including the use of weirs.

### 3.1.3 Influence Area Upper Amite River Basin

Two alternatives (Alternatives 10 and 11) were identified with an influence area of the upper ARB that use the strategy of holding water to address extreme frequency flood events (Figure 2-3).

Alternative 10: Dry Dams along tributaries (HW-1). The .01 AEP dry dams would be placed on the larger tributaries that flow into the Amite River to provide flood risk reduction to the immediate areas and to delay the release of water being conveyed into the Amite River.

Alternative 11: Small dry dams on the Amite River (HW-2). This alternative is from the recommendations in the 1995 ARBC commissioned study which recommended three locations: Grangeville Bridge, just North of Greenwell Springs, and the St Helena/Livingston Parish Boundary.

### 3.1.4 Influence Area of Upper and Lower Amite River Basin

Four alternatives (Alternatives 12 through 15) were identified as having an influence area of the upper and lower ARB. These alternatives include holding water back by a large scale dam, nonstructural and natural river restoration.

Alternative 12: Large scale .04 AEP dam (UL-1). This alternative is from the recommendations in the 1997 Darlington Reservoir Re-evaluation Study by USACE. The alternative includes an earthen dam that could be dry or wet, located on the Amite River in East Feliciana and St. Helena Parishes (Figure 2-3).

Alternative 13: Nonstructural (NS-1 and NS-2). Nonstructural allows for people and structures that are exposed and vulnerable to flood risk to adapt to flooding and to risks associated with flooding. NS-1 measure improves the Flood warning/Monitoring systems by installing rain gauges in the state of Mississippi and real time water level gauges in the backwater areas so predictive flooding could be identified more easily as requested by the Natural Weather Service. NS-2 measure consist of improving elevation and/or flood proofing of residential and non-residential structures or acquisitions/relocation assistance of floodplain properties. The alternative is located throughout the ARB.

Alternative 14: Conversion of sand and gravel mines in the Amite Riverine to bottomland hardwood forest and swamp forest. Per request of the Healthy Gulf Coalition letter submitted on April 23, 2019, the alternative was added which includes the conversion of 14,000 acres of fallow mines.

Alternative 15: *Restoration of River Meanders.* Per request of the USFWS letter submitted on June 25, 2019, the alternative was added which includes restoring meanders to critical sections of the river where straightening has occurred due to sand and gravel mining operations. No specific locations were suggested; however, based on the recommendations in the 2011 USACE Amite River Field Investigation and Geomorphic Assessment Report, the reach of the river from approximately river mile 114 to 73 had twenty-one preliminary restoration sites (Figure 3-1).

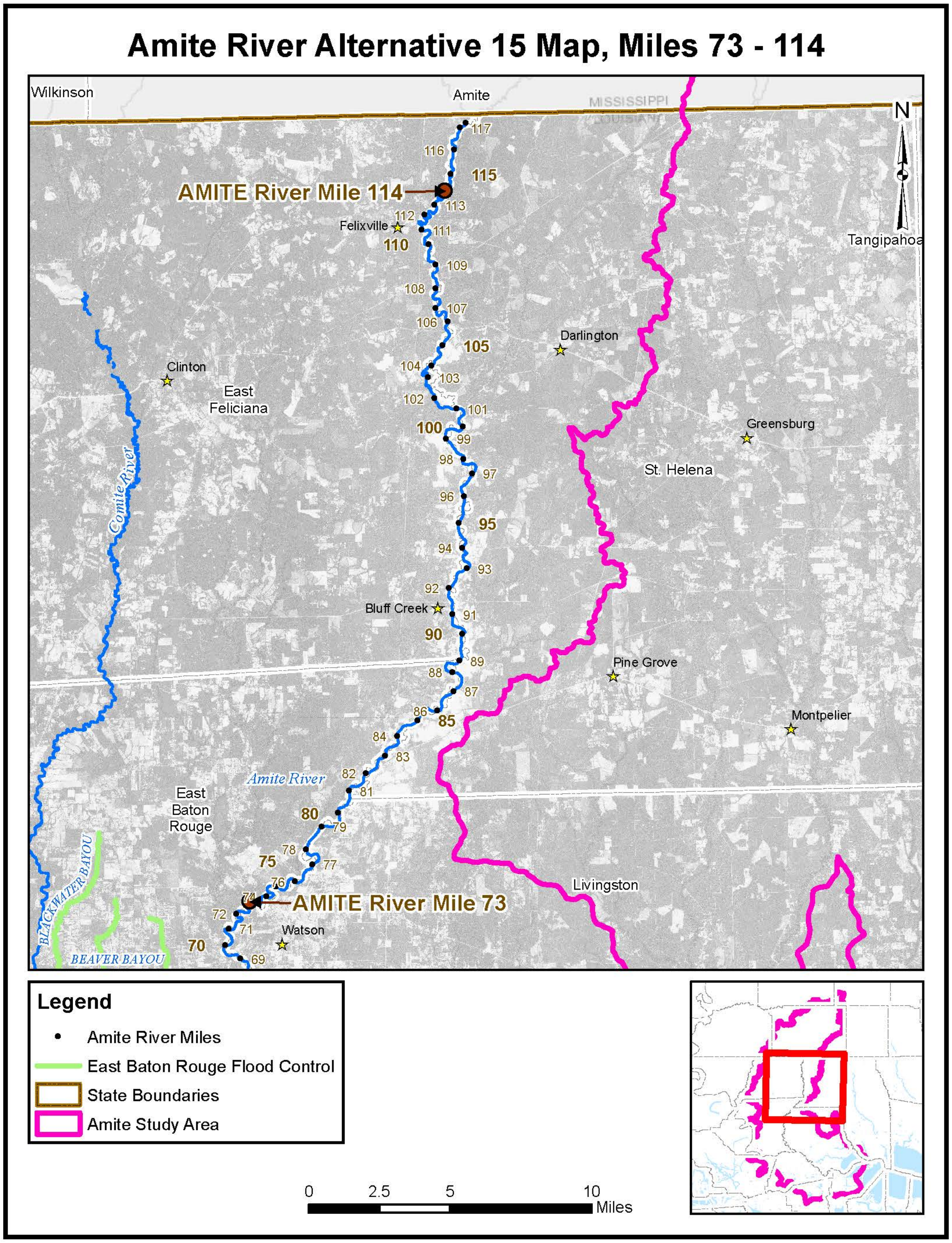



*Figure E-4 – Location of Alternative 15*

## 3.2 SCREENING CRITERIA

After the alternatives were assembled, a qualitative screening process was employed to carry forward the alternatives that showed the most promise (Table 3). Alternatives were assessed using the same specific planning study criteria used to assess individual mitigation measures as described in Section 2.2.

## 3.3 SCREENING OF ALTERNATIVES

The scoring results were compiled and averaged. After scoring, the PDT reviewed the results and confirmed that the highest scoring alternatives should be retained in addition to No Action and nonstructural. Alternatives 1, 10, 12 and 13 were carried forward to the final array of alternatives for further assessment and are discussed in the text of the main report. The lower scoring alternatives were reviewed further and were screened. Below is a general discussion regarding why each of the alternatives were screened. Appendix G of the main report provides an in-depth discussion of the hydrology of the ARB and of the areas that would be influenced by the alternatives.

### 3.3.1 Alternative 2: Dredging of the Amite River outfall and in the lower reaches of the Amite River

Per the LADOTD January 24, 2019 report by Dewberry Engineers Inc., the alternative ranged from a water surface elevation reduction of a maximum of 4-5 inches and would require dredging of 2 - 8 million cubic yards to begin seeing the lowerings. With a cost estimate minimum of $20-80 million for dredging and without a high density of structures that would be impacted, this alternative would have limited benefits.

### 3.3.2 Alternative 3: Lower Amite River Channel Bank Gapping

The Lower Amite River has very low banks and quickly overflows; therefore, the alternative has limited benefits. Also, implementing bank gapping could cause shoaling of the river thus resulting in reduced capacity of the river to carry flood water.

### 3.3.3 Alternative 4: Hwy 22 and Port Vincent Bridge Drainage Improvement

Appendix G of the main report provides an H&H discussion of the modeling results for this area including a discussion regarding Hwy 16 for Colyell Creek and the need for additional surveys to assess this area which is outside of this feasibility study. While lowerings could be achieved at each of these areas, the drainage would provide limited benefits due to the low density of structures in the area.

### 3.3.4 Alternative 5: Dredging and Storage along Bayou Manchac in Multiple Small Reservoirs

Along Bayou Manchac there are limited areas that are largely undeveloped that would be available to build small reservoirs. Additionally, as stated in the USACE 1995 Feasibility Study for the East Baton Rouge Parish Watershed Flood Control Projects, due to the lack of topographical relief of the watershed detention/retention storage, basins were determined to be impractical. Required containment structures, in conjunction with land requirements would be excessive in order to achieve significant flow retention. Detention/retention storage basins would also only reduce flood risk during localized rainfall events.

Clearing and snagging was determined to increase the flood risk as water would move more quickly into the area since the flooding along Bayou Manchac is in part due to backwater flooding from the Amite River.

### 3.3.5 Alternative 6: Flood Gate with Pump to Mississippi River along with Open Flood Gates at Turtle/Alligator Bayous, Nonstructural and Focused Structural

This alternative was screened out due to limited benefits and in large part due to the size and costs of the pumps required to implement the alternative. It was estimated that ten 1,000 cfs pumps each with 10' diameter discharge would be needed to pump into the Mississippi River over the levee.

### 3.3.6 Alternative 7: Reduction of Flow Restrictions from Bridges

Based on the hydraulic model for baseline conditions, minimal flow restrictions from bridges along the Amite River were identified; therefore it was screened out due to limited benefits. Many of the bridge restrictions presented by the public during the scoping of the study are likely from debris carried by the water during a flood event such as vegetation and general trash that become trapped within the bridge support system located in the river channel resulting in a reduction of flow.

### 3.3.7 Alternative 8: Dredging of the Upper and Central Amite Basin above I-12

The hydraulic model for baseline conditions did not show any areas of significance where clearing/snagging would reduce flood risk benefits due to the size of the channel and the floodplain.

### 3.3.8 Alternative 9: University Lakes as Reservoirs

The Baton Rouge Area Foundation provided their modeling and costs for the suggested plan. While the plan does have flood risk reduction benefits they were not enough to justify the project based on FRM alone; therefore, the alternative was screened.

### 3.3.9 Alternative 11: Small Dry Dams on the Amite River (HW-2)

The potential benefits from this alternative, as well as in channel weirs, would be limited to very few higher frequency events, since the river very quickly flows out of the channel. The limited benefits would also have to be adjusted for inducements of flooding upstream including along small tributaries. Additionally, in the upper basin where the small dry dams were proposed, the channel is up to two miles wide at flooding stages and the dam and/or weir would have to be fairly large with significant bank armoring. Without significant bank armoring and tie in points, these measures would have the potential to change the geomorphology and course of the river. This alternative was screened based on limited benefits.

### 3.3.10 Alternative 14: Conversion of Sand and Gravel Mines in the Amite Riverine to Bottomland Hardwood Forest

The baseline conditions of the H&H model shows that the area of the sand and gravel mines is already providing a higher storage/retention than what the conversion of floodplain forest would provide so the alternative was screened. Additionally, the location of the gravel pits are primarily not immediately adjacent to the main channel of the Amite River, so the velocity reductions from the conversion of the area to Bottomland Hardwood forest would be very limited.

### 3.3.11 Alternative 15: Restoration of River Meanders

Adding river meanders to the Amite River would increase the length of the river and thus additional storage capacity, and floodwaters would be slowed down on their journey to inundate populated areas downstream. There are potential benefits from this alternative at higher frequency events but very unlikely at lower frequency events; therefore, the alternative was screened due to limited benefits. Appendix G of the main report provides further H&H discussion of the alternative assessment.

## 3.4 THE FOCUSED AND FINAL ARRAY OF ALTERNATIVES

The focused and final array of alternatives carried forward for consideration are presented in Table 4 and Table 5. Sections 4 through 7 of the Main Report presents the evaluation of the focused and final Array and subsequent Tentatively Selected Plan.

*Table 3 Alternatives*

| | | | **Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective** | | | | | **Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Alt ID** | **Measures** | **Alternative Description** | **Reduce flood damages** | **Reduce risk to human life from flooding from rainfall events** | **Reduce interrupti-on to the nation's transportation corridors** | **Reduce risks to critical infrastructure (e.g. medical centers, schools, transportation etc.);** | **Engin-eering with nature** | **T & E** | **Critical Habitat** | **Cultural** | **Water Quality** | **Scenic Rivers** | **Local Flood Manag-ement Plans** | **BBA Authorizat-ion limits** | **Not to induce development within flood plain** |
| Alt 1 | No Action | No action would be taken under this plan. Damages would continue into the future. | n | n | n | n | n | n | N | n | n | n | n | n | n |
| Alt 2 | RW-1+RW-2 | Dredging of the Amite River outfall (RW-1) and in the lower reaches of the Amite River (RW-2) | + | n | n | n | + | n | N | - | + | - | n | + | n |
| Alt 3 | RW-6 | Lower Amite River Channel Bank Gapping (RW-6) | + | n | n | n | + | n | N | - | + | - | n | + | n |
| Alt 4 | RW-8 | Hwy 22 and Port Vincent Bridge drainage improvements (RW-8) | + | n | n | n | + | n | N | - | + | - | n | + | n |

| | | | Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective | | | | | Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alt 5 | HW-3+ RW-4 | Dredging (RW-4) and storage along Bayou Manchac in multiple small reservoirs (HW-3) | + | n | + | + | + | n | N | - | n | - | n | n | n |
| Alt 6 | RW-7+NS-2+FS-1 | Flood gate at Airline Hwy, Pump to MS River, open flood gates at Turtle and Alligator Bayous (RW-7) with the addition of nonstructural measures (NS-2) and ring levees for residential communities and critical infrastructure (FS-1) | + | n | ++ | ++ | ++ | n | N | - | n | - | n | + | n |
| Alt 7 | RW-5+RW-9 | Reduction of flow restrictions from bridges at I-12 (RW-5) and above I-12 (RW-9) | + | n | ++ | ++ | + | - | N | - | n | - | n | + | n |
| Alt 8 | RW-3 | Dredging of the Upper and Central Amite Basin, above I-12 (RW-3) | + | n | ++ | ++ | + | - | N | - | n | - | n | + | n |
| Alt 9 | HW-7 | University Lakes as reservoirs (HW-7) | + | n | n | n | - | n | n | n | n | n | ++ | + | n |
| Alt 10 | HW-1 | .01 AEP Dry Dams along tributaries (HW-1) | + | n | + | + | + | n | n | n | + | n | n | + | n |
| Alt 11 | HW-2 | Small dry dams on the Amite River (HW-2) | ++ | + | + | + | + | - | - | - | + | - | + | + | n |
| Alt 12 | UL-1 | Large scale .04 AEP dam (UL-1) | ++ | n | ++ | ++ | - | + | n | - | n | - | + | ++ | n |
| Alt 13 | NS-1+ NS-2 | Nonstructural (NS-1 and NS-2) | ++ | + | n | ++ | - | n | n | - | n | n | + | ++ | n |

| | | | **Exceeds (++), Meets (+), No Change (n), or Decreases (-) the Objective** | | | | | **Avoids Constraint/Considerations High (++), Medium (+), Low to no issue or not applicable (n), or Conflicts (-) with the Constraint/Consideration** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alt 14 | None | Conversion of sand and gravel mines in the Amite Riverine to bottomland hardwood forest and swamp forest | n | n | n | n | ++ | +<br>+ | n | - | ++ | ++ | n | n | n |
| Alt 15 | None | Restoration of River Meanders | n | n | n | n | ++ | + | ++ | - | n | n | n | - | n |

*Table 4 Focused Array of Alternatives*

| Alt ID | Management Measures | Alternative Description |
|---|---|---|
| Alt 1 | No Action | No action would be taken under this plan. Damages would continue into the future. |
| Alt 10 | HW-1 | 0.01 AEP Dry Dams along tributaries (HW-1) |
| Alt 12 | UL-1 | Large scale dam: 0.04 AEP dam (UL-1) |
| Alt 13 | NS-1+ NS-2 | Nonstructural (NS-1 and NS-2) |

*Table 5 Final Array of Alternatives*

| Alternative |
|---|
| No Action |
| Dry Dam along tributary: Sandy Creek Dry Dam 0.01 AEP |
| Large scale dam: Darlington Dry Dam 0.04 AEP |
| Nonstructural: 0.04 AEP Floodplain (NS-1 and NS-2) |

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Amite River and Tributaries - East of the Mississippi River, Louisiana


## Appendix F - Economic and Social Consideration

## November 2019

# CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# Section 1
# Background Information

## 1.1 INTRODUCTION

### 1.1.1 General

This appendix presents an economic evaluation of the flood risk management alternatives for the Amite River and Tributaries (ART) Study East of the Mississippi River, Louisiana. It was prepared in accordance with Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, and ER 1105-2-101, Planning Guidance, Risk Analysis for Flood Damage Reduction Studies. The National Economic Development Procedures Manual for Flood Risk Management and Coastal Storm Risk Management, prepared by the Water Resources Support Center, Institute for Water Resources, was also used as a reference, along with the User's Manual for the Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA).

This appendix consists of a description of the methodology used to determine National Economic Development (NED) damages and benefits under existing conditions and the project's costs. The damages and costs were calculated using Fiscal Year (FY) 2019 price levels. Costs were annualized using the FY 2020 Federal discount rate of 2.75 percent and a period of analysis of 50 years with the year 2026 as the base year. The expected annual damage and benefit estimates were compared to the annual construction costs and the associated Operations, Maintenance, Relocations, Rehabilitation, and Repair (OMRR&R) costs for each of the project alternatives.

### 1.1.2 NED Benefit Categories Considered

The NED procedure manuals for coastal and urban areas recognize four primary categories of benefits for flood risk management measures: inundation reduction, intensification, location, and employment benefits. The majority of the benefits attributable to a project alternative generally result from the reduction of actual or potential damages caused by inundation. Inundation reduction includes the reduction of physical damages to structures, contents, and vehicles and indirect losses to the national economy.

**Physical Flood Damage Reduction.** Physical flood damage reduction benefits include the decrease in potential damages to residential and commercial structures, their contents, and the privately owned vehicles associated with these structures.

**Emergency Cost Reduction Benefits.** Emergency costs are those costs incurred by a community during and immediately following a major storm. The cost of debris removal from inundated residential and non-residential structures was the only emergency cost reduction benefit considered for this analysis.

## 1.2 DESCRIPTION OF THE STUDY AREA

### 1.2.1 Geographic Location

The ART study area includes the Amite River Basin in addition to an influence area directly south of the basin, which extends to the Mississippi River. The area includes portions of four Mississippi counties: Amite, Lincoln, Franklin, and Wilkinson in the upper portion of the basin; and portions of eight Louisiana parishes: East Feliciana, St. Helena, East Baton Rouge, Livingston, Iberville, St. James, St. John the Baptist, and Ascension in the mid- to lower-basin. An inventory of residential and non-residential structures was developed for the portions of these counties and parishes within the HEC-RAS modeled area. Figure F:1-1 shows the structure inventory and the boundaries of the counties/parishes along with the study area boundary.

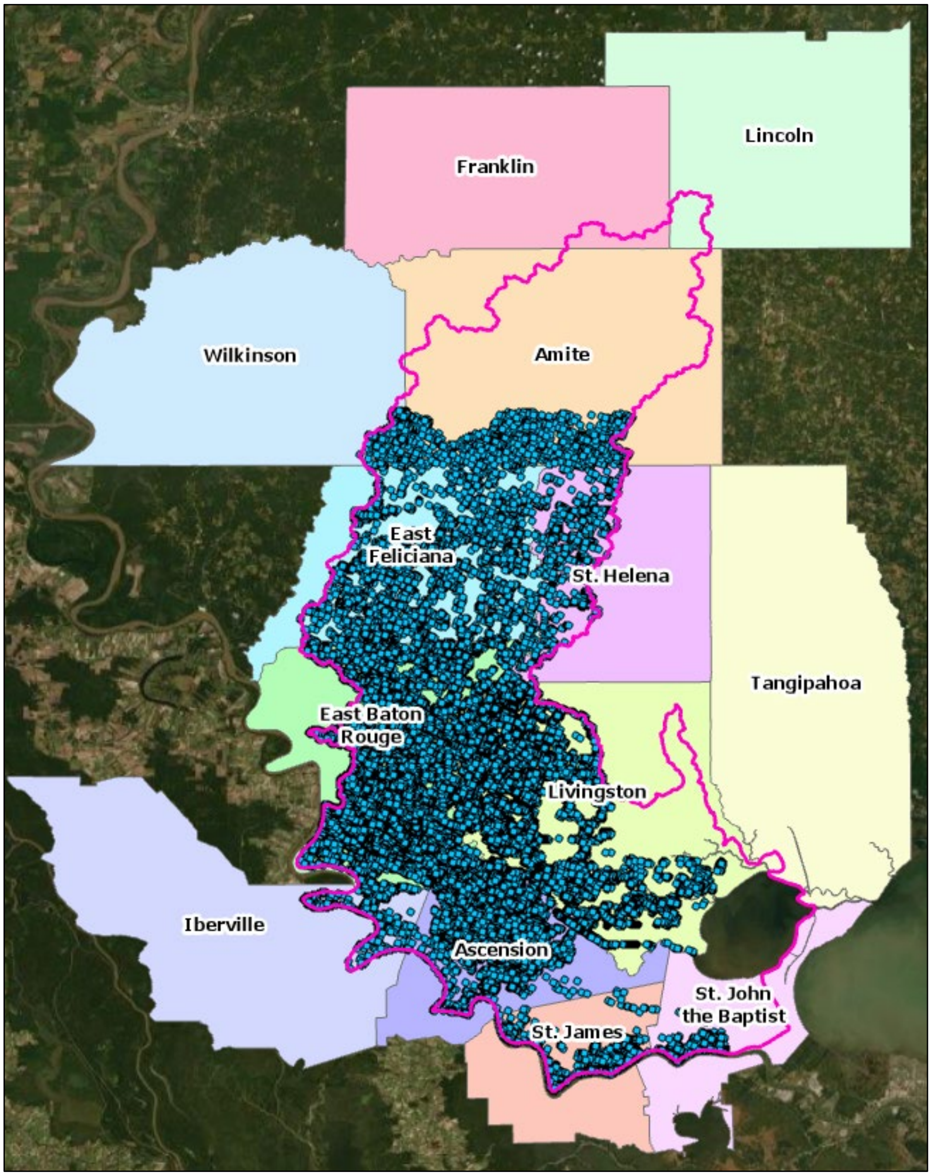



*Figure F:1-1. Parish/County Boundaries, Structure Inventory, and Study Area Boundary*

The portion of the study area included in the hydraulic model was divided into 106 reaches with each of the structure points functioning as a station. These settings were used to calculate flood damages using version 1.4.2 of the HEC-FDA certified model. Figure F:1-2 shows the study area reach boundaries for the ART study area.

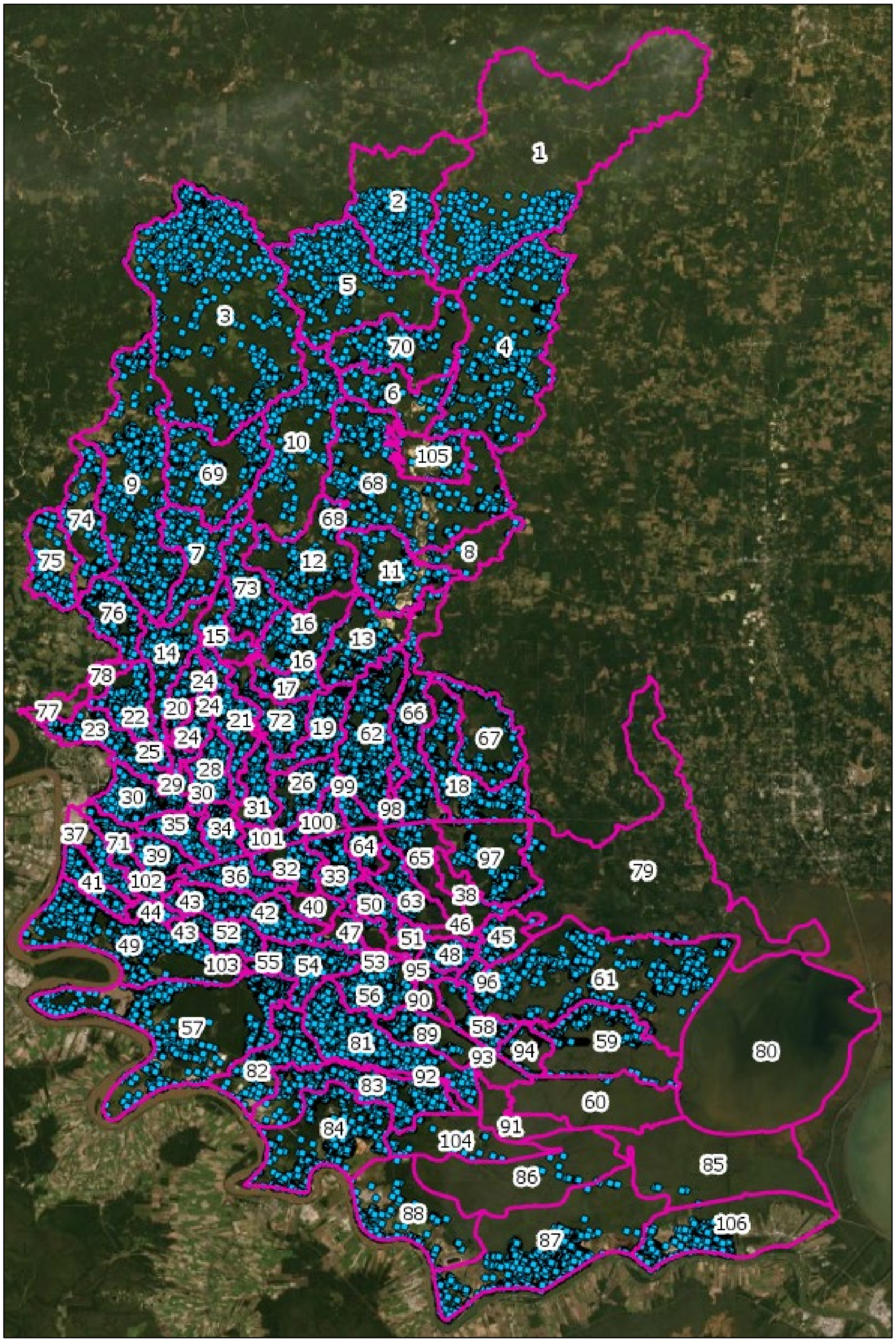



*Figure F:1-2. Study Area Reaches with Structure Inventory*

### 1.2.2 Land Use

The total number of acres of developed, agricultural, and undeveloped land in the study area is shown in Table F:1-1. As shown in the table, undeveloped land makes up the majority of the study area with 13 percent of the total acres categorized as developed land.

*Table F:1-1. Land Use in the Study Area*

| Land Class Name | Acres | Percentage of Total |
|---|---|---|
| Developed Land | 945,085 | 13% |
| Agricultural Land | 986,813 | 14% |
| Undeveloped Land | 5,097,445 | 73% |
| Total | 7,029,343 | 100% |

Source: USGS National Land Cover Database 2015

## 1.3 SOCIOECONOMIC SETTING

### 1.3.1 Population, Number of Households, and Employment

Tables F:1-2, F:1-3, and F:1-4 display the population, number of households, and the employment (number of jobs) for each of the parishes and counties for the years 2000, 2010, and 2017 as well as projections for the years 2025 and 2045. The 2000 and 2010 population, number of households and employment is based on estimates from the 2010 U.S. Census and the projections were developed by Moody’s Analytics (ECCA) Forecast, which has projections to the year 2045.

*Table F:1-2 Historical and Projected Population by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 76,627 | 107,215 | 122,948 | 136,988 | 161,973 |
| East Baton Rouge | 412,852 | 440,171 | 446,268 | 441,495 | 415,720 |
| East Feliciana | 21,360 | 20,267 | 19,412 | 18,140 | 15,910 |
| Iberville | 33,320 | 33,387 | 33,027 | 31,166 | 27,428 |
| Livingston | 91,814 | 128,026 | 138,228 | 150,306 | 166,260 |
| St. Helena | 10,525 | 11,203 | 10,363 | 9,681 | 8,592 |
| St. James | 21,201 | 22,006 | 21,790 | 22,599 | 23,727 |
| St. John the Baptist | 43,248 | 45,621 | 44,078 | 45,713 | 47,995 |
| Amite | 13,599 | 13,131 | 12,447 | 11,992 | 11,680 |
| Franklin | 8,448 | 8,118 | 7,765 | 7,517 | 7,476 |
| Lincoln | 33,166 | 34,869 | 34,347 | 35,400 | 36,479 |
| Wilkinson | 10,312 | 9,878 | 8,804 | 8,335 | 7,823 |
| Total | 776,472 | 873,893 | 899,477 | 919,332 | 931,063 |

Sources: 2000, 2010, 2017 from U.S. Census Bureau; 2025, 2045 from Moody's Analytics (ECCA) Forecast

*Table F:1-1. Existing Condition and Projected Households by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 26,995 | 38,050 | 44,890 | 51,815 | 66,244 |
| East Baton Rouge | 156,740 | 172,440 | 179,910 | 184,008 | 186,082 |
| East Feliciana | 6,694 | 6,996 | 6,922 | 6,752 | 6,411 |
| Iberville | 10,697 | 11,075 | 11,229 | 11,137 | 10,643 |
| Livingston | 32,997 | 46,297 | 52,184 | 57,891 | 69,149 |
| St. Helena | 3,890 | 4,323 | 4,116 | 3,995 | 3,810 |
| St. James | 7,002 | 7,691 | 7,945 | 8,561 | 9,727 |
| St. John the Baptist | 14,381 | 15,875 | 16,005 | 17,249 | 19,602 |
| Amite | 5,261 | 5,349 | 5,213 | 5,149 | 5,252 |
| Franklin | 3,205 | 3,214 | 3,118 | 3,138 | 3,272 |
| Lincoln | 12,563 | 13,313 | 13,682 | 14,272 | 15,446 |
| Wilkinson | 3,584 | 3,452 | 3,236 | 3,097 | 3,065 |
| Total | 284,008 | 328,074 | 348,450 | 367,063 | 398,703 |

Sources: 2000, 2010 from U.S. Census Bureau; 2017, 2025, 2045 from Moody’s Analytics (ECCA) Forecast

*Table F:1-2. Existing Condition and Projected Employment by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 | 2045 |
|---|---|---|---|---|---|
| Ascension | 36,431 | 49,414 | 59,670 | 65,803 | 82,614 |
| East Baton Rouge | 197,789 | 205,112 | 227,301 | 222,833 | 222,810 |
| East Feliciana | 7,811 | 7,427 | 7,866 | 7,321 | 6,820 |
| Iberville | 11,745 | 12,622 | 13,661 | 12,892 | 12,054 |
| Livingston | 42,326 | 56,675 | 66,010 | 70,000 | 82,219 |
| St. Helena | 3,830 | 4,097 | 4,171 | 3,868 | 3,649 |
| St. James | 8,102 | 8,949 | 8,940 | 9,257 | 10,448 |
| St. John the Baptist | 18,702 | 19,252 | 18,794 | 19,479 | 21,968 |
| Amite | 5,274 | 4,385 | 4,206 | 4,023 | 4,082 |
| Franklin | 3,234 | 2,866 | 2,721 | 2,650 | 2,747 |
| Lincoln | 13,981 | 12,940 | 13,614 | 13,749 | 14,784 |
| Wilkinson | 3,239 | 2,968 | 2,610 | 2,404 | 2,343 |
| Total | 352,463 | 386,704 | 429,564 | 434,280 | 466,538 |

Sources: 2000, 2010 from U.S. Bureau of Labor Statistics; 2017, 2025, 2045 from Moody’s Analytics (ECCA) Forecast

### 1.3.2 Income

Table F:1-5 shows the per capita personal income levels for the twelve parishes and counties for the years 2000, 2010, 2017, and 2025, with projections provided by Moody’s Analytics Forecast.

*Table F:1-5. Per Capita Income ($) by Parish/County*

| Parish/County | 2000 | 2010 | 2017 | 2025 |
|---|---|---|---|---|
| Ascension | 24,052 | 39,416 | 47,628 | 60,180 |
| East Baton Rouge | 27,228 | 39,651 | 48,120 | 60,048 |
| East Feliciana | 20,049 | 33,122 | 39,908 | 53,331 |
| Iberville | 18,681 | 32,342 | 38,960 | 50,288 |
| Livingston | 21,521 | 32,621 | 39,883 | 51,341 |
| St. Helena | 16,821 | 34,136 | 41,273 | 55,046 |
| St. James | 18,722 | 38,421 | 45,219 | 60,576 |
| St. John the Baptist | 20,002 | 33,894 | 41,505 | 57,423 |
| Amite | 17,923 | 25,620 | 32,225 | 41,711 |
| Franklin | 15,844 | 27,175 | 33,133 | 42,441 |
| Lincoln | 20,257 | 30,468 | 36,895 | 44,607 |
| Wilkinson | 14,667 | 24,322 | 28,745 | 37,916 |

Sources: 2000, 2010 from U.S. Census Bureau; 2017, 2025 from Moody's Analytics (ECCA) Forecast

### 1.3.3 Compliance with Policy Guidance Letter (PGL) 25 and Executive Order 11988

Given continued growth in employment and income, it is expected that development will continue to occur in the study area with or without the storm surge risk reduction system, and will not conflict with PGL 25 and EO 11988, which state that the primary objective of a flood risk reduction project is to protect existing development, rather than to make undeveloped land available for more valuable uses. However, the overall growth rate is anticipated to be the same with or without the project in place. Thus, the project would not induce development, but would rather reduce the risk of the population being displaced after a major storm event.

## 1.4 RECENT FLOOD HISTORY

### 1.4.1 Flood Events

The study area has experienced riverine flooding from excessive rainfall events in addition to incurring flood damages associated with hurricanes and tropical storms. Since 1851, the paths of 51 tropical events have crossed the study area. The paths and intensities of these storms are shown in Figure F:1-3.

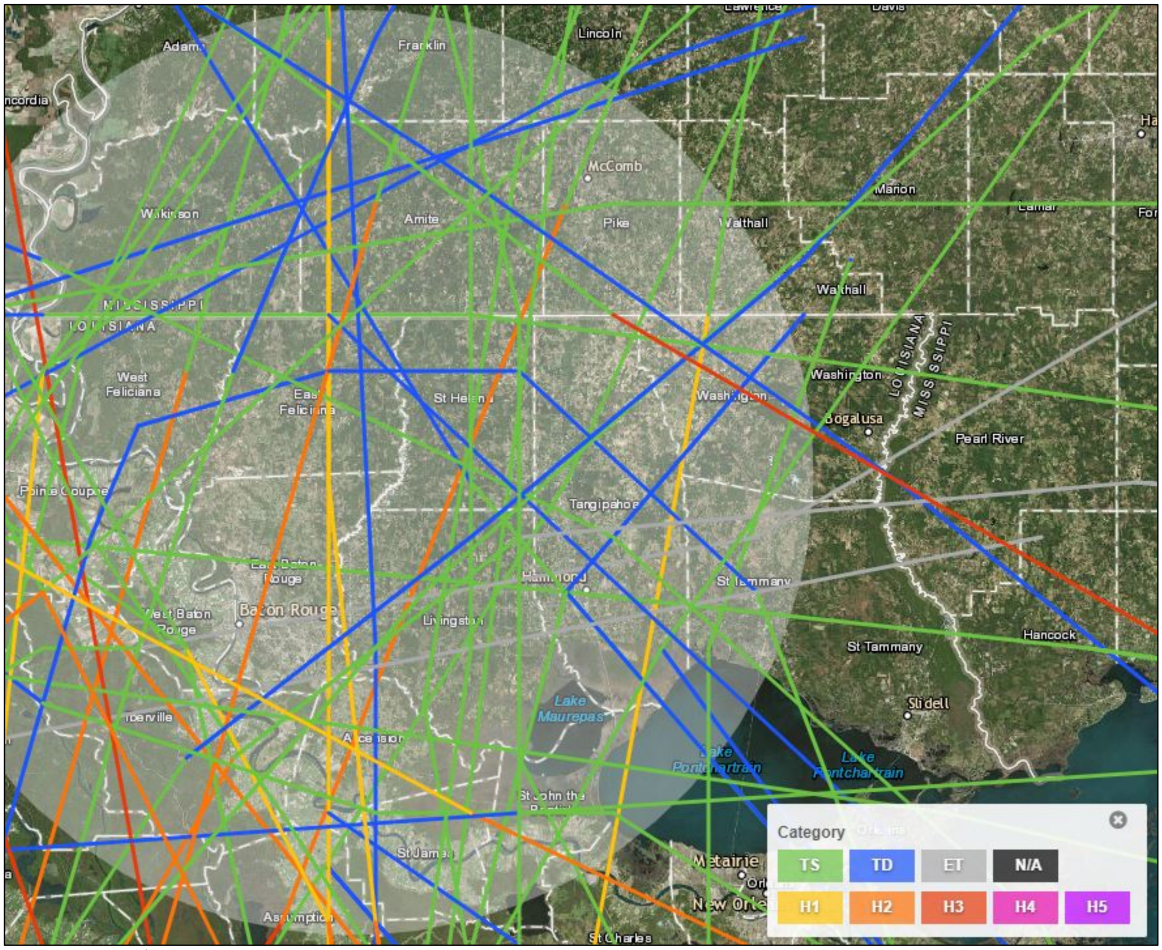



*Figure F:1-3. Hurricane and Tropical Storm Paths Since 1851*

### 1.4.2 FEMA Flood Claims

The most recent event to affect the study area was the 2016 Louisiana Floods. This event brought catastrophic flooding damage to Baton Rouge and the surrounding areas with both localized flooding and riverine flooding from the Amite and Comite Rivers and their tributaries. The FEMA flood claims for the most recent events to impact the area are shown in Table F:1-6.

Table F:1-7 shows the FEMA flood claims paid between January 1978 and September 2018 for all counties and parishes in the study area. The table includes the number of claims, number of paid losses, and the total amount paid in the dollar value at the time of the payment. The table excludes losses that were not covered by flood insurance.

*Table F:1-6. Top Tropical Storms by Amount Paid by FEMA*

| Event | Month & Year | Number of Paid Claims | Total Amount Paid (millions) |
|---|---|---|---|
| 2016 Louisiana Floods | August 2016 | 26,909 | $2,455.7 |
| Tropical Storm Lee | September 2011 | 9,900 | $462.2 |
| Hurricane Ike | September 2008 | 46,684 | $2,700.1 |
| Hurricane Gustav | September 2008 | 4,545 | $112.6 |
| Hurricane Rita | September 2005 | 9,354 | $466.2 |
| Hurricane Andrew | August 1992 | 5,587 | $169.1 |

Source: Federal Emergency Management Agency (FEMA)

Note 1: Total amount paid is at price level at time of the event.
Note 2: Claims and amount paid are for entire event, which may include areas outside of the study area.

*Table F:1-7. FEMA Flood Claims by Parish/County (January 1978-September 2018)*

| Parish/County | Total Number of Claims | Number of Paid Claims | Total Payments (millions) |
|---|---|---|---|
| Ascension | 6,606 | 5,658 | $336.8 |
| East Baton Rouge | 19,926 | 17,139 | $1,170.6 |
| East Feliciana | 83 | 72 | $2.8 |
| Iberville | 540 | 453 | $7.8 |
| Livingston | 14,394 | 12,684 | $813.9 |
| St. Helena | 51 | 38 | $2.3 |
| St. James | 249 | 204 | $6.2 |
| St. John the Baptist | 4,942 | 3,996 | $264.2 |
| Amite | 4 | 4 | $0.0 |
| Franklin | 3 | 1 | $0.0 |
| Lincoln | 23 | 16 | $0.1 |
| Wilkinson | 1,883 | 1,603 | $21.0 |
| Total | 48,704 | 41,868 | $2,625.8 |

Source: Federal Emergency Management Agency (FEMA)

# Section 2

# Economic and Engineering Inputs to the HED-FDA Model

## 2.1 HEC-FDA MODEL

### 2.1.1 Model Overview

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.4.2 Corps-certified model was used to calculate the damages and benefits for the Amite River and Tributaries FRM evaluation. The economic and engineering inputs necessary for the model to calculate damages for the project base year (2026) include the existing condition structure inventory, contents-to-structure value ratios, vehicle inventory, foundation heights, ground elevations, depth-damage relationships, and without-project and with-project stage-probability relationships.

The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution (with a mean value and a standard deviation) or a triangular probability distribution (with a most likely maximum, and minimum value) was entered into the model to quantify the uncertainty associated with the key economic variables. A normal probability distribution was entered into the model to quantify the uncertainty surrounding the first floor elevations. While normal distributions were preferred to represent the uncertainty in the economic variables, triangular distributions were utilized in select variables where not enough observations were known to fully develop a normal distribution. Instead of modeling without uncertainty, the economics team decided to use a triangular distribution to represent known variations in the data. The number of years that stages were recorded at a given gauge was entered for each study area reach to quantify the hydrologic uncertainty or error surrounding the stage-probability relationships.

## 2.2 ECONOMIC INPUTS TO THE HEC-FDA MODEL

### 2.2.1 Structure Inventory

A structure inventory of residential and non-residential structures within East Baton Rouge Parish was created from parcel data. After the parcels were converted to centroid points, the following modifications were made:

- Structures located within the parish, but outside of the study area boundary, were removed from the structure inventory database;
- Ground elevations were assigned based on LiDAR data used in the hydraulic model, and foundation heights were assigned based on Google Earth Street View and sampling techniques;
- Parcel resource types were assigned a corresponding occupancy from the 2019 RSMeans Square Foot Catalog;

- Total depreciated structure values were calculated based on the 2019 RSMeans Square Foot Catalog;
- Depth-damage functions were assigned to structure categories and structure occupancies;
- Stations (smaller geographic areas within a reach having consistent water surface profiles) and study area reaches (larger geographic area, containing stations, used to report damage results) were assigned to individual structures using GIS tools.

A structure inventory of residential and non-residential structures for the remainder of the study outside of East Baton Rouge Parish was obtained through the second version of the National Structure Inventory (NSI). After collection, the following modifications were made:

- Ground elevations were assigned based on the LiDAR data used in the hydraulic model, and foundation heights were assigned based on Google Earth Street View and sampling techniques;
- NSI occupancy types were assigned a corresponding occupancy from the 2019 RSMeans Square Foot Catalog;
- Total depreciated structure values were calculated based on the 2019 RSMeans Square Foot Catalog;
- Depth-damage functions were assigned to structure categories and structure occupancies;
- Stations (smaller geographic areas within a reach having consistent water surface profiles) and study area reaches (larger geographic area, containing stations, used to report damage results) were assigned to individual structures using GIS tools.

Table F:2-1 shows the total number of residential, mobile homes, commercial, industrial, and vehicles associated with residential units by study area reach.

*Table F:2-1. Number of Structures in the Existing Condition by Category*

| Reach Name | Residential | Commercial | Industrial | Total Structures |
|---|---|---|---|---|
| 1 | 317 | 1 | 1 | 319 |
| 2 | 356 | 4 | 1 | 361 |
| 3 | 2,241 | 127 | 25 | 2,393 |
| 4 | 731 | 17 | 6 | 754 |
| 5 | 373 | 6 | 4 | 383 |
| 6 | 153 | 8 | 0 | 161 |
| 7 | 634 | 13 | 12 | 659 |
| 8 | 34 | 0 | 0 | 34 |
| 9 | 2,295 | 94 | 35 | 2,424 |
| 10 | 573 | 16 | 10 | 599 |
| 11 | 387 | 5 | 30 | 422 |
| 12 | 731 | 5 | 5 | 741 |
| 13 | 916 | 26 | 19 | 961 |
| 14 | 2,025 | 86 | 47 | 2,158 |
| 15 | 383 | 4 | 6 | 393 |
| 16 | 957 | 9 | 13 | 979 |
| 17 | 743 | 14 | 3 | 760 |
| 18 | 1,886 | 157 | 47 | 2,090 |
| 19 | 4,186 | 126 | 55 | 4,367 |
| 20 | 958 | 8 | 4 | 970 |
| 21 | 4,157 | 62 | 8 | 4,227 |
| 22 | 4,770 | 181 | 64 | 5,015 |
| 23 | 4,941 | 288 | 193 | 5,422 |
| 24 | 1,624 | 18 | 8 | 1,650 |
| 25 | 657 | 13 | 16 | 686 |
| 26 | 4,580 | 296 | 79 | 4,955 |
| 27 | 1,045 | 18 | 1 | 1,064 |
| 28 | 3,986 | 160 | 29 | 4,175 |
| 29 | 195 | 6 | 9 | 210 |
| 30 | 12,900 | 1,026 | 248 | 14,174 |
| 31 | 3,359 | 41 | 18 | 3,418 |
| 32 | 1,947 | 154 | 92 | 2,193 |

*Table F:2-1. Number of Structures in the Existing Condition by Category*

| Reach Name | Residential | Commercial | Industrial | Total Structures |
|---|---|---|---|---|
| 33 | 2,756 | 121 | 50 | 2,927 |
| 34 | 7,243 | 488 | 240 | 7,971 |
| 35 | 6,354 | 1,200 | 451 | 8,005 |
| 36 | 7,527 | 804 | 217 | 8,548 |
| 37 | 7,234 | 762 | 151 | 8,147 |
| 38 | 58 | 3 | 2 | 63 |
| 39 | 6,506 | 1,057 | 182 | 7,745 |
| 40 | 485 | 14 | 7 | 506 |
| 41 | 7,953 | 1,025 | 75 | 9,053 |
| 42 | 10,110 | 1,164 | 547 | 11,821 |
| 43 | 1,086 | 127 | 61 | 1,274 |
| 44 | 2,478 | 194 | 54 | 2,726 |
| 45 | 364 | 2 | 0 | 366 |
| 46 | 73 | 3 | 0 | 76 |
| 47 | 418 | 2 | 11 | 431 |
| 48 | 643 | 21 | 9 | 673 |
| 49 | 13,977 | 1,642 | 323 | 15,942 |
| 50 | 1,082 | 25 | 4 | 1,111 |
| 51 | 511 | 15 | 14 | 540 |
| 52 | 4,526 | 607 | 215 | 5,348 |
| 53 | 276 | 6 | 6 | 288 |
| 54 | 5,524 | 347 | 151 | 6,022 |
| 55 | 528 | 69 | 20 | 617 |
| 56 | 3,911 | 104 | 39 | 4,054 |
| 57 | 4,336 | 290 | 150 | 4,776 |
| 58 | 1,149 | 42 | 16 | 1,207 |
| 59 | 1,864 | 8 | 3 | 1,875 |
| 60 | 32 | 0 | 0 | 32 |
| 61 | 1,777 | 27 | 19 | 1,823 |
| 62 | 4,859 | 112 | 62 | 5,033 |
| 63 | 2,476 | 39 | 22 | 2,537 |

*Table F:2-1. Number of Structures in the Existing Condition by Category*

| Reach Name | Residential | Commercial | Industrial | Total Structures |
|---|---|---|---|---|
| 64 | 1,572 | 18 | 12 | 1,602 |
| 65 | 1,080 | 30 | 15 | 1,125 |
| 66 | 3,258 | 268 | 68 | 3,594 |
| 67 | 476 | 8 | 6 | 490 |
| 68 | 610 | 14 | 10 | 634 |
| 69 | 740 | 69 | 17 | 826 |
| 70 | 210 | 1 | 1 | 212 |
| 71 | 9,081 | 1,311 | 218 | 10,610 |
| 72 | 2,690 | 93 | 30 | 2,813 |
| 73 | 948 | 10 | 12 | 970 |
| 74 | 359 | 23 | 5 | 387 |
| 75 | 432 | 10 | 2 | 444 |
| 76 | 2,447 | 94 | 25 | 2,566 |
| 77 | 29 | 1 | 0 | 30 |
| 78 | 40 | 0 | 0 | 40 |
| 79 | 242 | 2 | 1 | 245 |
| 81 | 9,155 | 493 | 217 | 9,865 |
| 82 | 5,389 | 264 | 165 | 5,818 |
| 83 | 4,863 | 454 | 132 | 5,449 |
| 84 | 3,075 | 331 | 143 | 3,549 |
| 85 | 0 | 0 | 0 | 0 |
| 86 | 16 | 0 | 0 | 16 |
| 87 | 3,964 | 273 | 80 | 4,317 |
| 88 | 319 | 35 | 19 | 373 |
| 89 | 1,203 | 41 | 29 | 1,273 |
| 90 | 178 | 10 | 0 | 188 |
| 92 | 525 | 32 | 8 | 565 |
| 93 | 20 | 2 | 1 | 23 |
| 94 | 575 | 24 | 6 | 605 |
| 95 | 574 | 17 | 2 | 593 |
| 96 | 205 | 3 | 0 | 208 |
| 97 | 811 | 37 | 17 | 865 |

*Table F:2-1. Number of Structures in the Existing Condition by Category*

| Reach Name | Residential | Commercial | Industrial | Total Structures |
|---|---|---|---|---|
| 98 | 1,221 | 55 | 13 | 1,289 |
| 99 | 1,064 | 97 | 38 | 1,199 |
| 100 | 2,248 | 268 | 74 | 2,590 |
| 101 | 3,056 | 395 | 106 | 3,557 |
| 102 | 1,238 | 108 | 11 | 1,357 |
| 103 | 532 | 23 | 17 | 572 |
| 104 | 39 | 11 | 6 | 56 |
| 105 | 94 | 0 | 0 | 94 |
| 106 | 2,255 | 189 | 83 | 2,527 |
| Total | 239,989 | 18,423 | 5,778 | 264,190 |

**Structure Values.** The 2019 RSMeans Square Foot Costs Data catalog (RSMeans catalog) was used to assign a depreciated replacement cost to the residential and non-residential structures in the study area reaches. Residential replacement costs per square foot were provided for four exterior walls types (wood siding on wood frame, brick veneer on wood frame, stucco on wood frame, and solid masonry) and three sizes (1-story, 2-story, and split-level) for homes constructed with average quality materials. An average replacement cost per square foot for the four exterior wall types was calculated for each size. Based on windshield surveys, it was determined that the majority of the structures in the study area were in average condition, with an approximate age of 20 years. The associated depreciation proportion was used to calculate a most-likely depreciated square foot cost. An additional regional adjustment factor (85 percent of the national square foot costs) for the Baton Rouge area was then applied to the depreciated cost per square foot. The square footage for each of the individual residential structures was multiplied by the most-likely depreciated cost per square for the average construction class to obtain a total depreciated cost. Finally, the Marshall and Swift Valuation Service was used to calculate a depreciated replacement cost per square foot for the manufactured or mobile homes in the study area.

Non-residential replacement costs per square foot were provided in the RSMeans catalog for six exterior wall types, which were specific to each occupancy type. An average replacement cost per square foot was calculated for each of the six exterior wall types in each non-residential occupancy. The RSMeans catalog depreciation schedule for non-residential structures provides depreciation percentages for three building materials: frame, masonry on wood, and masonry on masonry or steel. Based on windshield surveys, it was determined that the majority of the structures in the study area were built with masonry on wood, with an observed age of 20 years. The associated depreciation proportion was used to calculate a most-likely depreciated square foot cost. An additional regional adjustment factor (85 percent of the national square foot costs) for the Baton Rouge area was then applied to the depreciated cost per square foot. The square footage for each of the individual structures was multiplied by the most-likely depreciated cost per square foot for each non-residential occupancy to obtain a total depreciated cost.

Table F:2-2 shows the average depreciated replacement cost for residential and non-residential structure categories.

*Table F:2-2. Residential and Non-Residential Structure Inventory (FY19, $1,000s)*

| Category | Occupancy Type | Number | Average Depreciated Replacement Value |
|---|---|---|---|
| Residential | 1-Story Slab | 115,320 | $192.5 |
| | 1-Story Pier | 60,859 | $190.8 |
| | 2-Story Slab | 31,552 | $212.4 |
| | 2-Story Pier | 16,241 | $219.2 |
| | Mobile Home | 16,017 | $26.9 |
| | **Total Residential** | **239,989** | |
| Non-Residential | Eating and Recreation | 2,076 | $1,275.4 |
| | Professional | 5,128 | $827.7 |
| | Public and Semi-Public | 1,901 | $1,133.8 |
| | Repair and Home Use | 2,112 | $731.1 |
| | Retail and Personal Services | 4,487 | $845.6 |
| | Warehouse | 5,647 | $729.4 |
| | Multi-Family Occupancy | 2,463 | $920.3 |
| | **Total Non-Residential** | **23,814** | |
| Autos | Vehicles | 238,161 | $10.1 |

**Structure Value Uncertainty.** A triangular probability distribution based on the depreciated replacement costs was used to represent the uncertainty surrounding the residential structure values in each occupancy category. The most-likely depreciated value for residential structures was based a 20 percent depreciation rate (consistent with an estimated age of a 20-year old structure in average condition), the minimum value was based on a 45 percent depreciation rate (consistent with an estimated age of a 30-year old structure in poor condition), and the maximum value was based on a 7 percent depreciation rate (consistent with an estimated age of a 10-year old structure in good condition). These values were then converted to a percentage of the most-likely value with the most-likely value equal to 100 percent of the average value for each occupancy category. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values in each residential occupancy category.

A triangular probability distribution based on the depreciated replacement costs was used to represent the uncertainty surrounding the non-residential structure values in each occupancy category. The most-likely depreciated value for non-residential structures was based a 25 percent depreciation rate (consistent with an observed age of a 20-year old masonry on wood structure), the minimum value was based on a 40 percent depreciation rate (consistent with an observed age of a 30-year old frame structure), and the maximum value was based on an 8 percent depreciation rate (consistent with an observed age of a 10-year old masonry on masonry or steel structure). These values were then converted to a percentage of the most-likely value with the most-likely value equal to 100 percent of the average value for each occupancy category. The triangular probability distributions were entered into the HEC-FDA model to represent the uncertainty surrounding the structure values in each non-residential occupancy category.

Table F:2-3 shows the minimum and maximum percentages of the most-likely structure values assigned to the various structure categories.

*Table F:2-3. Structure Value Uncertainty Parameters*

| Category | Occupancy Type | Structure Value Error | |
|---|---|---|---|
| | | Lower (%) | Upper (%) |
| Residential | 1-Story Slab | 69 | 116 |
| | 1-Story Pier | 69 | 116 |
| | 2-Story Slab | 69 | 116 |
| | 2-Story Pier | 69 | 116 |
| | Mobile Home | 48 | 147 |
| Non-Residential | Eating and Recreation | 80 | 123 |
| | Professional | 80 | 123 |
| | Public and Semi-Public | 80 | 123 |
| | Repair and Home Use | 80 | 123 |
| | Retail and Personal Services | 80 | 123 |
| | Warehouse | 80 | 123 |
| | Multi-Family Occupancy | 80 | 123 |

### 2.2.2 Residential and Non-Residential Content-to-Structure Value Ratios

The content-to-structure value ratios (CSVRs) applied to the residential and non-residential structure occupancies were taken from an extensive survey of owners in coastal Louisiana for three large CSRM evaluations. These interviews included a sampling from residential and non-residential content categories from each of the three evaluation areas.

Since only a limited number of property owners participated in the field surveys and the participants were not randomly selected, statistical bootstrapping was performed to address the potential sampling error in estimating the mean and standard deviation of the CSVR values. Statistical bootstrapping uses re-sampling with replacement to improve the estimate of a population statistic when the sample size is insufficient for straightforward statistical inference. The bootstrapping method has the effect of increasing the sample size and accounts for distortions caused by a specific sample that may not be fully representative of the population.

### 2.2.3 Content-to-Structure Value Ratio Uncertainty

For each of the residential and non-residential occupancies, a mean CSVR and a standard deviation was calculated and entered into the HEC-FDA model. A normal probability density function was used to describe the uncertainty surrounding the CSVR for each content category. The expected CSVR percentage values and standard deviations for each of the residential and non-residential occupancies are shown in Table F:2-4.

*Table F:2-4. Content-to-Structure Value Ratios (CSVRs) and Standard Deviations (SDs) by Occupancy*

| Category | Occupancy Type | CSVR (%) | SD (%) |
|---|---|---|---|
| Residential | 1-Story Slab | 69 | 37 |
| | 1-Story Pier | 69 | 37 |
| | Two-Story Slab | 67 | 35 |
| | Two-Story Pier | 67 | 35 |
| | Mobile Home | 114 | 79 |
| Non-Residential | Eating and Recreation | 170 | 293 |
| | Professional | 54 | 54 |
| | Public and Semi-Public | 55 | 80 |
| | Repair and Home Use | 236 | 295 |
| | Retail and Personal Services | 119 | 105 |
| | Warehouse | 207 | 325 |
| | Multi-Family Occupancy | 28 | 17 |

### 2.2.4 Vehicle Inventory and Values

Based on 2017 Census estimates for the state of Louisiana, there are an average of 1.67 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. According to the Edmunds Used Vehicle Report, the average value of a used car was $20,250 as of the first quarter 2019. Because only those vehicles not used for evacuation can be included in the damage calculations, an adjusted average vehicle value of $10,150 ($20,250 x 1.67 x 0.30) was assigned to each individual residential automobile structure record in the HEC-FDA model. If an individual structure contained more than one housing unit, then the adjusted vehicle value was assigned to each housing unit in a residential or multi-family structure category. Only vehicles associated with residential structures were included in the analysis. Finally, every apartment building was assumed to contain 25 units so every apartment building has $253,750 as the average value for vehicles.

### 2.2.5 Vehicle Value Uncertainty

The uncertainty surrounding the values assigned to the vehicles in the inventory was determined using a triangular probability distribution function. The average value of a used car, $20,250, was used as the most-likely value. The average value of a new vehicle, $36,500, before taxes, license, and shipping charges was used as the maximum value, while the average 10-year depreciation value of a vehicle, $3,000, was used as the minimum value. The percentages were developed for the most-likely, minimum, and the maximum values with the most-likely equal to 100 percent, and the minimum and the maximum values as percentages of the most-likely value (minimum=15 percent, most-likely=100 percent, maximum=180 percent). These percentages were entered into the HEC-FDA model as a triangular probability distribution to represent the uncertainty surrounding the vehicle value.

### 2.2.6 First Floor Elevations

Topographical data based on Light Detection and Ranging (LiDAR) data using the North American Vertical Datum of 1988 (NAVD 88) were 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 (DEM) with a 2-foot by 2-foot grid resolution developed by the United States Geological Survey (USGS), which was resampled at a 40-foot by 40-foot resolution. This ground elevation raster was obtained from the HEC-RAS hydraulic model to avoid continuity errors between the engineering and economic inputs. 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.

**Sampling of Foundation Heights Above Ground.** The foundation heights of the residential and non-residential structures above the ground were determined using statistical random sampling procedures. Sampling was necessary due to varying types of structure foundations (slab on grade and pier/pile) and the large variation in the heights of these foundations above the ground elevation. Statistical formulas were used to account for the estimated variation, acceptable error, and level of confidence and to determine a statistically significant number of structures to be surveyed. A focused Agency Technical Review (ATR) was conducted in on this process in April of 2017 to confirm the adequacy of the sampling techniques used to develop the results.

The East Baton Rouge portion of the study area was divided into 58 neighborhoods, which were used to stratify the sample and ensure the entire area was sampled from. A total of 347 residential and non-residential structures were randomly selected for the sample in East Baton Rouge Parish. If a selected structure had been demolished or razed, then an adjacent structure was surveyed in its place. The survey team used Google Earth to collect the required information including the height of the foundation above ground (measured from the bottom of the front door to adjacent ground), the foundation type (slab or pier), and the number of stories (1-story, and 2 or more stories). This information was used to develop the average height above ground of slab on grade and pier/pile foundation structures in each neighborhood, the proportion of slab on grade foundations and pier/pile foundations, and the proportion of 1-story and 2-story structures in each neighborhood.

The mean foundation height and proportions of sampled residential 1-story and 2-story pile foundation structures and residential 1-story and 2-story slab foundation structures were applied to all the unsampled residential structures in each East Baton Rouge neighborhood. The mean foundation height and proportions of the sampled commercial 1-story and 2-story pile foundation structures and commercial 1-story and 2-story slab foundation structures were randomly applied to the unsampled commercial structures in each neighborhood. Since the commercial depth-damage relationships are only provided for commercial 1-story structures, all the commercial structures were treated as 1-story structures.

The remainder of the study area was stratified by the occupancy and foundation types provided in the National Structure Inventory. A total of 357 residential and non-residential structures were randomly selected for the sample outside of East Baton Rouge Parish. If a selected structure had been demolished or razed, then an adjacent structure was surveyed in its place. The survey team used Google Earth to collect the required information including the height of the foundation above ground (measured from the bottom of the front door to adjacent ground) and the foundation type (slab or pier). This information was used to develop the average height above ground of slab on grade and pier/pile foundation structures and the proportion of slab on grade foundations and pier/pile foundations.

The mean foundation height and proportions of sampled residential 1-story and 2-story pile foundation structures and residential 1-story and 2-story slab foundation structures were applied to all the unsampled residential structures outside East Baton Rouge Parish. The mean foundation height and proportions of the sampled commercial 1-story and 2-story pile foundation structures and commercial 1-story and 2-story slab foundation structures were randomly applied to the unsampled commercial structures. Since the commercial depth-damage relationships are only provided for commercial 1-story structures, all the commercial structures were treated as 1-story structures.

### 2.2.7 Uncertainty Surrounding Elevations

There are two sources of uncertainty surrounding the first floor elevations: the use of the LiDAR data for the ground elevations, and the methodology used to determine the structure foundation heights above ground elevation. The error surrounding the LiDAR data was determined to be plus or minus 0.5895 feet at the 95 percent level of confidence. This uncertainty was normally distributed with a mean of zero and a standard deviation of 0.3 feet.

The uncertainty surrounding the foundation heights for the residential and commercial structures was estimated by calculating the standard deviations surrounding the sampled mean values for the combined inventory. An overall weighted average standard deviation for the four structure groups was computed for each structure category. The standard deviation was calculated to be 0.75 feet for residential pier foundation structures and 0.25 feet for slab foundation structures. The standard deviation for non-residential structures was calculated to be 0.64 feet.

The standard deviations for the ground elevations and foundation heights were combined, which resulted in a 0.81 feet standard deviation for residential pier foundation structures and 0.439 for slab foundation structures. For non-residential structures, the combined standard deviation was calculated to be 0.71 feet. Table F:2-5 displays the calculations used to combine the uncertainty surrounding the ground elevations with uncertainty surrounding the foundation height to derive the uncertainty surrounding the first floor elevations of residential and non-residential structures. Table F:2-6 displays the average foundation heights and standard deviations by occupancy type.

*Table F:2-5. First Floor Stage Uncertainty Standard Deviation (SD) Calculation*

**Ground - LiDAR**

(conversion cm to inches to feet)

| | | |
|---|---|---|
| +/- 18 cm @ 95% confidence | | 18cm |
| | x | 0.393 |
| z = (x - u)/ std. dev. | | 7.074in |
| | ÷ | 12 |
| 1.96 = (0.5895 - 0)/ std.dev.<br>0.3007 = std.dev. | | 0.5895ft |

**Foundation Height**

(shown in feet)

| Residential | | Commercial | Industrial |
|---|---|---|---|
| Pier | Slab | All | All |
| 0.75 | 0.25 | 0.64 | 0.64 |

**Combined First Floor**

(shown in feet)

| Residential | | Commercial | Industrial | |
|---|---|---|---|---|
| Pier | Slab | All | All | |
| 0.30 | 0.30 | 0.30 | 0.30 | ground std. dev. |
| 0.09 | 0.09 | 0.09 | 0.09 | ground std. dev. Squared |
| 0.75 | 0.25 | 0.64 | 0.64 | 1st floor std. dev. |
| 0.56 | 0.06 | 0.41 | 0.41 | 1st floor std. dev. squared |
| 0.65 | 0.15 | 0.50 | 0.50 | Sum of Squared |
| **0.81** | **0.39** | **0.71** | **0.71** | **Square Root of Sum of Squared = Combined Std. Dev.** |

Note 1: Mobile Homes are assigned the same uncertainty as Residential Pier.

Note 2: Autos do not have foundations, so only ground uncertainty is used.

*Table F:2-6. Average Foundation Heights and Standard Deviations (SD) by Occupancy Type (feet)*

| Category | Occupancy Type | Average Foundation Height | Standard Deviations | | |
|---|---|---|---|---|---|
| | | | Ground Stage SD | Foundation Height SD | First Floor SD |
| Residential | 1-Story Slab | 0.58 | 0.30 | 0.25 | 0.39 |
| | 1-Story Pier | 1.97 | 0.30 | 0.75 | 0.81 |
| | 2-Story Slab | 0.63 | 0.30 | 0.25 | 0.39 |
| | 2-Story Pier | 2.00 | 0.30 | 0.75 | 0.81 |
| | Mobile Home | 3.15 | 0.30 | 0.75 | 0.81 |
| Non-Residential | Eating and Recreation | 0.65 | 0.30 | 0.64 | 0.71 |
| | Professional | 0.63 | 0.30 | 0.64 | 0.71 |
| | Public and Semi-Public | 0.65 | 0.30 | 0.64 | 0.71 |
| | Repair and Home Use | 0.64 | 0.30 | 0.64 | 0.71 |
| | Retail and Personal Services | 0.64 | 0.30 | 0.64 | 0.71 |
| | Warehouse | 0.64 | 0.30 | 0.64 | 0.71 |
| | Multi-Family Occupancy | 0.62 | 0.30 | 0.64 | 0.71 |
| Autos | Vehicles | 0.00 | 0.30 | 0.00 | 0.30 |

### 2.2.8 Debris Removal Costs

Debris removal costs are typically discussed in the "Other Benefit Categories" section of the Economic Appendix. However, since debris removal costs were included as part of the HEC-FDA structure records for the individual residential and non-residential structures in the Amite study area, these costs are being treated as an economic input. The HEC-FDA model does not report debris removal costs separately from the total expected annual without-project and with-project damages.

Following Hurricanes Katrina and Rita, interviews were conducted with experts in the fields of debris collection, processing and disposal to estimate the cost of debris removal following a storm event. Information obtained from these interviews was used to assign debris removal costs for each residential and non-residential structure in the structure inventory. The experts provided a minimum, most likely, and maximum estimate for the cleanup costs associated with the 2 feet, 5 feet, and 12 feet depths of flooding. A prototypical structure size in square feet was used for the residential occupancy categories and for the non-residential occupancy categories. The experts were asked to estimate the percentage of the total cleanup caused by floodwater and to exclude any cleanup that was required by high winds.

In order to account for the cost/damage surrounding debris cleanup, values for debris removal were incorporated into the structure inventory for each record according to its occupancy type. These values were then assigned a corresponding depth-damage function with uncertainty in the HEC-FDA model. For all structure occupancy types, 100 percent damage was reached at 12 feet of flooding. All values and depth-damage functions were selected according to the freshwater flooding data specified in a report titled "Development of Depth-Emergency Cost and Infrastructure Damage Relationships for Selected South Louisiana Parishes." The debris clean-up values provided in the report were expressed in 2010 price levels for the New Orleans area. These values were converted to 2019 price levels using the indexes provided by Gordian's 40th edition of "Square Foot Costs with RSMeans Data." The debris removal costs were included as the "other" category on the HEC-FDA structure records for the individual residential and non-residential structures and used to calculate the expected annual without-project and with-project debris removal and cleanup costs.

### 2.2.9 Debris Removal Costs Uncertainty

The uncertainty surrounding debris percentage values at 2-feet, 5-feet and 12-feet depths of flooding were based on range of values provided by the four experts in the fields of debris collection, processing, and disposal. The questionnaires used in the interview process were designed to elicit information from the experts regarding the cost of each stage of the debris cleanup process by structure occupancy type. The range of responses from the experts were used to calculate a mean value and standard deviation value for the cleanup costs percentages provided at 2-feet, 5-feet, and 12-feet depths of flooding. The mean values and the standard deviation values were entered into the HEC-FDA model as a normal probability distribution to represent the uncertainty surrounding the costs of debris removal for residential and non-residential structures. The depth-damage relationships containing the damage percentages at the various depths of flooding and the corresponding standard deviations representing the uncertainty are shown with in the depth–damage tables.

### 2.2.10 Depth-Damage Relationships

The depth-damage relationships, developed by a panel of building and construction experts for the Lower Atchafalaya and Morganza to the Gulf, Louisiana feasibility studies, were used in the economic analysis. These relationships were deemed appropriate because the two study areas are geographically close and have similar structure categories and occupancies. Because the ART study area is mainly impacted by riverine and rainfall flooding, the long-duration freshwater (2 to 3 days) depth-damage curves were selected.

Depth-damage relationships indicate the percentage of the total structure and content value that would be damaged at various depths of flooding. For residential structures, damage percentages were provided at each 1-foot increment from 2 feet below the first floor elevation to 16 feet above the first floor elevation for the structural components and the content components. Damage percentages were determined for each 0.5- foot increment from 0.5-foot below first floor elevation to 2 feet above first floor, and for each 1-foot increment from 2 feet to 15 feet above first floor elevation for non-residential structures. Vehicle damage relationships were provided from 0.5-foot above the ground to 3 feet above the ground (which corresponds to a total loss of the vehicle's value).

### 2.2.11 Uncertainty Surrounding Depth-Damage Relationships

A triangular probability density function was used to determine the uncertainty surrounding the damage percentage associated with each depth of flooding for all occupancy types. A minimum, maximum, and most-likely damage estimate was provided by a panel of experts for each depth of flooding. The specific range of values regarding probability distributions for the depth-damage curves can be found in the final report dated May 1997 entitled *Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies.* The specific range of values regarding probability distributions for the debris depth-damage curves can be found in the final report dated March 2012 entitled *Development of Depth-Emergency Cost and Infrastructure Damage Relationships for Selected South Louisiana Parishes.*

Tables F:2-6 through F:2-10 show the damage relationships for structures, contents, vehicles, and debris removal. The tables contain the damage percentages at each depth of flooding along with the uncertainty surrounding the damage percentages.

*Table F:2-6. Depth-Damage Relationships for Structures, Contents, Vehicles, and Debris Removal*

| Residential 1-Story Pier 1STY-PIER | | | | Residential 1-Story Slab 1STY-SLAB | | | | Residential 2-Story Pier 2STY-PIER | | | | Residential 2-Story Slab 2STY-SLAB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** | **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** | **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** | **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1.1 | 0 | 0 | 0 | -1.1 | 0 | 0 | 0 | -1.1 | 0 | 0 | 0 | -1.1 | 0 | 0 | 0 |
| -1 | 1.6 | 0 | 3.6 | -1 | 0 | 0 | 0 | -1 | 1.5 | 0 | 3.4 | -1 | 0 | 0 | 0 |
| -0.5 | 2.7 | 0.9 | 4 | -0.5 | 1 | 0 | 6 | -0.5 | 2.4 | 0.4 | 5.6 | -0.5 | 0 | 0 | 0 |
| 0 | 19.8 | 3.5 | 41.9 | 0 | 9.8 | 2.8 | 41.2 | 0 | 8.7 | 0.4 | 30.5 | 0 | 5.6 | 0 | 34 |
| 0.5 | 47.1 | 14.8 | 51.2 | 0.5 | 31.1 | 14.1 | 45.5 | 0.5 | 22.6 | 10.8 | 34.3 | 0.5 | 18.5 | 5.8 | 38.3 |
| 1 | 53.8 | 44 | 64.5 | 1 | 36.7 | 26.6 | 45.5 | 1 | 27.5 | 19.2 | 34.3 | 1 | 24.4 | 14.1 | 40.5 |
| 1.5 | 56.1 | 46.6 | 65.2 | 1.5 | 40.4 | 28.5 | 45.5 | 1.5 | 29.2 | 21.5 | 34.6 | 1.5 | 25.2 | 15.3 | 40.8 |
| 2 | 58.5 | 47.3 | 65.2 | 2 | 43.1 | 30 | 54.6 | 2 | 32.9 | 27.6 | 43.7 | 2 | 28.4 | 20.8 | 48.3 |
| 3 | 63.7 | 52.1 | 72.2 | 3 | 48.2 | 36 | 57 | 3 | 34.7 | 28.6 | 43.7 | 3 | 30.7 | 22.4 | 48.3 |
| 4 | 71.2 | 61.8 | 75.8 | 4 | 60.3 | 52.1 | 75.9 | 4 | 41.7 | 31 | 55.2 | 4 | 38.6 | 27.8 | 65.2 |
| 5 | 75.6 | 65.1 | 92.5 | 5 | 64.7 | 52.7 | 75.9 | 5 | 44.2 | 35.3 | 55.9 | 5 | 40.8 | 32.2 | 65.2 |
| 6 | 78.8 | 67.7 | 98.2 | 6 | 67.1 | 53.6 | 80.3 | 6 | 45.2 | 37.2 | 58.8 | 6 | 41.4 | 33.2 | 67.3 |
| 7 | 79.3 | 70.6 | 98.2 | 7 | 67.5 | 56.6 | 80.3 | 7 | 45.8 | 38 | 58.8 | 7 | 41.7 | 33.2 | 67.3 |
| 8 | 83.3 | 74.7 | 102.3 | 8 | 71.9 | 62.9 | 89.1 | 8 | 47.8 | 38 | 61.2 | 8 | 44.5 | 34.3 | 73 |
| 9 | 87.1 | 74.7 | 107.9 | 9 | 78.2 | 67.2 | 92.8 | 9 | 60.9 | 48.3 | 75.7 | 9 | 54.2 | 44.8 | 74.1 |
| 10 | 87.4 | 74.7 | 107.9 | 10 | 78.9 | 67.2 | 96.2 | 10 | 62.9 | 53.1 | 76.9 | 10 | 56.1 | 49.4 | 75.2 |
| 11 | 87.8 | 74.7 | 108.2 | 11 | 79 | 67.2 | 96.2 | 11 | 64.3 | 55.9 | 80.7 | 11 | 57.1 | 50.5 | 75.2 |
| 12 | 87.9 | 74.7 | 108.2 | 12 | 79 | 67.2 | 96.2 | 12 | 65.8 | 57.1 | 80.8 | 12 | 58.8 | 52.9 | 75.2 |
| 13 | 88.2 | 74.7 | 109.2 | 13 | 79.5 | 67.2 | 96.2 | 13 | 68.3 | 57.6 | 85.6 | 13 | 60.7 | 55.1 | 75.2 |
| 14 | 88.3 | 74.7 | 109.2 | 14 | 79.5 | 67.2 | 96.2 | 14 | 69.6 | 58.6 | 91.9 | 14 | 60.7 | 55.1 | 75.2 |
| 15 | 88.5 | 74.7 | 109.2 | 15 | 79.5 | 67.2 | 96.2 | 15 | 70.4 | 60.7 | 91.9 | 15 | 60.8 | 55.1 | 75.2 |
| | | | | | | | | | | | | | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** | **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** | **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** | **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | -1.1 | 0 | 0 | 0 | -1.1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 | -0.5 | 0 | 0 | 0 | -1 | 0.1 | 0 | 0.2 | -1 | 0.1 | 0 | 0.2 |
| 0 | 35 | 27.5 | 38.6 | 0 | 35 | 27.5 | 38.6 | -0.5 | 0.7 | 0 | 1.5 | -0.5 | 0.7 | 0 | 1.5 |
| 0.5 | 46.8 | 39.9 | 51.2 | 0.5 | 46.8 | 39.9 | 51.2 | 0 | 21.3 | 19.6 | 22.1 | 0 | 21.3 | 19.6 | 22.1 |

| | | | |
|---|---|---|---|
| 1 | 48.4 | 45.2 | 51.9 |
| 1.5 | 50.3 | 48 | 54.9 |
| 2 | 56.7 | 53 | 59.1 |
| 3 | 67.5 | 65.6 | 69.5 |
| 4 | 76.3 | 74.1 | 80.6 |
| 5 | 80.9 | 78.5 | 85.4 |
| 6 | 88.1 | 85.5 | 92.9 |
| 7 | 88.4 | 85.7 | 93.2 |
| 8 | 89.1 | 86.4 | 93.9 |
| 9 | 89.1 | 86.5 | 94 |
| 10 | 89.1 | 86.5 | 94 |
| 11 | 89.1 | 86.5 | 94 |
| 12 | 89.1 | 86.5 | 94 |
| 13 | 89.1 | 86.5 | 94 |
| 14 | 89.1 | 86.5 | 94 |
| 15 | 89.1 | 86.5 | 94 |
| | | | |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | |
| 2 | 85 | 15 | |
| 5 | 92 | 14 | |
| 12 | 100 | 15 | |

| | | | |
|---|---|---|---|
| 1 | 48.4 | 45.2 | 51.9 |
| 1.5 | 50.3 | 48 | 54.9 |
| 2 | 56.7 | 53 | 59.1 |
| 3 | 67.5 | 65.6 | 69.5 |
| 4 | 76.3 | 74.1 | 80.6 |
| 5 | 80.9 | 78.5 | 85.4 |
| 6 | 88.1 | 85.5 | 92.9 |
| 7 | 88.4 | 85.7 | 93.2 |
| 8 | 89.1 | 86.4 | 93.9 |
| 9 | 89.1 | 86.5 | 94 |
| 10 | 89.1 | 86.5 | 94 |
| 11 | 89.1 | 86.5 | 94 |
| 12 | 89.1 | 86.5 | 94 |
| 13 | 89.1 | 86.5 | 94 |
| 14 | 89.1 | 86.5 | 94 |
| 15 | 89.1 | 86.5 | 94 |
| | | | |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviatio n** | |
| 0 | 0 | 0 | |
| 2 | 87 | 14 | |
| 5 | 94 | 15 | |
| 12 | 100 | 15 | |

| | | | |
|---|---|---|---|
| 0.5 | 24.8 | 22.9 | 25.8 |
| 1 | 30.7 | 29.7 | 36.1 |
| 1.5 | 34.6 | 33.5 | 35.6 |
| 2 | 37.7 | 36.5 | 38.8 |
| 3 | 45.6 | 44.2 | 46.9 |
| 4 | 50.5 | 49 | 53.9 |
| 5 | 55.7 | 54 | 59.5 |
| 6 | 60.6 | 58.7 | 64.7 |
| 7 | 61.6 | 59.7 | 65.7 |
| 8 | 62.3 | 60.4 | 66.4 |
| 9 | 68.1 | 66 | 72.7 |
| 10 | 68.1 | 66 | 72.7 |
| 11 | 72 | 69.7 | 76.7 |
| 12 | 74 | 71.7 | 78.9 |
| 13 | 75.8 | 73.4 | 80.8 |
| 14 | 77 | 74.6 | 82.1 |
| 15 | 77.2 | 74.8 | 82.3 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviatio n** | |
| 0 | 0 | 0 | |
| 2 | 84 | 14 | |
| 5 | 91 | 14 | |
| 12 | 100 | 15 | |

| | | | |
|---|---|---|---|
| 0.5 | 24.8 | 22.9 | 25.8 |
| 1 | 30.7 | 29.7 | 36.1 |
| 1.5 | 34.6 | 33.5 | 35.6 |
| 2 | 37.7 | 36.5 | 38.8 |
| 3 | 45.6 | 44.2 | 46.9 |
| 4 | 50.5 | 49 | 53.9 |
| 5 | 55.7 | 54 | 59.5 |
| 6 | 60.6 | 58.7 | 64.7 |
| 7 | 61.6 | 59.7 | 65.7 |
| 8 | 62.3 | 60.4 | 66.4 |
| 9 | 68.1 | 66 | 72.7 |
| 10 | 68.1 | 66 | 72.7 |
| 11 | 72 | 69.7 | 76.7 |
| 12 | 74 | 71.7 | 78.9 |
| 13 | 75.8 | 73.4 | 80.8 |
| 14 | 77 | 74.6 | 82.1 |
| 15 | 77.2 | 74.8 | 82.3 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviatio n** | |
| 0 | 0 | 0 | |
| 2 | 87 | 14 | |
| 5 | 94 | 15 | |
| 12 | 100 | 15 | |

*Table F:2-7. Depth-Damage Relationships for Structures, Contents, Vehicles, and Debris Removal*

| **Residential Mobile Home MOBILE** | | | |
|---|---|---|---|
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1.1 | 0 | 0 | 0 |
| -1 | 7.3 | 0 | 10.8 |
| -0.5 | 11.2 | 0 | 18.9 |
| 0 | 32.2 | 9.6 | 54.7 |
| 0.5 | 48.5 | 39.8 | 61.6 |
| 1 | 54 | 49.6 | 62.2 |
| 1.5 | 56.1 | 52.8 | 62.8 |
| 2 | 58.9 | 55.8 | 69.7 |
| 3 | 60.3 | 59.1 | 71.2 |
| 4 | 64.3 | 60.7 | 75.4 |
| 5 | 67.5 | 61.4 | 82.2 |
| 6 | 68 | 61.4 | 82.2 |
| 7 | 69 | 61.4 | 84 |
| 8 | 80 | 73 | 95.1 |
| 9 | 81.7 | 73 | 95.1 |
| 10 | 82.8 | 73 | 95.1 |
| 11 | 82.8 | 73 | 95.1 |
| 12 | 82.8 | 73 | 95.1 |
| 13 | 82.8 | 73 | 95.1 |
| 14 | 82.8 | 73 | 95.1 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0.1 | 0 | 0.1 |
| 0.5 | 15 | 14.5 | 15.4 |
| 1 | 30.1 | 29.1 | 30.9 |
| 1.5 | 45.6 | 44.2 | 46.9 |
| 2 | 58.8 | 57 | 62.8 |
| 3 | 69.2 | 67.1 | 73.9 |
| 4 | 78.3 | 75.9 | 83.6 |

| **Commercial Multi-Family Occupancy MULTI** | | | |
|---|---|---|---|
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 27.1 | 7.3 | 38.3 |
| 1 | 31.6 | 19.7 | 45.1 |
| 1.5 | 34 | 27.2 | 49.2 |
| 2 | 36.3 | 28.1 | 50.7 |
| 3 | 37.8 | 28.9 | 51.1 |
| 4 | 44.9 | 41.2 | 52.2 |
| 5 | 47.1 | 46.6 | 56.9 |
| 6 | 49.3 | 51.4 | 56.9 |
| 7 | 51.7 | 52.4 | 69.2 |
| 8 | 58.6 | 60.5 | 75.4 |
| 9 | 61 | 65.2 | 75.4 |
| 10 | 63.5 | 65.2 | 75.4 |
| 11 | 63.6 | 65.2 | 75.4 |
| 12 | 65.3 | 65.3 | 75.4 |
| 13 | 65.3 | 65.3 | 75.4 |
| 14 | 65.4 | 65.3 | 75.4 |
| 15 | 65.6 | 65.3 | 75.4 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 10 | 3.7 | 13.2 |
| 1 | 30 | 21.2 | 32.3 |
| 1.5 | 30 | 26.5 | 32.7 |
| 2 | 30 | 28 | 34.2 |
| 3 | 30 | 28.7 | 35.1 |
| 4 | 60 | 58.1 | 61.7 |

| **Commercial Professional PROF** | | | |
|---|---|---|---|
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0.5 | 0 | 1.5 |
| 0 | 0.5 | 0 | 1.5 |
| 0.5 | 13.1 | 3.8 | 20 |
| 1 | 16.7 | 11.9 | 21.2 |
| 1.5 | 19.3 | 13.9 | 29.8 |
| 2 | 21.1 | 14.4 | 31.4 |
| 3 | 23.4 | 16.5 | 33 |
| 4 | 27.5 | 20.7 | 36.4 |
| 5 | 28 | 21.1 | 37.3 |
| 6 | 30 | 21.1 | 47 |
| 7 | 31.6 | 21.1 | 52.5 |
| 8 | 39.2 | 26.8 | 58.5 |
| 9 | 46.1 | 32.1 | 65.1 |
| 10 | 46.8 | 39.6 | 65.1 |
| 11 | 51 | 39.7 | 65.6 |
| 12 | 53.6 | 41.3 | 66.7 |
| 13 | 54 | 41.6 | 66.7 |
| 14 | 55.3 | 42.9 | 67.8 |
| 15 | 55.4 | 42.9 | 67.8 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 10.5 | 9.5 | 12.7 |
| 1 | 14.6 | 13.2 | 17.5 |
| 1.5 | 19.2 | 17.3 | 23 |
| 2 | 23.2 | 20.9 | 27.8 |
| 3 | 67.6 | 61 | 81.2 |
| 4 | 86.9 | 78.3 | 100 |

| **Commercial Public and Semi-Public PUBLIC** | | | |
|---|---|---|---|
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0.5 | 0 | 1.5 |
| 0 | 0.5 | 0 | 1.5 |
| 0.5 | 13.1 | 3.8 | 20 |
| 1 | 16.7 | 11.9 | 21.2 |
| 1.5 | 19.3 | 13.9 | 29.8 |
| 2 | 21.1 | 14.4 | 31.4 |
| 3 | 23.4 | 16.5 | 33 |
| 4 | 27.5 | 20.7 | 36.4 |
| 5 | 28 | 21.1 | 37.3 |
| 6 | 30 | 21.1 | 47 |
| 7 | 31.6 | 21.1 | 52.5 |
| 8 | 39.2 | 26.8 | 58.5 |
| 9 | 46.1 | 32.1 | 65.1 |
| 10 | 46.8 | 39.6 | 65.1 |
| 11 | 51 | 39.7 | 65.6 |
| 12 | 53.6 | 41.3 | 66.7 |
| 13 | 54 | 41.6 | 66.7 |
| 14 | 55.3 | 42.9 | 67.8 |
| 15 | 55.4 | 42.9 | 67.8 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0.9 | 0.8 | 1.1 |
| 1 | 1.7 | 1.5 | 2 |
| 1.5 | 1.7 | 1.5 | 2 |
| 2 | 1.7 | 1.5 | 2 |
| 3 | 90 | 90 | 100 |
| 4 | 100 | 90 | 100 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 82.4 | 79.8 | 87.9 | | 5 | 80 | 77.3 | 82.1 | | 5 | 86.9 | 78.3 | 100 | | 5 | 100 | 90 | 100 |
| 6 | 84.3 | 81.7 | 89.9 | | 6 | 80 | 77.3 | 82.1 | | 6 | 99 | 89.1 | 100 | | 6 | 100 | 90 | 100 |
| 7 | 84.4 | 81.7 | 90 | | 7 | 80 | 77.3 | 82.1 | | 7 | 99 | 89.2 | 100 | | 7 | 100 | 90 | 100 |
| 8 | 84.4 | 81.7 | 90 | | 8 | 100 | 96.7 | 100 | | 8 | 99 | 89.2 | 100 | | 8 | 100 | 90 | 100 |
| 9 | 84.4 | 81.7 | 90 | | 9 | 100 | 96.7 | 100 | | 9 | 99 | 89.2 | 100 | | 9 | 100 | 90 | 100 |
| 10 | 84.4 | 81.7 | 90 | | 10 | 100 | 96.7 | 100 | | 10 | 99 | 89.2 | 100 | | 10 | 100 | 90 | 100 |
| 11 | 84.4 | 81.7 | 90 | | 11 | 100 | 96.7 | 100 | | 11 | 99 | 89.2 | 100 | | 11 | 100 | 90 | 100 |
| 12 | 84.4 | 81.7 | 90 | | 12 | 100 | 96.8 | 100 | | 12 | 99 | 89.2 | 100 | | 12 | 100 | 90 | 100 |
| 13 | 84.4 | 81.7 | 90 | | 13 | 100 | 96.8 | 100 | | 13 | 99 | 89.2 | 100 | | 13 | 100 | 90 | 100 |
| 14 | 84.4 | 81.7 | 90 | | 14 | 100 | 96.8 | 100 | | 14 | 99 | 89.2 | 100 | | 14 | 100 | 90 | 100 |
| 15 | 84.4 | 81.7 | 90 | | 15 | 100 | 96.8 | 100 | | 15 | 99 | 89.2 | 100 | | 15 | 100 | 90 | 100 |
| | | | | | | | | | | | | | | | | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | | | 0 | 0 | 0 | | | 0 | 0 | 0 | | | 0 | 0 | 0 | |
| 2 | 85 | 15 | | | 2 | 81 | 8 | | | 2 | 96 | 23 | | | 2 | 96 | 23 | |
| 5 | 92 | 15 | | | 5 | 89 | 8 | | | 5 | 98 | 23 | | | 5 | 98 | 23 | |
| 12 | 100 | 15 | | | 12 | 100 | 9 | | | 12 | 100 | 23 | | | 12 | 100 | 23 | |

*Table F:2-8. Depth-Damage Relationships for Structures, Contents, Vehicles, and Debris Removal*

| Commercial Repair and Home Use REPAIR | | | | Commercial Retail and Personal Services RETAIL | | | | Commercial Eating and Recreation EAT | | | | Autos Vehicles AUTO | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth in Structure | Structure Percent Damage | Structure Lower Percent | Structure Upper Percent | Depth in Structure | Structure Percent Damage | Structure Lower Percent | Structure Upper Percent | Depth in Structure | Structure Percent Damage | Structure Lower Percent | Structure Upper Percent | Depth in Structure | Structure Percent Damage | Structure Lower Percent | Structure Upper Percent |
| -1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 | -0.5 | 0.5 | 0 | 1.5 | -0.5 | 0.5 | 0 | 1.5 | 0.5 | 0 | 0 | 0 |
| 0 | 3.9 | 2.4 | 22.8 | 0 | 0.5 | 0 | 1.5 | 0 | 0.5 | 0 | 1.5 | 1 | 6 | 4 | 8 |
| 0.5 | 15.2 | 4.8 | 24.7 | 0.5 | 13.1 | 3.8 | 20 | 0.5 | 13.1 | 3.8 | 20 | 1.5 | 15 | 13 | 17 |
| 1 | 17.3 | 10.4 | 25.6 | 1 | 16.7 | 11.9 | 21.2 | 1 | 16.7 | 11.9 | 21.2 | 2 | 19 | 18 | 21 |
| 1.5 | 19 | 13.2 | 25.6 | 1.5 | 19.3 | 13.9 | 29.8 | 1.5 | 19.3 | 13.9 | 29.8 | 3 | 100 | 100 | 100 |
| 2 | 22.1 | 16 | 35.6 | 2 | 21.1 | 14.4 | 31.4 | 2 | 21.1 | 14.4 | 31.4 | | | | |
| 3 | 24.4 | 18 | 36 | 3 | 23.4 | 16.5 | 33 | 3 | 23.4 | 16.5 | 33 | | | | |
| 4 | 31.2 | 21.1 | 52.7 | 4 | 27.5 | 20.7 | 36.4 | 4 | 27.5 | 20.7 | 36.4 | | | | |
| 5 | 31.9 | 21.7 | 52.7 | 5 | 28 | 21.1 | 37.3 | 5 | 28 | 21.1 | 37.3 | | | | |
| 6 | 32.2 | 21.7 | 53.2 | 6 | 30 | 21.1 | 47 | 6 | 30 | 21.1 | 47 | | | | |
| 7 | 32.8 | 21.7 | 53.2 | 7 | 31.6 | 21.1 | 52.5 | 7 | 31.6 | 21.1 | 52.5 | | | | |
| 8 | 42.5 | 32.5 | 62.1 | 8 | 39.2 | 26.8 | 58.5 | 8 | 39.2 | 26.8 | 58.5 | | | | |
| 9 | 44.6 | 34.2 | 62.1 | 9 | 46.1 | 32.1 | 65.1 | 9 | 46.1 | 32.1 | 65.1 | | | | |
| 10 | 45.8 | 36.1 | 62.1 | 10 | 46.8 | 39.6 | 65.1 | 10 | 46.8 | 39.6 | 65.1 | | | | |
| 11 | 46.6 | 36.1 | 62.1 | 11 | 51 | 39.7 | 65.6 | 11 | 51 | 39.7 | 65.6 | | | | |
| 12 | 46.9 | 36.1 | 62.5 | 12 | 53.6 | 41.3 | 66.7 | 12 | 53.6 | 41.3 | 66.7 | | | | |
| 13 | 46.9 | 36.1 | 62.5 | 13 | 54 | 41.6 | 66.7 | 13 | 54 | 41.6 | 66.7 | | | | |
| 14 | 47.3 | 36.1 | 65.2 | 14 | 55.3 | 42.9 | 67.8 | 14 | 55.3 | 42.9 | 67.8 | | | | |
| 15 | 47.3 | 36.1 | 66.2 | 15 | 55.4 | 42.9 | 67.8 | 15 | 55.4 | 42.9 | 67.8 | | | | |
| | | | | | | | | | | | | | | | |
| Depth in Structure | Content Percent Damage | Content Lower Percent | Content Upper Percent | Depth in Structure | Content Percent Damage | Content Lower Percent | Content Upper Percent | Depth in Structure | Content Percent Damage | Content Lower Percent | Content Upper Percent | | | | |
| -1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | | | | |
| -0.5 | 0 | 0 | 0 | -0.5 | 0 | 0 | 0 | -0.5 | 0 | 0 | 0 | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | |
| 0.5 | 17 | 15.3 | 19.6 | 0.5 | 49.8 | 44.7 | 62.2 | 0.5 | 15.9 | 14.3 | 18.3 | | | | |
| 1 | 23.7 | 21.4 | 27.3 | 1 | 65.8 | 59.2 | 82.3 | 1 | 56.8 | 51.1 | 65.1 | | | | |
| 1.5 | 32.9 | 29.7 | 37.8 | 1.5 | 65.8 | 59.2 | 82.3 | 1.5 | 72.9 | 65.5 | 83.7 | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 33.7 | 30.3 | 38.7 | | 2 | 74.2 | 66.8 | 92.8 | | 2 | 95.9 | 86.3 | 100 | | | | | |
| 3 | 63.9 | 57.5 | 73.4 | | 3 | 79.9 | 72.2 | 95.6 | | 3 | 97.7 | 87.9 | 100 | | | | | |
| 4 | 66 | 59.4 | 75.9 | | 4 | 85.5 | 76.9 | 95.6 | | 4 | 100 | 89.9 | 100 | | | | | |
| 5 | 68 | 61.2 | 78.2 | | 5 | 91.1 | 82 | 95.6 | | 5 | 100 | 90.1 | 100 | | | | | |
| 6 | 73 | 65.8 | 84 | | 6 | 91.1 | 82 | 95.6 | | 6 | 100 | 90.1 | 100 | | | | | |
| 7 | 76.4 | 68.7 | 87.8 | | 7 | 91.1 | 82 | 95.6 | | 7 | 100 | 90.1 | 100 | | | | | |
| 8 | 76.4 | 68.7 | 87.8 | | 8 | 91.1 | 82 | 95.6 | | 8 | 100 | 90.1 | 100 | | | | | |
| 9 | 76.4 | 68.7 | 87.8 | | 9 | 92.7 | 83.5 | 95.6 | | 9 | 100 | 90.1 | 100 | | | | | |
| 10 | 76.4 | 68.7 | 87.8 | | 10 | 92.7 | 83.5 | 95.6 | | 10 | 100 | 90.1 | 100 | | | | | |
| 11 | 76.4 | 68.7 | 87.8 | | 11 | 92.7 | 83.5 | 95.6 | | 11 | 100 | 90.1 | 100 | | | | | |
| 12 | 76.4 | 68.7 | 87.8 | | 12 | 92.7 | 83.5 | 95.6 | | 12 | 100 | 90.1 | 100 | | | | | |
| 13 | 76.4 | 68.7 | 87.8 | | 13 | 92.7 | 83.5 | 95.6 | | 13 | 100 | 90.1 | 100 | | | | | |
| 14 | 76.4 | 68.7 | 87.8 | | 14 | 92.7 | 89.8 | 95.6 | | 14 | 100 | 90.1 | 100 | | | | | |
| 15 | 76.4 | 68.7 | 87.8 | | 15 | 92.7 | 89.8 | 95.6 | | 15 | 100 | 90.1 | 100 | | | | | |
| | | | | | | | | | | | | | | | | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | | | | |
| 0 | 0 | 0 | | | 0 | 0 | 0 | | | 0 | 0 | 0 | | | | | | |
| 2 | 96 | 23 | | | 2 | 96 | 23 | | | 2 | 96 | 23 | | | | | | |
| 5 | 98 | 23 | | | 5 | 98 | 23 | | | 5 | 98 | 23 | | | | | | |
| 12 | 100 | 23 | | | 12 | 100 | 23 | | | 12 | 100 | 23 | | | | | | |

*Table F:2-9. Depth-Damage Relationships for Structures, Contents, Vehicles, and Debris Removal*

| Commercial Professional PROFFP | | | |
|---|---|---|---|
| | | | |
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 27.5 | 20.7 | 36.4 |
| 5 | 28 | 21.1 | 37.3 |
| 6 | 30 | 21.1 | 47 |
| 7 | 31.6 | 21.1 | 52.5 |
| 8 | 39.2 | 26.8 | 58.5 |
| 9 | 46.1 | 32.1 | 65.1 |
| 10 | 46.8 | 39.6 | 65.1 |
| 11 | 51 | 39.7 | 65.6 |
| 12 | 53.6 | 41.3 | 66.7 |
| 13 | 54 | 41.6 | 66.7 |
| 14 | 55.3 | 42.9 | 67.8 |
| 15 | 55.4 | 42.9 | 67.8 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 86.9 | 78.3 | 100 |

| Commercial Public and Semi-Public PUBLICFP | | | |
|---|---|---|---|
| | | | |
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 27.5 | 20.7 | 36.4 |
| 5 | 28 | 21.1 | 37.3 |
| 6 | 30 | 21.1 | 47 |
| 7 | 31.6 | 21.1 | 52.5 |
| 8 | 39.2 | 26.8 | 58.5 |
| 9 | 46.1 | 32.1 | 65.1 |
| 10 | 46.8 | 39.6 | 65.1 |
| 11 | 51 | 39.7 | 65.6 |
| 12 | 53.6 | 41.3 | 66.7 |
| 13 | 54 | 41.6 | 66.7 |
| 14 | 55.3 | 42.9 | 67.8 |
| 15 | 55.4 | 42.9 | 67.8 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 100 | 90 | 100 |

| Commercial Repair and Home Use REPAIRFP | | | |
|---|---|---|---|
| | | | |
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 31.2 | 21.1 | 52.7 |
| 5 | 31.9 | 21.7 | 52.7 |
| 6 | 32.2 | 21.7 | 53.2 |
| 7 | 32.8 | 21.7 | 53.2 |
| 8 | 42.5 | 32.5 | 62.1 |
| 9 | 44.6 | 34.2 | 62.1 |
| 10 | 45.8 | 36.1 | 62.1 |
| 11 | 46.6 | 36.1 | 62.1 |
| 12 | 46.9 | 36.1 | 62.5 |
| 13 | 46.9 | 36.1 | 62.5 |
| 14 | 47.3 | 36.1 | 65.2 |
| 15 | 47.3 | 36.1 | 66.2 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 66 | 59.4 | 75.9 |

| Commercial Retail and Personal Services RETAILFP | | | |
|---|---|---|---|
| | | | |
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 27.5 | 20.7 | 36.4 |
| 5 | 28 | 21.1 | 37.3 |
| 6 | 30 | 21.1 | 47 |
| 7 | 31.6 | 21.1 | 52.5 |
| 8 | 39.2 | 26.8 | 58.5 |
| 9 | 46.1 | 32.1 | 65.1 |
| 10 | 46.8 | 39.6 | 65.1 |
| 11 | 51 | 39.7 | 65.6 |
| 12 | 53.6 | 41.3 | 66.7 |
| 13 | 54 | 41.6 | 66.7 |
| 14 | 55.3 | 42.9 | 67.8 |
| 15 | 55.4 | 42.9 | 67.8 |
| | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 |
| 4 | 85.5 | 76.9 | 95.6 |

| | | | |
|---|---|---|---|
| 5 | 86.9 | 78.3 | 100 |
| 6 | 99 | 89.1 | 100 |
| 7 | 99 | 89.2 | 100 |
| 8 | 99 | 89.2 | 100 |
| 9 | 99 | 89.2 | 100 |
| 10 | 99 | 89.2 | 100 |
| 11 | 99 | 89.2 | 100 |
| 12 | 99 | 89.2 | 100 |
| 13 | 99 | 89.2 | 100 |
| 14 | 99 | 89.2 | 100 |
| 15 | 99 | 89.2 | 100 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | |
| 2 | 96 | 23 | |
| 5 | 98 | 23 | |
| 12 | 100 | 23 | |

| | | | |
|---|---|---|---|
| 5 | 100 | 90 | 100 |
| 6 | 100 | 90 | 100 |
| 7 | 100 | 90 | 100 |
| 8 | 100 | 90 | 100 |
| 9 | 100 | 90 | 100 |
| 10 | 100 | 90 | 100 |
| 11 | 100 | 90 | 100 |
| 12 | 100 | 90 | 100 |
| 13 | 100 | 90 | 100 |
| 14 | 100 | 90 | 100 |
| 15 | 100 | 90 | 100 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | |
| 2 | 96 | 23 | |
| 5 | 98 | 23 | |
| 12 | 100 | 23 | |

| | | | |
|---|---|---|---|
| 5 | 68 | 61.2 | 78.2 |
| 6 | 73 | 65.8 | 84 |
| 7 | 76.4 | 68.7 | 87.8 |
| 8 | 76.4 | 68.7 | 87.8 |
| 9 | 76.4 | 68.7 | 87.8 |
| 10 | 76.4 | 68.7 | 87.8 |
| 11 | 76.4 | 68.7 | 87.8 |
| 12 | 76.4 | 68.7 | 87.8 |
| 13 | 76.4 | 68.7 | 87.8 |
| 14 | 76.4 | 68.7 | 87.8 |
| 15 | 76.4 | 68.7 | 87.8 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | |
| 2 | 96 | 23 | |
| 5 | 98 | 23 | |
| 12 | 100 | 23 | |

| | | | |
|---|---|---|---|
| 5 | 91.1 | 82 | 95.6 |
| 6 | 91.1 | 82 | 95.6 |
| 7 | 91.1 | 82 | 95.6 |
| 8 | 91.1 | 82 | 95.6 |
| 9 | 92.7 | 83.5 | 95.6 |
| 10 | 92.7 | 83.5 | 95.6 |
| 11 | 92.7 | 83.5 | 95.6 |
| 12 | 92.7 | 83.5 | 95.6 |
| 13 | 92.7 | 83.5 | 95.6 |
| 14 | 92.7 | 89.8 | 95.6 |
| 15 | 92.7 | 89.8 | 95.6 |
| | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | |
| 0 | 0 | 0 | |
| 2 | 96 | 23 | |
| 5 | 98 | 23 | |
| 12 | 100 | 23 | |

*Table F:2-10. Depth-Damage Relationships for Structures, Contents, Vehicles, and Debris Removal*

| Commercial Eating and Recreation EATFP | | | | | Commercial Multi-Family Occupancy MULTIFP | | | | | Industrial Warehouse WAREFP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** | | **Depth in Structure** | **Structure Percent Damage** | **Structure Lower Percent** | **Structure Upper Percent** | | **Depth in Structure** | **Structure Percent Damage** | **Structur e Lower Percent** | **Structure Upper Percent** |
| -1 | 0 | 0 | 0 | | -1 | 0 | 0 | 0 | | -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 | | -0.5 | 0 | 0 | 0 | | -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | | 0.5 | 0 | 0 | 0 | | 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 | | 1.5 | 0 | 0 | 0 | | 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | | 3 | 0 | 0 | 0 | | 3 | 0 | 0 | 0 |
| 4 | 27.5 | 20.7 | 36.4 | | 4 | 44.9 | 41.2 | 52.2 | | 4 | 31.2 | 21.1 | 52.7 |
| 5 | 28 | 21.1 | 37.3 | | 5 | 47.1 | 46.6 | 56.9 | | 5 | 31.9 | 21.7 | 52.7 |
| 6 | 30 | 21.1 | 47 | | 6 | 49.3 | 51.4 | 56.9 | | 6 | 32.2 | 21.7 | 53.2 |
| 7 | 31.6 | 21.1 | 52.5 | | 7 | 51.7 | 52.4 | 69.2 | | 7 | 32.8 | 21.7 | 53.2 |
| 8 | 39.2 | 26.8 | 58.5 | | 8 | 58.6 | 60.5 | 75.4 | | 8 | 42.5 | 32.5 | 62.1 |
| 9 | 46.1 | 32.1 | 65.1 | | 9 | 61 | 65.2 | 75.4 | | 9 | 44.6 | 34.2 | 62.1 |
| 10 | 46.8 | 39.6 | 65.1 | | 10 | 63.5 | 65.2 | 75.4 | | 10 | 45.8 | 36.1 | 62.1 |
| 11 | 51 | 39.7 | 65.6 | | 11 | 63.6 | 65.2 | 75.4 | | 11 | 46.6 | 36.1 | 62.1 |
| 12 | 53.6 | 41.3 | 66.7 | | 12 | 65.3 | 65.3 | 75.4 | | 12 | 46.9 | 36.1 | 62.5 |
| 13 | 54 | 41.6 | 66.7 | | 13 | 65.3 | 65.3 | 75.4 | | 13 | 46.9 | 36.1 | 62.5 |
| 14 | 55.3 | 42.9 | 67.8 | | 14 | 65.4 | 65.3 | 75.4 | | 14 | 47.3 | 36.1 | 65.2 |
| 15 | 55.4 | 42.9 | 67.8 | | 15 | 65.6 | 65.3 | 75.4 | | 15 | 47.3 | 36.1 | 66.2 |
| | | | | | | | | | | | | | |
| **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** | | **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** | | **Depth in Structure** | **Content Percent Damage** | **Content Lower Percent** | **Content Upper Percent** |
| -1 | 0 | 0 | 0 | | -1 | 0 | 0 | 0 | | -1 | 0 | 0 | 0 |
| -0.5 | 0 | 0 | 0 | | -0.5 | 0 | 0 | 0 | | -0.5 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | | 0.5 | 0 | 0 | 0 | | 0.5 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 |
| 1.5 | 0 | 0 | 0 | | 1.5 | 0 | 0 | 0 | | 1.5 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 | | 2 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | | 3 | 0 | 0 | 0 | | 3 | 0 | 0 | 0 |
| 4 | 100 | 89.9 | 100 | | 4 | 60 | 58.1 | 61.7 | | 4 | 34.1 | 30.6 | 39.2 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 100 | 90.1 | 100 | | 5 | 80 | 77.3 | 82.1 | | 5 | 41.6 | 37.4 | 47.7 |
| 6 | 100 | 90.1 | 100 | | 6 | 80 | 77.3 | 82.1 | | 6 | 49 | 44.1 | 56.3 |
| 7 | 100 | 90.1 | 100 | | 7 | 80 | 77.3 | 82.1 | | 7 | 56.5 | 50.9 | 64.9 |
| 8 | 100 | 90.1 | 100 | | 8 | 100 | 96.7 | 100 | | 8 | 63.9 | 57.6 | 73.5 |
| 9 | 100 | 90.1 | 100 | | 9 | 100 | 96.7 | 100 | | 9 | 71.4 | 64.2 | 82 |
| 10 | 100 | 90.1 | 100 | | 10 | 100 | 96.7 | 100 | | 10 | 75.2 | 67.6 | 86.3 |
| 11 | 100 | 90.1 | 100 | | 11 | 100 | 96.7 | 100 | | 11 | 75.2 | 67.6 | 86.3 |
| 12 | 100 | 90.1 | 100 | | 12 | 100 | 96.8 | 100 | | 12 | 75.2 | 67.6 | 86.3 |
| 13 | 100 | 90.1 | 100 | | 13 | 100 | 96.8 | 100 | | 13 | 75.2 | 67.6 | 86.3 |
| 14 | 100 | 90.1 | 100 | | 14 | 100 | 96.8 | 100 | | 14 | 75.2 | 67.6 | 86.3 |
| 15 | 100 | 90.1 | 100 | | 15 | 100 | 96.8 | 100 | | 15 | 75.2 | 67.6 | 86.3 |
| | | | | | | | | | | | | | |
| **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviation** | | | **Depth in Structure** | **Debris Percent Damage** | **Debris Standard Deviatio n** | |
| 0 | 0 | 0 | | | 0 | 0 | 0 | | | 0 | 0 | 0 | |
| 2 | 96 | 23 | | | 2 | 81 | 8 | | | 2 | 85 | 19 | |
| 5 | 98 | 23 | | | 5 | 89 | 8 | | | 5 | 89 | 19 | |
| 12 | 100 | 23 | | | 12 | 100 | 9 | | | 12 | 100 | 19 | |

## 2.3 ENGINEERING INPUTS TO THE HEC-FDA MODEL

### 2.3.1 Stage-Probability Relationships

Stage-probability relationships were provided for the base year (2026) without-project and with-project conditions. Water surface profiles were provided for eight annual exceedance probability (AEP) events: 0.50 (2-year), 0.20 (5-year), 0.10 (10-year), 0.04 (25-year), 0.02 (50-year), 0.01 (100-year), 0.005 (200-year), and 0.002 percent (500-year). The water surface profiles were based on a combination of rainfall and surge from the lower portion of the basin. Relative sea level rise was added to the areas impacted by surge.

### 2.3.2 Uncertainty Surrounding the Stage-Probability Relationships

A 50-year equivalent record length was used to quantify the uncertainty surrounding the stage-probability relationships for each study area reach. Based on this equivalent record length, the HEC-FDA model calculated the confidence limits surrounding the stage-probability functions.

# Section 3

# National Economic Development (NED) Flood Damage and Benefit Calculations

## 3.1 HEC-FDA MODEL CALCULATIONS

The HEC-FDA model was utilized to evaluate flood damages using risk-based analysis. Damages were reported at the index location for each of the 106 study area reaches for which a structure inventory had been created. A range of possible values, with a maximum and a minimum value for each economic variable (first floor elevation, structure and content values, and depth-damage relationships), was entered into the HEC-FDA model to calculate the uncertainty or error surrounding the elevation-damage, or stage-damage, relationships. The model also used the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-probability relationships.

The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, a sampling technique was used to select from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes.

### 3.1.1 Stage-Damage Relationships with Uncertainty

The HEC-FDA model used the economic and engineering inputs to generate a stage-damage relationship for each structure category in each study area reach under base year (2026) conditions. The possible occurrences of each economic variable were derived through the use of Monte Carlo simulation. A total of 1,000 iterations were executed in the model for the stage-damage relationships. The sum of all sampled values was divided by the number of samples to yield the expected value for a specific simulation. A mean and standard deviation was automatically calculated for the damages at each stage.

### 3.1.2 Stage-Probability Relationships with Uncertainty

The HEC-FDA model used an equivalent record length (50 years) for each study area reach to generate a stage-probability relationship with uncertainty for the without-project condition under base year (2026) conditions through the use of graphical analysis. The model used the eight stage-probability events together with the equivalent record length to define the full range of the stage-probability functions by interpolating between the data points. Confidence bands surrounding the stages for each of the probability events were also provided.

### 3.1.3 Without-Project Expected Annual Damages

The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighing the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). For the without-project alternative, the EAD were totaled for each study area reach to obtain the total without-project EAD under base year (2026) conditions.

Table F:3-1 shows the number and type of structures that are damaged by each annual exceedance probability event for the year 2026 under without-project conditions. Table F:3-2 shows the without-project damages for the structure categories for each of the annual exceedance probability event for the year 2026.

*Table F:3-1. Structures Damaged by Probability Event and Category in Existing Without-Project Conditions*

| Annual Exceedance Probability (AEP) | Residential | Commercial | Industrial | Total |
|---|---|---|---|---|
| **Base year 2026** | | | | |
| 0.50 (2 yr) | 0 | 0 | 0 | 0 |
| 0.20 (5 yr) | 0 | 0 | 0 | 0 |
| 0.10 (10 yr) | 2,493 | 162 | 83 | 2,738 |
| 0.04 (25 yr) | 4,293 | 256 | 131 | 4,680 |
| 0.02 (50 yr) | 6,774 | 410 | 260 | 7,444 |
| 0.01 (100 yr) | 10,359 | 738 | 393 | 11,490 |
| 0.005 (200 yr) | 17,104 | 1,264 | 588 | 18,956 |
| 0.002 (500 yr) | 34,191 | 2,433 | 1,105 | 37,729 |

*Table F:3-2. Damages by Probability Event and Category in Existing Without-Project Conditions (FY19, $1,000s)*

| Annual Exceedance Probability (AEP) | Residential | Commercial | Industrial | Total |
|---|---|---|---|---|
| **Base year 2026** | | | | |
| 0.50 (2 yr) | $0 | $0 | $0 | $0 |
| 0.20 (5 yr) | $0 | $0 | $0 | $0 |
| 0.10 (10 yr) | $245,830 | $25,411 | $14,096 | $285,337 |
| 0.04 (25 yr) | $441,573 | $58,221 | $24,360 | $524,155 |
| 0.02 (50 yr) | $708,702 | $104,615 | $44,315 | $857,632 |
| 0.01 (100 yr) | $1,110,101 | $342,148 | $88,510 | $1,540,759 |
| 0.005 (200 yr) | $1,929,066 | $980,480 | $176,111 | $3,085,658 |
| 0.002 (500 yr) | $4,310,859 | $1,927,512 | $405,559 | $6,643,930 |

### 3.1.4 Expected Annual Damages and Benefits for the Project Alternatives

The HEC-FDA model was used to calculate the 2026 expected annual damages for the final array of plans. The final array included the following project plans: without project (no action); Darlington Reduced Wet Dam; Darlington Dry Dam; Sandy Creek Dam; Lilley, Darlington, and Bluff Creek Dams; nonstructural measures for the 25-year floodplain (0.04 AEP); and nonstructural measures for the 50-year floodplain (0.02 AEP). Due to time constraints, hydraulic modeling for Darlington Dam was only completed for the dry alternative. The damages and benefits were then applied to the reduced wet alternative. For more information about this decision and corresponding risk, please see the Appendix G: Hydrologic and Hydraulic Models. Tables F:3-3 through F:3-5 show the base year expected annual damages and benefits, damages by category, and damage reduction for the final array.

*Table F:3-3. Expected Annual Damages and Benefits 2026 (FY19, $1,000s)*

| Plan | Expected Annual Damages | Expected Annual Benefits |
|---|---|---|
| Without Project | $173,983 | $0 |
| Darlington Dam | $108,917 | $65,066 |
| Sandy Creek Dam | $160,334 | $13,649 |
| Lilley, Darlington, and Bluff Creek Dams | $167,852 | $6,131 |
| 0.04 AEP Nonstructural | $120,436 | $53,547 |
| 0.02 AEPr Nonstructural | $110,441 | $63,542 |

*Table F:3-4. Structure Categories and Project Alternatives Expected Annual Damages 2026 (FY19, $1,000s)*

| Plan | Vehicles | Commercial | Industrial | Residential | Total |
|---|---|---|---|---|---|
| Without Project | $7,542 | $43,325 | $14,391 | $108,725 | $173,983 |
| Darlington Dam | $4,693 | $23,752 | $9,393 | $71,080 | $108,917 |
| Sandy Creek Dam | $7,058 | $39,529 | $13,923 | $99,825 | $160,334 |
| Lilley, Darlington, and Bluff Creek Dams | $7,286 | $42,308 | $14,662 | $103,596 | $167,852 |
| 0.04 AEP Nonstructural | $7,584 | $36,526 | $11,408 | $64,918 | $120,436 |
| 0.02 AEP Nonstructural | $7,536 | $33,553 | $10,433 | $58,919 | $110,441 |

*Table F:3-5. Expected Annual Damages 2026 (FY19, $1,000s)*

| Plan Name | Total Without Project Damages | Total With Project Damages | Damage Reduced |
|---|---|---|---|
| Darlington Dam | $173,983 | $108,917 | $65,066 |
| Sandy Creek Dam | $173,983 | $160,334 | $13,649 |
| Lilley, Darlington, and Bluff Creek Dams | $173,983 | $167,852 | $6,131 |
| 0.04 AEP Nonstructural | $173,983 | $120,436 | $53,547 |
| 0.02 AEP Nonstructural | $173,983 | $110,441 | $63,542 |

# Section 4
# Project Costs of the TSP

## 4.1 CONSTRUCTION SCHEDULE

Construction of the Darlington Dam alternative is expected to take 4 years, while the other dam alternatives are expected to take 2 years to build. Construction would continue through the year 2026, which was established as the base year for analysis.

## 4.2 STRUCTURAL COSTS

Structural cost estimates for the final array were developed by the New Orleans District Cost Engineering Branch and were commensurate with a level 4 cost estimate. An abbreviated cost risk analysis was completed to determine the contingencies used for all structural measures. The structural costs include acquisitions associated with the real estate plan in conjunction with the Darlington Dam alternative. Details of the acquisitions can be found in the Real Estate Appendix.

## 4.3 NONSTRUCTURAL COSTS – ACQUISITION, ELEVATION & FLOODPROOFING

Based on the economic analysis of the focused array, the NED plan is the Darlington Dry Dam. Nonstructural measures will be used to reduce the residual risk associated with the TSP. The residential and nonresidential structures, damaged under the with project conditions in year 2026 that incurred flood damages by the stage associated with the 0.04 AEP event, were considered eligible for elevation, and floodproofing based upon criteria described in Section 4.4.

Nonstructural cost estimates for the final array were developed through a joint effort between the New Orleans District Economics and Cost Engineering Branches. A 34.5 percent contingency was applied to all nonstructural cost estimates to represent the uncertainty regarding the cost and schedule risk of these measures. The contingency amount was computed during a detailed cost risk analysis performed for the Southwest Coastal Louisiana Feasibility Study and was applied to this study after reviewing the associated risks and concluding they were similar for both studies.

### 4.3.1 Residential Structures

The estimate of the cost to elevate all residential structures was computed once model execution was completed. Elevation costs were based on the difference in the number of feet between the original first floor elevation and the target elevation (the future condition 100-year stage, including sea level rise) for each structure in the HEC-FDA module. The number of feet that each structure was raised was rounded to the closest 1-foot increment, with the exception that structures less than 1 foot below the target elevation were rounded-up to 1 foot. Elevation costs by structure were summed to yield an estimate of total structure elevation costs.

The cost per square foot for raising a structure was based on data obtained during interviews in 2008 with representatives of three major metropolitan New Orleans area firms that specialize in the structure elevation. Composite costs were derived for residential structures by type: slab and pier foundation, 1- story and 2- story configuration, and for mobile homes. These composite unit costs also vary by the number of feet that structures may be elevated. Table F:4-1 displays the costs for each of the five residential categories analyzed and by the number of feet elevated.

The cost per square foot to raise an individual structure to the target height was multiplied by the footprint square footage of each structure to compute the costs to elevate the structure. The footprint square footage for each structure was determined by applying the average square footage estimated for each residential structure. Added to the elevation cost was the cost of performing an architectural survey, which is associated with cultural resources concerns. The total costs for all elevated structures were annualized over the 50-year period of analysis of the project using the FY 2020 Federal discount rate of 2.75 percent. The square foot costs for elevation was price indexed to FY19 price levels using RSMeans cost catalog

### 4.3.2 Non-residential Structures

The floodproofing measures were applied to all non-residential structures. Separate cost estimates were developed to floodproof non-residential structures based on their relative square footage. Table F:4-2 shows a summary of square footage costs for floodproofing. These costs were developed for the Draft Nonstructural Alternatives Feasibility Study, Donaldsonville, LA to the Gulf evaluation (September 14, 2012) by contacting local contractors and were adopted for this study due to the similarity in the structure types between the two study areas. Added to the floodproofing cost was the cost of performing an architectural survey, which is associated with cultural resources concerns. Again, final cost estimates are expressed in FY 2019 prices.

*Table F:4-1. Nonstructural Elevation Costs for Residential Structures (FY19, $/Sq ft)*

| Height (ft) | 1-Story Pier | 1-Story Slab | 2-Story Pier | 2-Story Slab | Mobile |
|---|---|---|---|---|---|
| 1 | 105 | 118 | 116 | 130 | 58 |
| 2 | 105 | 118 | 116 | 130 | 58 |
| 3 | 109 | 121 | 120 | 133 | 58 |
| 4 | 109 | 125 | 120 | 143 | 71 |
| 5 | 109 | 125 | 120 | 143 | 71 |
| 6 | 112 | 128 | 122 | 144 | 71 |
| 7 | 112 | 128 | 122 | 144 | 71 |
| 8 | 114 | 132 | 125 | 149 | 71 |
| 9 | 114 | 132 | 125 | 149 | 71 |
| 10 | 114 | 132 | 125 | 149 | 71 |
| 11 | 114 | 132 | 125 | 149 | 71 |
| 12 | 114 | 132 | 125 | 149 | 71 |
| >=13 | 116 | 136 | 128 | 157 | 71 |

*Table F:4-2. Nonstructural Floodproofing Costs for Non-residential Structures FY19)*

| ***Square Footage*** | **Cost** |
|---|---|
| *<=20,000* | 153,006 |
| *30,000* | 361,536 |
| *40,000* | 361,536 |
| *50,000* | 361,536 |
| *60,000* | 361,536 |
| *70,000* | 361,536 |
| *80,000* | 361,536 |
| *90,000* | 361,536 |
| *100,000* | 361,536 |
| >= *110,000* | 893,720 |

## 4.4 NONSTRUCTURAL COSTS – ACQUISITION & RELOCATION ASSISTANCE

As previously described, the default criteria for applying nonstructural mitigation measures is elevating residential structures and floodproofing nonresidential structures. The two exceptions to this criteria are based on engineering limitations with elevation height and structures being located in FEMA regulated floodways.

Following detailed design, it may also become necessary to acquire structures for permanent evacuation of the FEMA regulatory floodway. Such determination would be based on risk and performance. Additionally, if a structure would require elevating greater than 13 feet to meet the future year 0.01 AEP BFE, the structure would not be eligible for elevation. The 13 feet height is based on guidance provided in the FEMA publication P-550. During further refinement, should the Life Safety Risk Analysis indicate the need for acquisitions for permanent evacuation of the FEMA regulatory floodway or any other areas of critical concern, then eminent domain would be retained as a method of accomplishing acquisitions required of the NFS, consistent with USACE Planning Bulletins 2016-01 and 2019-03. Relocation Assistance for occupants of acquired structures would therefore apply to owner-occupants as well as tenants of the residential/non-structural structure who would be eligible to receive relocation benefits including advisory services and moving expenses, in accordance with 49 CFR Part 24.

Outside of the acquisitions required as part of the Darlington Dam measure, acquisitions have not been included in the economic analysis of the nonstructural measures of the TSP. Should acquisitions will be required in the FEMA regulated floodway, costs have been presented in the following two sections for acquisition and relocations. The final report will fully incorporate any acquisitions and relocation costs and benefits associated with the recommended plan.

### 4.4.1 Acquisition

The estimate of the cost of acquiring structures was computed once model execution was completed. Acquisition costs are based on the cost of acquiring the parcel of land, the structure(s) built on the land, an architectural survey, and miscellaneous costs associated with the acquisition process. The depreciated replacement value of the structure (excluding any contents) was used to represent the cost of the structure, which was previously described as being sourced from RSMeans Square Foot Cost data. The cost of acquiring the parcel was provided by the New Orleans Real Estate Branch, and is based on a square foot estimate for residential and non-residential structures. The square foot estimate was applied to the size of the parcel of land and not the size of the structure and varies based on if the structure is located within the floodway or floodplain. Added to the acquisition cost was the cost of performing an architectural survey, which is associated with cultural resources concerns. Finally, a cost of $47,000 for residential structures and $141,000 for non-residential structures was added to represent the cost of demolition, deed changes, legal fees, and regarding the surface. These miscellaneous costs associated with acquisition were sourced from the 2010 USACE Cedar Rapids, Iowa Feasibility Report. The prices derived from the 2010 report were price indexed to 2019 price levels. Acquisition costs by structure were summed to yield an estimate of total structure acquisition cost.

### 4.4.2 Relocation Assistance

The estimate of the cost of relocation assistance to owners of property that will be acquired was computed after model execution was completed. Relocation costs are based on the cost of relocating the occupant that has been removed from the acquired parcel. Costs associated with Uniform Relocation Assistance and Real Property Acquisition Act of 1970 (URA) include assisting the occupant with moving costs and incidentals for residential structures and moving costs, searching expenses, and re-establishing costs for non-residential structures. The URA costs amount to $38,000 per residential structure and $50,000 per non-residential structure. Relocation costs by structure were summed to yield an estimate of total structure relocation cost.

The total acquisition and relocation costs were added together and applied on a per structure basis to determine the full cost of acquisition and relocation assistance.

## 4.5 ANNUAL PROJECT COSTS

The initial construction costs (first costs) were used to determine the interest during construction and gross investment cost at the end of the installation period (2026). The FY 2020 Federal interest rate of 2.75 percent was used to discount the costs to the base year and then amortize the costs over the 50-year period of analysis.

The annual OMRR&R costs for the Darlington Dry Dam and Reduced Wet Dam from the 1997 Darlington Reservoir Re-evaluation Study were indexed to present value for use in this analysis. The Darlington Dry Dam cost was utilized as a parametric cost for the smaller dry dam alternatives.

# Section 5

# Results of the Economic Analysis

## 5.1 NET BENEFIT ANALYSIS

### 5.1.1 Calculation of Net Benefits

The expected annual benefits were compared to the annual costs to develop a benefit-to-cost ratio for the alternatives. The net benefits for the alternatives were calculated by subtracting the annual costs from the base year expected annual benefits. The net benefits were used to determine the economic justification of the project alternatives and identify the National Economic Development (NED) plan. This analysis found the Darlington Dry Dam alternative to be the NED plan, which is also the structural component of the Tentatively Selected Plan (TSP). Tables F:5-1 through F:5-6 show the net benefits for the project plans in the final array. First Costs may vary by up to $1,000 due to rounding.

*Table F:5-1. Darlington Reduced Wet Dam Total Expected Annual Net Benefits (FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $108,917 | $65,066 |
| Total Benefits | | | $65,066 |
| | | | |
| First Costs | | | $1,788,531 |
| Interest During Construction | | | $100,590 |
| Annual Operation & Maintenance Costs | | | $658 |
| Total Annual Costs | | | $70,633 |
| | | | |
| B/C Ratio | | | 0.92 |
| Expected Annual Net Benefits | | | -$5,567 |

*Table F:5-2. Darlington Dry Dam Total Expected Annual Net Benefits (FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $108,917 | $65,066 |
| Total Benefits | | | $65,066 |
| | | | |
| First Costs | | | $1,278,523 |
| Interest During Construction | | | $71,907 |
| Annual Operation & Maintenance Costs | | | $439 |
| Total Annual Costs | | | $50,461 |
| | | | |
| B/C Ratio | | | 1.29 |
| Expected Annual Net Benefits | | | $14,605 |

*Table F:5-3. Sandy Creek Dry Dam Total Expected Annual Net Benefits (FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $160,334 | $13,649 |
| Total Benefits | | | $13,649 |
| First Costs | | | $270,977 |
| Interest During Construction | | | $7,477 |
| Annual Operation & Maintenance Costs | | | $220 |
| Total Annual Costs | | | $10,534 |
| B/C Ratio | | | 1.3 |
| Expected Annual Net Benefits | | | $3,115 |

*Table F:5-4. Lilley, Darlington, and Bluff Creek Dry Dams*

*Total Expected Annual Net Benefits*
*(FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $167,852 | $6,131 |
| Total Benefits | | | $6,131 |
| First Costs | | | $349,980 |
| Interest During Construction | | | $9,658 |
| Annual Operation & Maintenance Costs | | | $659 |
| Total Annual Costs | | | $13,980 |
| B/C Ratio | | | 0.44 |
| Expected Annual Net Benefits | | | -$7,849 |

*Table F:5-5. 0.04 AEP Nonstructural*

*Total Expected Annual Net Benefits*
*(FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $120,436 | $53,547 |
| Total Benefits | | | $53,547 |
| | | | |
| First Costs | | | $1,335,282 |
| Interest During Construction | | | $4,536 |
| Annual Operation & Maintenance Costs | | | $0 |
| Total Annual Costs | | | $49,628 |
| | | | |
| B/C Ratio | | | 1.08 |
| Expected Annual Net Benefits | | | $3,919 |

*Table F:5-6. 0.02 AEP Nonstructural*

*Total Expected Annual Net Benefits*
*(FY19, $1,000s, 2.75% Discount Rate)*

| Item | Expected Annual Without Project Damages | Expected Annual With Project Damages | Expected Annual Benefits and Costs |
|---|---|---|---|
| Damage Category | | | |
| Structure, Contents, Vehicles, and Debris Removal | $173,983 | $110,441 | $63,542 |
| Total Benefits | | | $63,542 |
| | | | |
| First Costs | | | $2,160,836 |
| Interest During Construction | | | $7,340 |
| Annual Operation & Maintenance Costs | | | $0 |
| Total Annual Costs | | | $80,311 |
| | | | |
| B/C Ratio | | | 0.79 |
| Expected Annual Net Benefits | | | -$16,769 |

## 5.2 RISK ANALYSIS

### 5.2.1 Benefit Exceedance Probability Relationship

The HEC-FDA model incorporates the uncertainty surrounding the economic and engineering inputs to generate results that can be used to assess the performance of proposed plans. The HEC-FDA model was used to calculate expected annual without-project and with-project damages and the damages reduced for each of the project alternatives. Table F:5-7 shows the expected annual benefits and the benefits at the 75, 50, and 25 percentiles for the final array. These percentiles reflect the percentage chance that the benefits will be greater than or equal to the indicated values. The benefit exceedance probability relationship for each of the project alternatives can be compared to the point estimate of the average annual costs for each of the project alternatives. The table indicates the percent chance that the expected annual benefits will exceed the annual costs, therefore the benefit cost ratio is greater than one and the net benefits are positive.

*Table F:5-7. Probability Expected Annual Damages Exceed Annual Costs (FY19, $1,000s, 2.75% Discount Rate)*

| Plan Name | Expected Annual Damages Reduced | Probability Damage Reduced Exceeds Indicated Values | | | Annual Costs | Probability Benefits Exceed Costs |
|---|---|---|---|---|---|---|
| | | 75% | 50% | 25% | | |
| Darlington Reduced Wet Dam | $65,066 | $27,812 | $46,086 | $78,825 | $50,461 | Between 25 and 50 percent |
| Darlington Dry Dam | $65,066 | $27,812 | $46,086 | $78,825 | $50,461 | Between 25 and 50 percent |
| Sandy Creek Dam | $13,649 | $6,935 | $10,299 | $14,094 | $10,534 | Between 25 and 50 percent |
| Lilley, Darlington, and Bluff Creek Dams | $6,131 | $5,055 | $5,786 | $4,512 | $13,980 | Less than 25 percent |
| 0.04 AEP Nonstructural | $53,547 | $38,589 | $50,185 | $66,366 | $49,628 | Between 50 and 75 percent |
| 0.02 AEP Nonstructural | $63,542 | $43,071 | $58,403 | $79,461 | $80,311 | Less than 25 percent |

### 5.2.2 Residual Risk

The flood risk that remains in the floodplain after the proposed alternative is implemented is known as the residual flood risk. Nonstructural measures can be used to reduce the residual risk associated with construction of the structural component of the Tentatively Selected Plan (TSP). The residential and non-residential structures damaged under with project conditions in 2026 that incurred flood damages by the stage associated with the 0.4 (25-year) AEP event were considered eligible for acquisition, elevation, and floodproofing. Residential structures would be either acquired by the Federal government or elevated to the stage associated with the future year with project 0.01 (100-year) AEP event (not to exceed 13 feet). Non-residential structures would be either acquired by the Federal government or floodproofed to three feet above ground elevation. A preliminary analysis found a total of 3,252 residential structures were eligible for acquisition or elevation and an additional 314 non-residential structures were eligible for acquisition or floodproofing. Table F:5-8 shows the expected annual net benefits for the TSP of Darlington Dry Dam with elevation and floodproofing in the 25-year floodplain (0.04 AEP) to address residual risk.

As previously stated in Section 4.4, acquisitions will be mandatory and used conditionally for structures in the FEMA regulated floodway or structures being elevating greater than 13 feet to meet the future year 0.01 AEP BFE. Benefits associated with such acquisitions and relocation assistance have not yet been developed.  As hydraulic and economic modeling is refined, the benefits of acquisitions and relocation assistance will be developed and included in the analysis for the recommended plan.

*Table F:5-8. Darlington Dry Dam with 0.04 AEP Elevations and Floodproofing Total Expected Annual Net Benefits*

| Item | Expected Annual Benefits and Costs |
|---|---|
| Damage Category | |
| Structure, Contents, Vehicles, and Debris Removal | $109,065 |
| Total Benefits | $109,065 |
| | |
| Structural First Costs | $1,278,524 |
| Nonstructural First Costs* | $1,024,198 |
| Total First Costs | $2,302,722 |
| Interest During Construction | $75,386 |
| Annual Operation & Maintenance Costs | $439 |
| Total Annual Costs | $88,527 |
| | |
| B/C Ratio | 1.23 |
| Expected Annual Net Benefits | $20,539 |

*Note: Acquisitions and related relocation assistance were not included at this stage of the analysis, so related costs are not included in the Nonstructural First Costs item.

Mississippi River Valley Division
Regional Planning and Environmental Division South

# Appendix G-1: Hydrologic and Hydraulic Models

## Amite River and Tributaries Study East of the Mississippi River, Louisiana Feasibility Study with Integrated Environmental Impact Statement

November 2019

# CONTENTS

# 1.0 GENERAL DESCRIPTION OF WORK

The US Army Corps of Engineers (USACE), New Orleans District (MVN), Hydraulics, Hydrology, and Coastal Engineering Branch (HH&C) performed hydrologic and hydraulic modeling for the Amite River and Tributaries (AR&T) Flood Risk Management (FRM) project. The purpose of this hydrologic and hydraulic modeling effort is to evaluate various design alternatives for FRM in the Amite River Basin. Hydrologic and Hydraulic models of the Amite River Basin were provided by the Louisiana Department of Transportation (LaDOT), and modified by the HH&C for use in this modeling effort. Modeling was performed for the 0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.005, and 0.002 Annual Exceedance Probability (AEP) rainfall events for existing conditions (year 2026), three design alternatives (year 2026), and Future without Project (FWOP, year 2076). Maximum water surface elevation results were extracted for each model run, and provided to the Project Delivery Team (PDT) for use in economic, environmental, and engineering analyses.

# 2.0 SOFTWARE

## 2.1 HEC-HMS 4.3

The latest version of the USACE Hydraulic Engineering Center’s (HEC) Hydrologic Modeling System (HMS) that was available at the time of model development was used for the hydrologic modeling.

## 2.2 HEC-RAS 5.0.6

The latest version of the HEC’s River Analysis System (RAS) that was available at the time of model development was used for the hydraulic modeling.

# 3.0 MODEL DEVELOPMENT

The hydrologic and hydraulic models of the Amite River Basin were provided to the MVN HH&C Branch by the (LaDOT). Development, calibration, and validation of the models are discussed in the LaDOT’s Amite River Basin Numerical Model Project Report, however some discussion is provided in this appendix. The LaDOT report is included in this document as Appendix G-2.

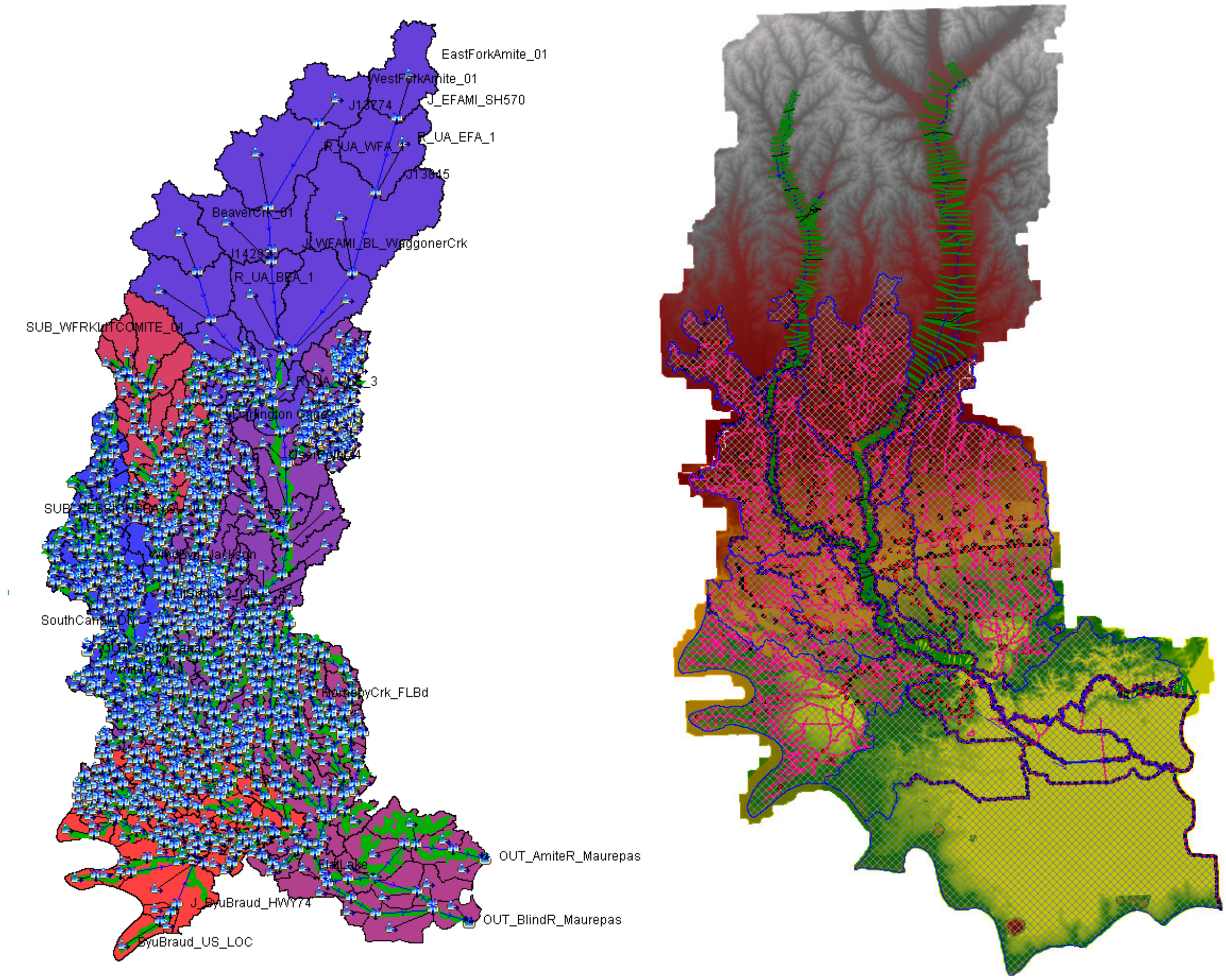



Figure G-1 shows the geometry for the HMS and RAS models.

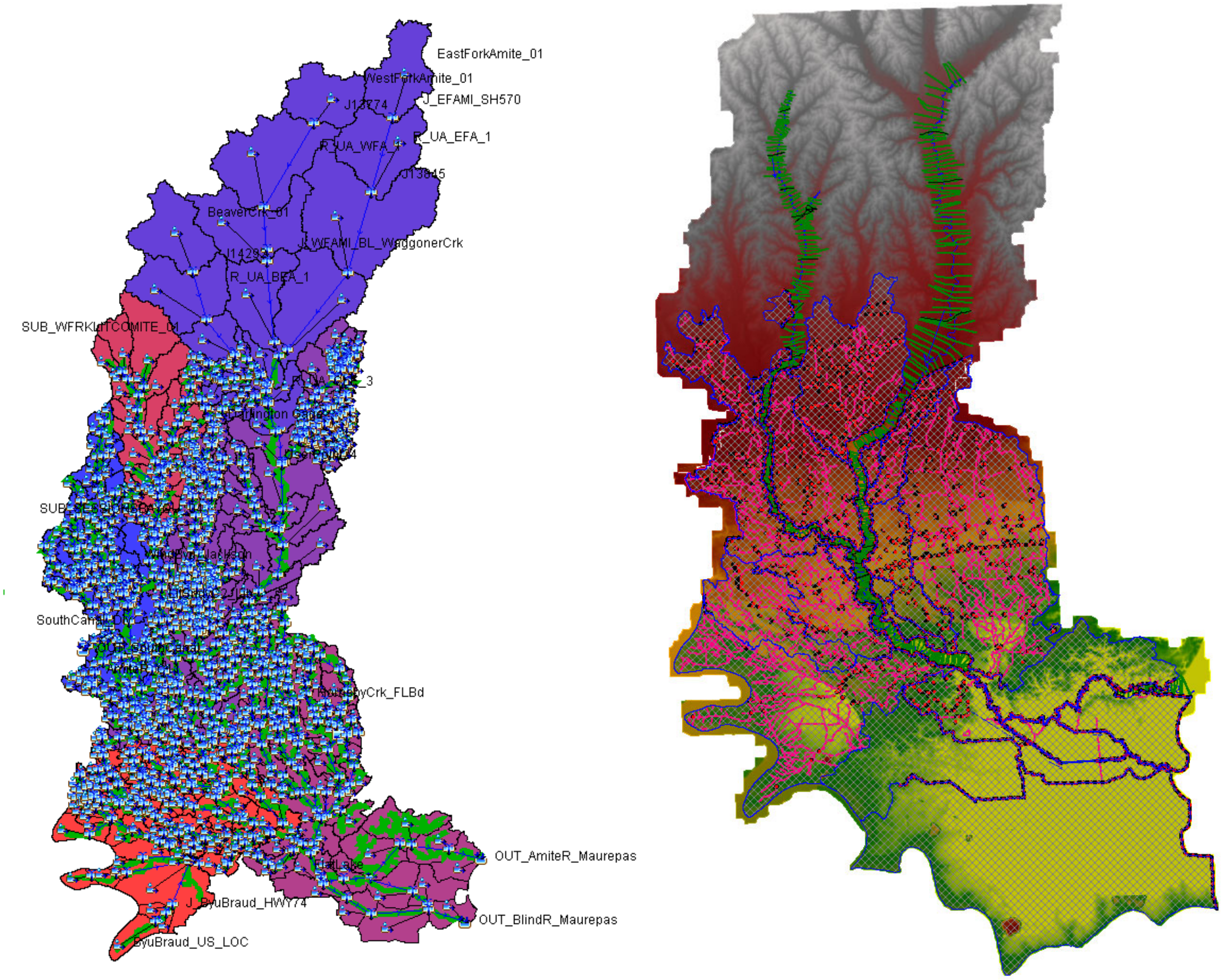


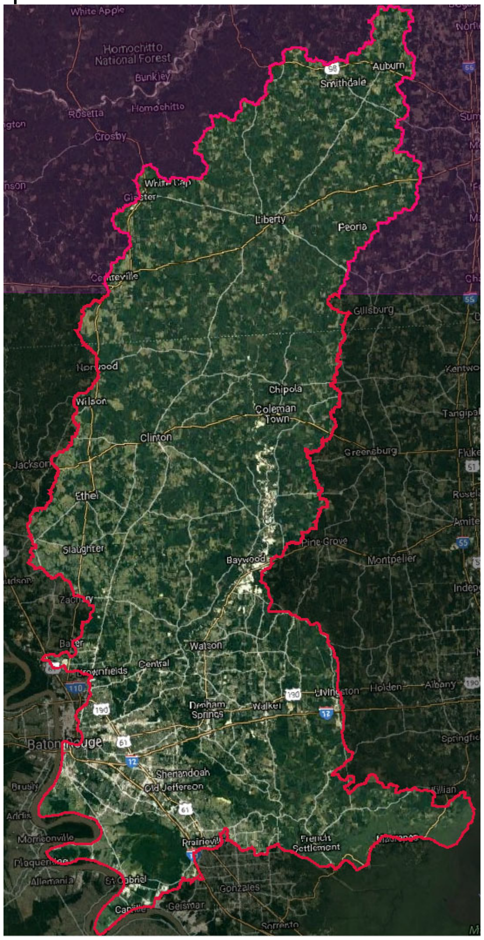

Figure G-1 – HEC-HMS Model Geometry (left) and HEC-RAS Model Geometry (right)

# 4.0 HYDROLOGY, CLIMATE CHANGE, AND STORM SURGE

## 4.1 Basin Hydrology

The Amite River Basin covers approximately 2,200 square miles in Mississippi and Louisiana. The Amite River runs for approximately 117 miles in a mostly southerly direction through Mississippi and Louisiana.

The Amite River begins with an East Fork and a West Fork in southwest Mississippi, both starting at elevations of over 450 feet. These forks are the steepest portions of the Amite River, with elevations dropping to approximately 200 feet and lengths of approximately 49 miles. The forks merge just south of Mississippi's border with Louisiana. The middle portion of the Amite River runs for approximately 61 miles and drops approximately 180 feet between the confluence of the upper forks and the confluence with the Comite River. The Comite River, a right bank tributary that meets the Amite River near Denham Springs, is the Amite's largest tributary. The lower portion of the Amite River runs for approximately 54 miles and discharges into Lake Maurepas. This is the flattest portion of the Amite River, dropping from approximately 20 feet to nearly sea level. Near French Settlement, Downstream of Port Vincent, the Amite River Diversion Canal splits off from the Amite River, sending a portion of the river's water southwest




to the Blind River, which also flows into Lake Maurepas. Figure G-2shows the boundary of the Amite River Basin.

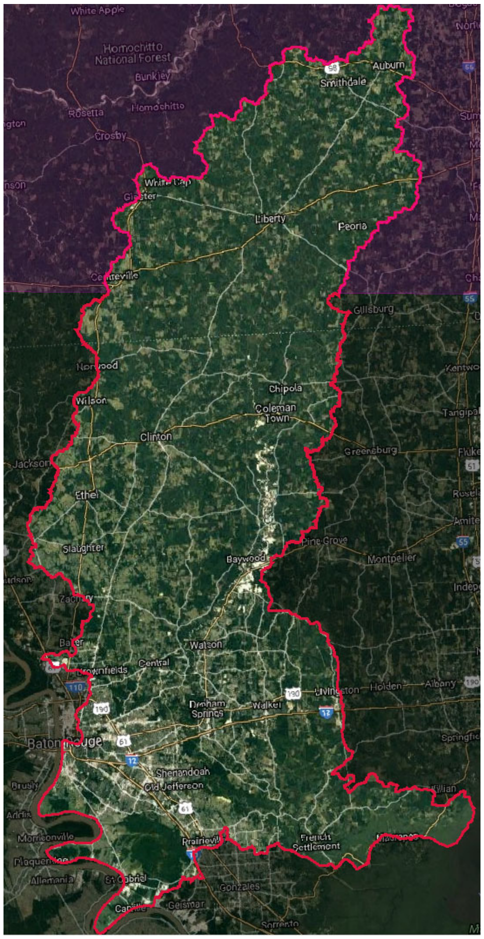


Figure G-2 – Amite River Basin in Louisiana and Mississippi

## 4.2 Precipitation and Runoff

Eight precipitation events were evaluated: the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 200-year, and 500-year average recurrence interval, 24-hour duration events. Precipitation hyetographs were developed for each of those events based on rainfall intensities from the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 Point Precipitation Frequency Estimates. Figure G-3 shows frequency estimates of precipitation intensity for the Amite River Basin from NOAA Atlas 14.

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.534 (0.430-0.662) | 0.607 (0.488-0.754) | 0.730 (0.585-0.907) | 0.834 (0.664-1.04) | 0.979 (0.756-1.25) | 1.09 (0.825-1.41) | 1.21 (0.882-1.59) | 1.33 (0.931-1.79) | 1.49 (1.00-2.05) | 1.62 (1.06-2.25) |
| 10-min | 0.781 (0.629-0.969) | 0.889 (0.715-1.10) | 1.07 (0.857-1.33) | 1.22 (0.973-1.52) | 1.43 (1.11-1.83) | 1.60 (1.21-2.07) | 1.77 (1.29-2.33) | 1.95 (1.36-2.62) | 2.19 (1.47-3.00) | 2.37 (1.55-3.29) |
| 15-min | 0.953 (0.767-1.18) | 1.08 (0.872-1.35) | 1.30 (1.05-1.62) | 1.49 (1.19-1.86) | 1.75 (1.35-2.24) | 1.95 (1.47-2.52) | 2.16 (1.58-2.85) | 2.38 (1.66-3.20) | 2.67 (1.80-3.66) | 2.89 (1.90-4.02) |
| 30-min | 1.43 (1.15-1.78) | 1.63 (1.31-2.03) | 1.97 (1.58-2.44) | 2.25 (1.79-2.80) | 2.64 (2.04-3.38) | 2.95 (2.23-3.82) | 3.27 (2.38-4.31) | 3.60 (2.52-4.84) | 4.04 (2.72-5.55) | 4.38 (2.87-6.09) |
| 60-min | 1.93 (1.55-2.39) | 2.20 (1.77-2.73) | 2.64 (2.12-3.29) | 3.02 (2.41-3.77) | 3.54 (2.73-4.53) | 3.95 (2.98-5.11) | 4.37 (3.19-5.75) | 4.80 (3.36-6.45) | 5.38 (3.62-7.38) | 5.82 (3.82-8.09) |
| 2-hr | 2.43 (1.97-2.99) | 2.76 (2.24-3.40) | 3.32 (2.68-4.10) | 3.79 (3.04-4.69) | 4.44 (3.45-5.63) | 4.95 (3.76-6.35) | 5.47 (4.02-7.14) | 6.00 (4.23-8.00) | 6.71 (4.55-9.15) | 7.25 (4.79-10.0) |
| 3-hr | 2.73 (2.23-3.35) | 3.12 (2.54-3.82) | 3.76 (3.04-4.61) | 4.29 (3.46-5.29) | 5.04 (3.93-6.37) | 5.63 (4.29-7.18) | 6.22 (4.59-8.09) | 6.83 (4.84-9.08) | 7.65 (5.21-10.4) | 8.28 (5.50-11.4) |
| 6-hr | 3.26 (2.67-3.95) | 3.75 (3.07-4.55) | 4.57 (3.73-5.56) | 5.27 (4.28-6.44) | 6.26 (4.93-7.87) | 7.05 (5.42-8.95) | 7.86 (5.84-10.2) | 8.70 (6.21-11.5) | 9.84 (6.76-13.3) | 10.7 (7.18-14.6) |
| 12-hr | 3.77 (3.12-4.55) | 4.40 (3.63-5.31) | 5.48 (4.51-6.62) | 6.42 (5.25-7.78) | 7.77 (6.18-9.73) | 8.87 (6.88-11.2) | 10.0 (7.51-12.9) | 11.2 (8.07-14.7) | 12.9 (8.92-17.3) | 14.2 (9.56-19.2) |
| 24-hr | 4.33 (3.60-5.18) | 5.10 (4.24-6.10) | 6.44 (5.33-7.72) | 7.62 (6.28-9.16) | 9.36 (7.51-11.7) | 10.8 (8.44-13.5) | 12.3 (9.30-15.7) | 13.9 (10.1-18.2) | 16.1 (11.3-21.5) | 17.9 (12.2-24.1) |
| 2-day | 4.97 (4.17-5.89) | 5.85 (4.90-6.94) | 7.39 (6.17-8.79) | 8.77 (7.28-10.5) | 10.8 (8.74-13.4) | 12.5 (9.85-15.6) | 14.3 (10.9-18.1) | 16.2 (11.8-21.0) | 18.8 (13.3-25.0) | 21.0 (14.3-28.0) |
| 3-day | 5.42 (4.56-6.39) | 6.35 (5.34-7.50) | 7.98 (6.69-9.44) | 9.43 (7.86-11.2) | 11.6 (9.41-14.3) | 13.3 (10.6-16.6) | 15.2 (11.7-19.3) | 17.2 (12.7-22.3) | 20.0 (14.2-26.5) | 22.3 (15.3-29.6) |
| 4-day | 5.82 (4.91-6.84) | 6.78 (5.72-7.97) | 8.45 (7.11-9.96) | 9.94 (8.31-11.8) | 12.1 (9.89-14.9) | 13.9 (11.1-17.2) | 15.9 (12.2-20.0) | 17.9 (13.2-23.0) | 20.8 (14.7-27.3) | 23.0 (15.9-30.5) |
| 7-day | 6.90 (5.87-8.06) | 7.90 (6.71-9.24) | 9.63 (8.15-11.3) | 11.2 (9.40-13.1) | 13.4 (11.0-16.3) | 15.2 (12.2-18.7) | 17.2 (13.3-21.5) | 19.2 (14.3-24.6) | 22.1 (15.8-28.9) | 24.4 (16.9-32.1) |
| 10-day | 7.84 (6.69-9.12) | 8.88 (7.57-10.3) | 10.7 (9.06-12.4) | 12.2 (10.3-14.3) | 14.5 (11.9-17.5) | 16.4 (13.1-20.0) | 18.3 (14.2-22.8) | 20.4 (15.2-25.9) | 23.2 (16.7-30.2) | 25.5 (17.8-33.5) |
| 20-day | 10.4 (8.97-12.0) | 11.6 (10.00-13.4) | 13.7 (11.7-15.8) | 15.4 (13.1-17.9) | 17.9 (14.8-21.4) | 19.9 (16.1-24.0) | 22.0 (17.2-27.1) | 24.1 (18.1-30.4) | 27.1 (19.5-34.9) | 29.4 (20.6-38.2) |
| 30-day | 12.7 (11.0-14.6) | 14.1 (12.2-16.2) | 16.5 (14.2-19.0) | 18.4 (15.8-21.3) | 21.2 (17.6-25.1) | 23.3 (18.9-27.9) | 25.5 (20.0-31.1) | 27.7 (20.8-34.6) | 30.7 (22.2-39.2) | 32.9 (23.2-42.7) |
| 45-day | 15.7 (13.6-17.9) | 17.5 (15.2-20.0) | 20.3 (17.6-23.3) | 22.7 (19.5-26.0) | 25.8 (21.4-30.2) | 28.1 (22.8-33.3) | 30.3 (23.8-36.8) | 32.6 (24.6-40.4) | 35.5 (25.8-45.0) | 37.6 (26.7-48.5) |
| 60-day | 18.4 (16.0-20.9) | 20.5 (17.9-23.4) | 23.9 (20.7-27.3) | 26.5 (22.9-30.4) | 30.0 (24.9-34.9) | 32.4 (26.4-38.3) | 34.8 (27.4-41.9) | 37.0 (28.0-45.6) | 39.7 (28.9-50.1) | 41.6 (29.6-53.6) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Figure G-3 – Point Precipitation Frequency Estimates from NOAA Atlas 14 for the Amite River Basin

Infiltration and initial abstraction hydrologic losses were calculated by the hydrologic model based on land use and imperviousness. Discussion of those parameters can be found in the Amite River Basin Numerical Model Project Report. That report is included as Appendix G-2. Forecasts of the Amite River Basin over the project life show an expected increase in urban development. Urban development correlates with an increase in impervious area, which leads to increases in runoff. A forecast of urban growth provided by the project delivery team showed an expected 35% increase over the project life. HH&C utilized this forecast to increase the impervious area by 35% for future conditions in the hydrological calculations.

### 4.3 Hydrology Non-Stationarity

In order to evaluate potential impacts to project performance in the future due to climate-based changes in hydrology, the USACE Non-Stationarity Detection Tool was used. According to the Trend Analysis for the Amite River at Port Vincent between 1985 and 2015 (Figure G-4), there has been a statistically significant downward trend in annual peak streamflow. Additionally, according to the Projected Annual Maximum Monthly Streamflow from the Climate Hydrology Assessment Tool (Figure G-5), there is an expected downward trend in annual maximum monthly streamflow. Because of this expected decrease in peak flow rates in the Amite River due to climate change, project performance is not expected to be adversely affected by climate change-induced hydrologic non-stationarity.

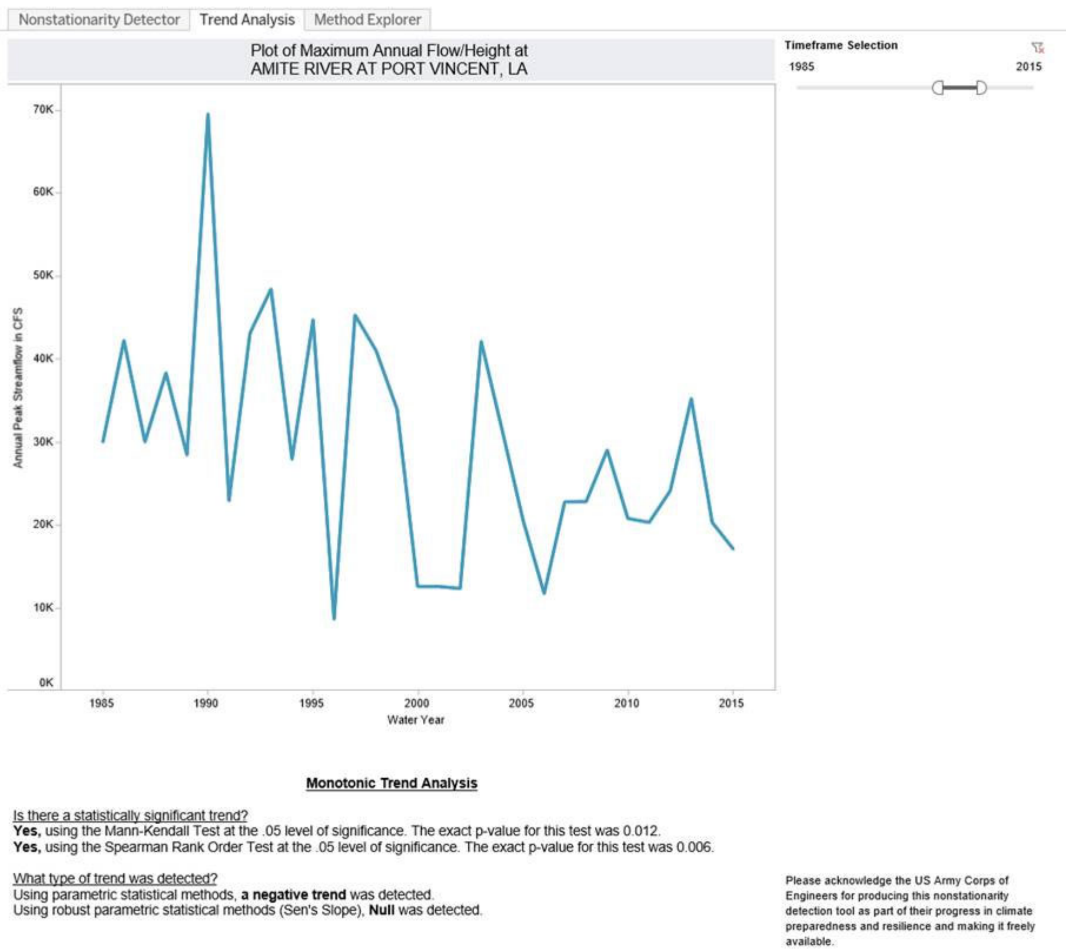



Figure G-4 – Peak Streamflow Trend Analysis for the Amite River at Port Vincent

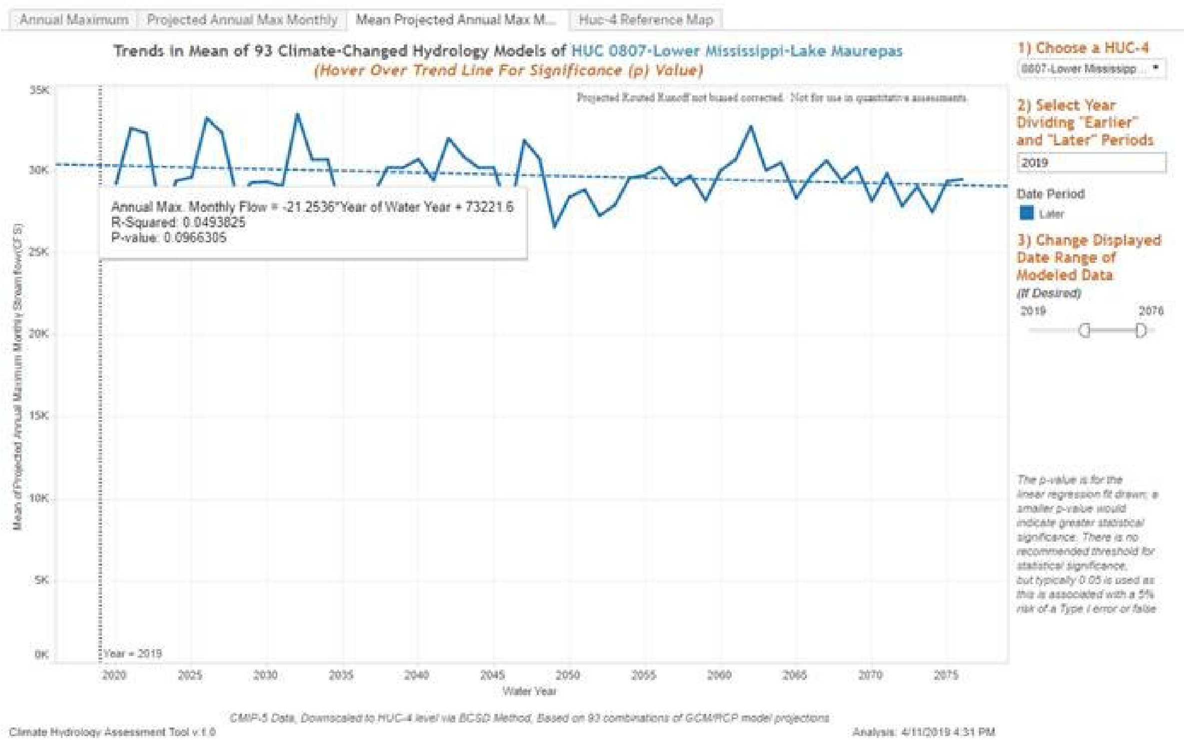



Figure G-5 – Mean Projected Annual Maximum Monthly Streamflow for the Amite River at Port Vincent

While climate-based changes are not expected to adversely affect project performance, population growth and urban development is expected to affect the Amite River Basin. An analysis of future growth by the economics team forecast approximately 35% growth in the Amite River Basin. HH&C translated that projected growth to projected increases in runoff by increasing the amount of impervious area in the hydrology model. Future conditions model runs have increased flow rates at all flow boundaries. Thus, projected increases in runoff flow rates have been considered in evaluation of project performance.

### 4.4 Storm Surge

The lower portion of the Amite River Basin experiences impacts from storm surge, which propagates through Lake Maurepas. Recent ADCIRC storm surge modeling was performed using a refined grid in the Lake Pontchartrain and Lake Maurepas region. Results from that modeling were obtained and reviewed by HH&C for potential impacts to this project.

At this time, results from storm surge modeling have not been incorporated into the hydraulic analysis for this project. For future milestones of this project, results from storm surge modeling will be coupled with results from the hydraulic modeling for each AEP event. This will be done during post processing, by layering maximum storm surge modeling results with maximum hydraulic modeling results, and taking the larger water surface elevation of the two results grids. HH&C compared the maximum water surface elevation grids for storm surge modeling and hydraulic modeling, and determined that only in the region within near Lake Maurepas would the storm surge results have a higher maximum water surface elevation. In that region, there are very few structures, and thus impacts to project performance and TSP selection are not expected to be significant. Figure G-6 shows the 100 year maximum water surface elevations from storm surge modeling.

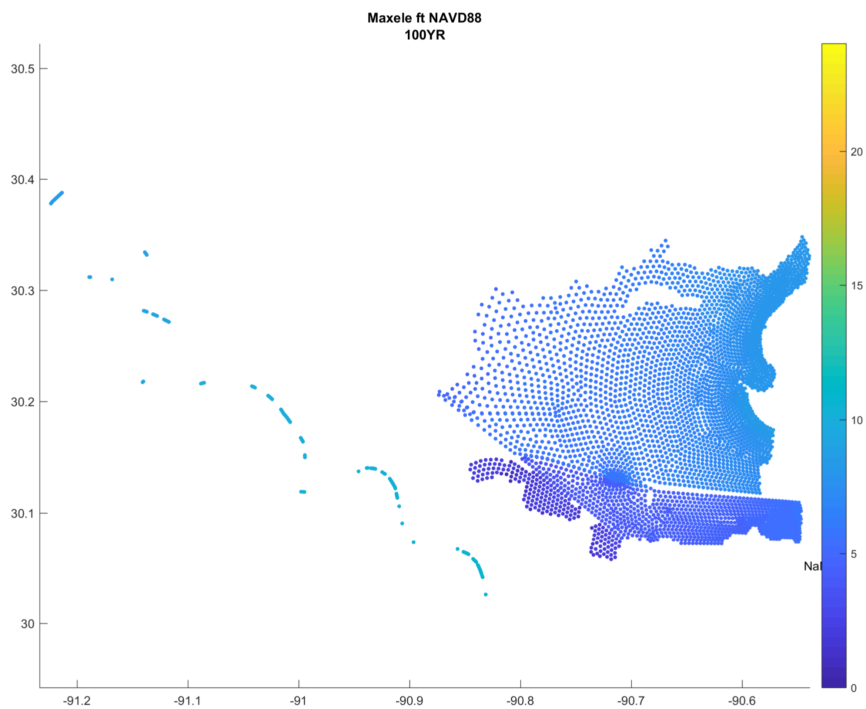



Figure G-6 – 100-year maximum water surface elevations from storm surge modeling

### 4.5 Sea Level Rise

In order to evaluate potential future changes in project performance due to sea level rise, the USACE Sea-Level Calculator was used. The Lake Pontchartrain gage at Frenier is the closest gage to the AR&T study area, and thus was selected for this analysis. The Sea-Level Calculator provides three rates of sea level change: low, intermediate, and high. Between the latest full year of recorded stages for Lake Maurepas (2018) and the project baseline year (2026), the low, intermediate, and high estimates of sea level rise are 0.2 ft, 0.2 ft, and 0.4 ft, respectively.

Between the project baseline year (2026) and the 50-year project life (2076), the low, intermediate, and high estimates of sea level rise are 1.37 ft, 1.90 ft, and 3.56 ft, respectively. The AR&T Project Delivery Team (PDT) determined that the intermediate rate of sea level rise should be used in this project for future conditions model runs.

USACE Curves computed using criteria in USACE EC 1165-2-212

Gauge 85550: Lake Pontchartrain at Frenier: Jan 1950 to Dec 2002
All values are in feet

| Year | USACE Low | USACE Int | USACE High |
|---|---|---|---|
| 2018 | 0.7 | 0.8 | 1.0 |
| 2019 | 0.7 | 0.8 | 1.0 |
| 2020 | 0.8 | 0.8 | 1.1 |
| 2021 | 0.8 | 0.9 | 1.1 |
| 2022 | 0.8 | 0.9 | 1.2 |
| 2023 | 0.9 | 0.9 | 1.2 |
| 2024 | 0.9 | 1.0 | 1.3 |
| 2025 | 0.9 | 1.0 | 1.3 |
| 2026 | 0.9 | 1.0 | 1.4 |

USACE Curves computed using criteria in USACE EC 1165-2-212

Gauge 85550: Lake Pontchartrain at Frenier: Jan 1950 to Dec 2002
All values are in feet

| Year | USACE Low | USACE Int | USACE High |
|---|---|---|---|
| 2026 | 0.94 | 1.04 | 1.37 |
| 2031 | 1.07 | 1.21 | 1.64 |
| 2036 | 1.21 | 1.38 | 1.93 |
| 2041 | 1.35 | 1.56 | 2.24 |
| 2046 | 1.49 | 1.75 | 2.57 |
| 2051 | 1.63 | 1.94 | 2.92 |
| 2056 | 1.76 | 2.13 | 3.28 |
| 2061 | 1.90 | 2.32 | 3.67 |
| 2066 | 2.04 | 2.53 | 4.07 |
| 2071 | 2.18 | 2.73 | 4.49 |
| 2076 | 2.31 | 2.94 | 4.93 |

Figure G-7 shows the estimates of sea level rise for Lake Pontchartrain at Frenier.

USACE Curves computed using criteria in USACE EC 1165-2-212

Gauge 85550: Lake Pontchartrain at Frenier: Jan 1950 to Dec 2002
All values are in feet

| Year | USACE Low | USACE Int | USACE High |
|---|---|---|---|
| 2018 | 0.7 | 0.8 | 1.0 |
| 2019 | 0.7 | 0.8 | 1.0 |
| 2020 | 0.8 | 0.8 | 1.1 |
| 2021 | 0.8 | 0.9 | 1.1 |
| 2022 | 0.8 | 0.9 | 1.2 |
| 2023 | 0.9 | 0.9 | 1.2 |
| 2024 | 0.9 | 1.0 | 1.3 |
| 2025 | 0.9 | 1.0 | 1.3 |
| 2026 | 0.9 | 1.0 | 1.4 |

USACE Curves computed using criteria in USACE EC 1165-2-212

Gauge 85550: Lake Pontchartrain at Frenier: Jan 1950 to Dec 2002
All values are in feet

| Year | USACE Low | USACE Int | USACE High |
|---|---|---|---|
| 2026 | 0.94 | 1.04 | 1.37 |
| 2031 | 1.07 | 1.21 | 1.64 |
| 2036 | 1.21 | 1.38 | 1.93 |
| 2041 | 1.35 | 1.56 | 2.24 |
| 2046 | 1.49 | 1.75 | 2.57 |
| 2051 | 1.63 | 1.94 | 2.92 |
| 2056 | 1.76 | 2.13 | 3.28 |
| 2061 | 1.90 | 2.32 | 3.67 |
| 2066 | 2.04 | 2.53 | 4.07 |
| 2071 | 2.18 | 2.73 | 4.49 |
| 2076 | 2.31 | 2.94 | 4.93 |

Figure G-7 – Estimated Sea Level Change from Sea-Level Calculator for Lake Pontchartrain at Frenier

Lake Maurepas is connected to Lake Pontchartrain via Pass Manchac and marshes. Lake Pontchartrain is connected to the Gulf of Mexico via The Rigolets and Chef Menteur Pass, as well as marshes. Through this connection of Lake Maurepas to the Gulf of Mexico, there is some tidal influence in Lake Maurepas. From review of the USACE gage 85420 Pass Manchac near Pontchatoula, which is located in the eastern end of Lake Maurepas, the tidal range is approximately 0.2 feet from peak to trough. From analysis of the sensitivity of the Amite River basin to small differences in downstream boundaries, this difference is negligible.

Additional hydraulic modeling is planned for after the TSP is selected, for purposes of checking project performance sensitivity against the low and high estimates of sea level rise. The differences between intermediate and low, and intermediate and high are approximately 1.5 feet each. There is fairly low sensitivity of the Amite River Basin to differences in the Lake Maurepas stage, especially for areas with a significant number of structures, which are mostly in the middle portion of the basin. Because of the relatively small differences between sea level rise forecasts, and the low sensitivity of the Amite River Basin to stages in Lake Maurepas, future modeling of low and high sea level rise estimates is not expected to have a significant impact on project performance.

## 4.6 Climate Vulnerability

Climate vulnerability was assessed to determine if the USACE's mission of flood risk management is vulnerable to climate change in the Amite River Basin. USACE's Screening-Level Climate Change Vulnerability Assessment Tool at the Watershed_Scale, which assesses vulnerabilities to climate change for USACE's missions, was used for this assessment. For the Lower Mississippi-Lake Maurepas watershed (hydrologic unit code-4 (HUC-4) watershed 0807), which includes the Amite River basin, no vulnerability to Flood Risk Reduction was found. The only vulnerability found for HUC-4 watershed 0807 was for the Recreation business line for the Dry – 2085 scenario & Epoch, as shown in

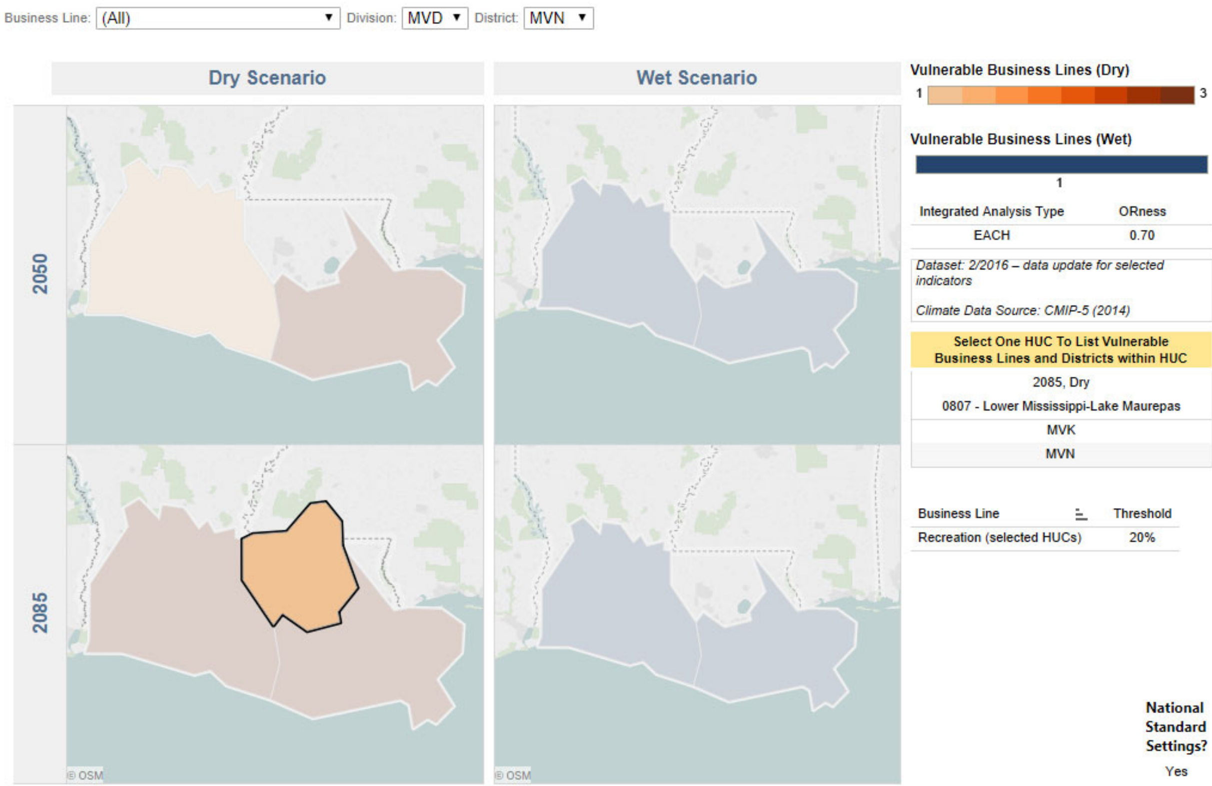



Figure G-8.

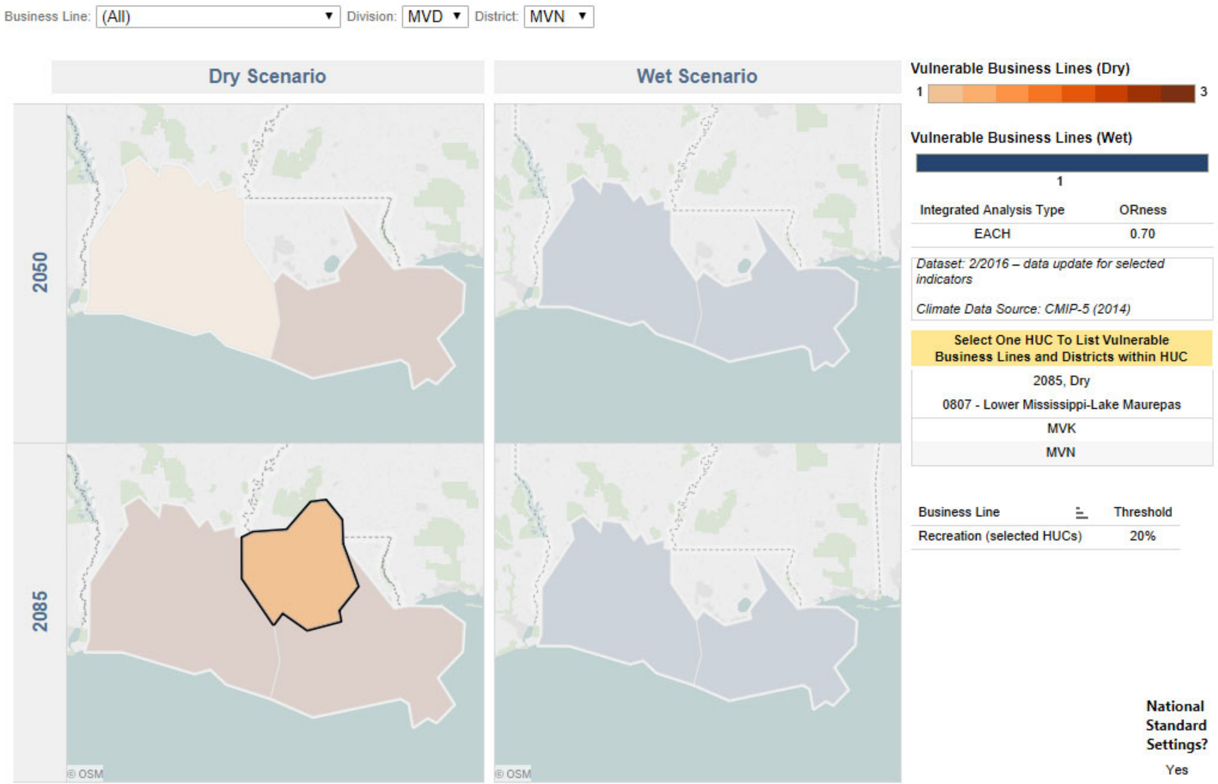



Figure G-8 – Scenario Comparison Over Time map for MVN. The only vulnerability shown for HUC-4 watershed 0807 is for recreation.

### 4.7 Hydrologic Modeling

Hydrologic modeling was performed using the HEC-HMS model provided by the LaDOTD. The hydrologic model domain covers the entire Amite River Basin, from southern Mississippi to southeast Louisiana. Figure G-9 shows the geometry of the hydrologic model.

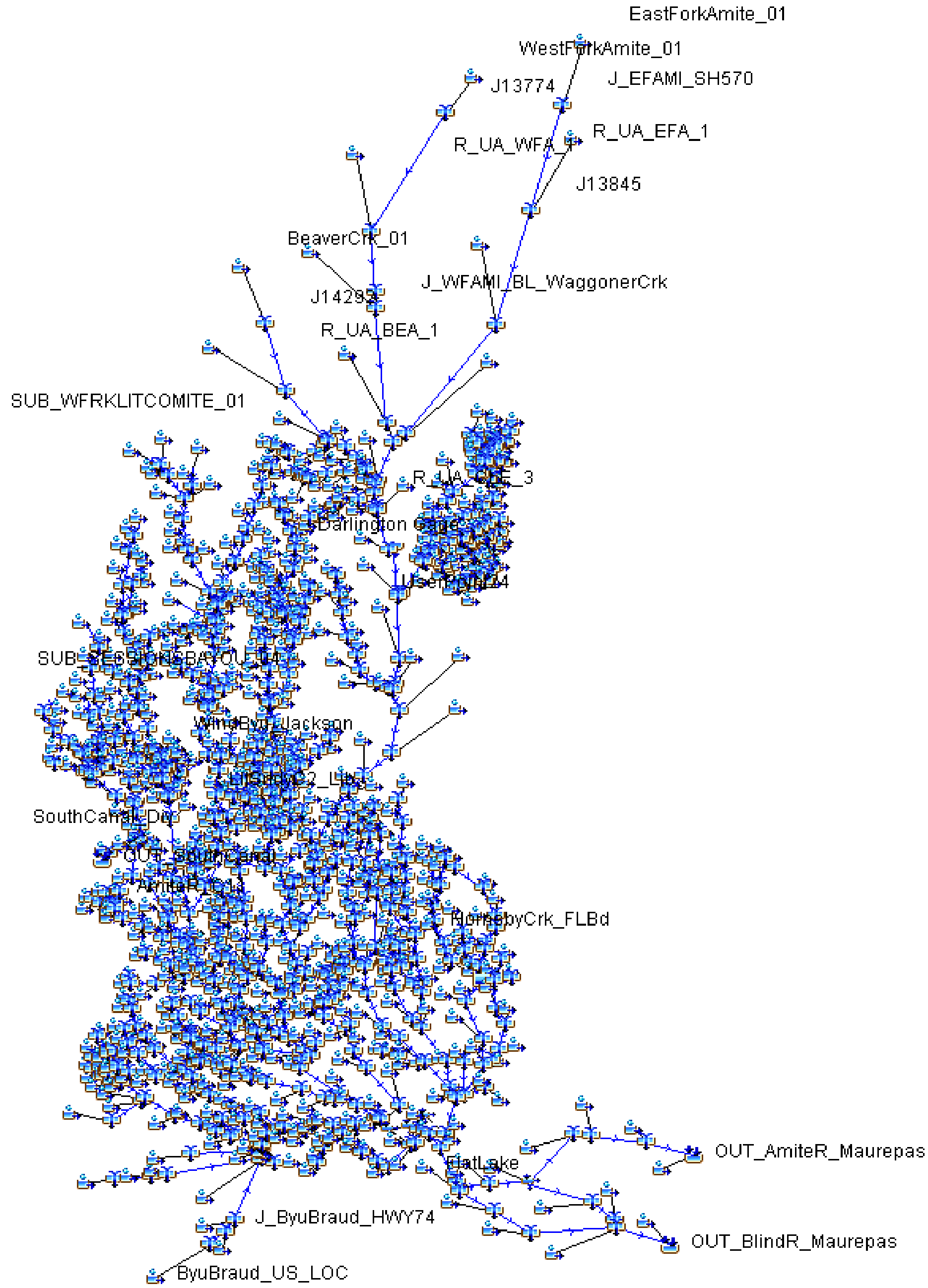



Figure G-9 – Hydrologic Model Geometry

Initial abstraction and infiltration losses were calculated by the hydrologic model based on runoff coefficients and imperviousness parameters. The model routed the runoff and spatially distributed it to 422 riverine output locations that were utilized as unsteady inflow boundary conditions in the hydraulic model. Figure G-10 shows the sub-basins and junctions for Claycut

Bayou, a tributary of the Amite River. A portion of those hydrologic nodes are used as model output locations.

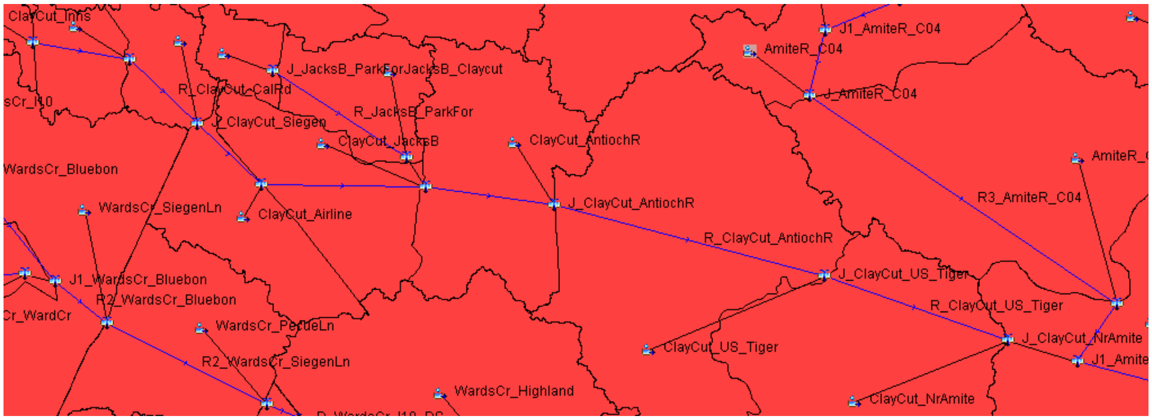



Figure G-10 – Example Hydrologic Nodes for Claycut Bayou

Each of the 24-hour AEP precipitation events was applied to the entire Amite River Basin in the HMS model. This was done with the existing model for the baseline year (2026), and with an adjusted imperviousness parameter for the future conditions (2076). Figure G-11 shows the 200 year precipitation hyetograph and flow output hydrograph for Sandy Creek near Mahoney Road.

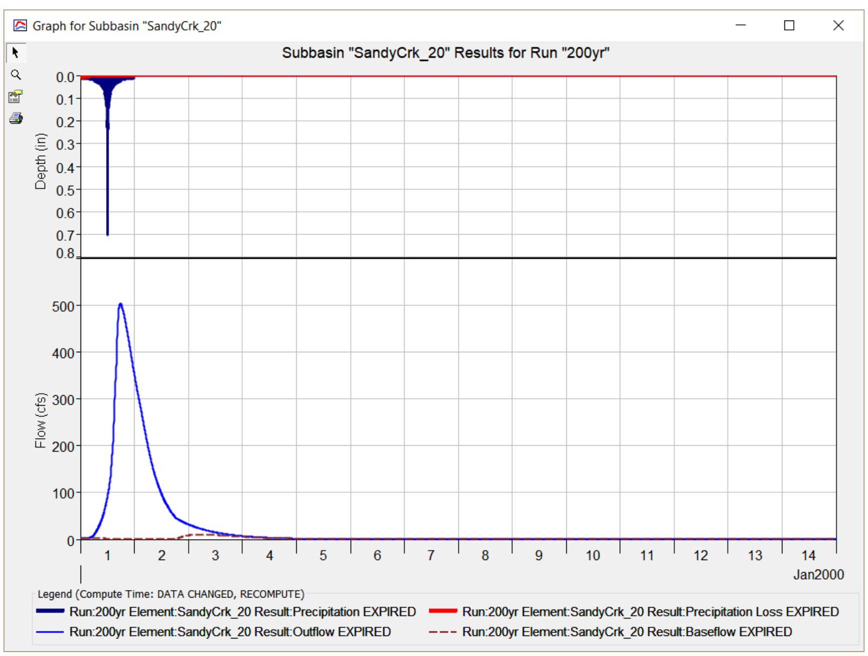



Figure G-11 – Example Precipitation Hyetograph and Flow Output Hydrograph

# 5.0 HYDRAULIC MODELING

## 5.1 Overview

Hydraulic modeling was performed using the HEC-RAS model obtained from the LaDOTD. The model is a one-dimensional/two-dimensional (1D/2D) unsteady flow hydraulic model. The model covers the Amite River Basin near the Louisiana/Mississippi border to the outlet of Amite River at Lake Maurepas. The model does not cover the portion of the Amite River Basin that is north of the state border. The datum of the model is NAVD 1988 (Geoid 12B).

Two versions of the model geometry were utilized in this modeling effort. One model geometry represents the Amite River Basin baseline conditions. That geometry was used for baseline runs, FWOP runs, and all alternative runs except for Darlington Dam. The second model geometry represents the Amite River Basin with Darlington Dam. That geometry was used for the Darlington Dam alternative runs. Figure G-12 shows the two model's domains.

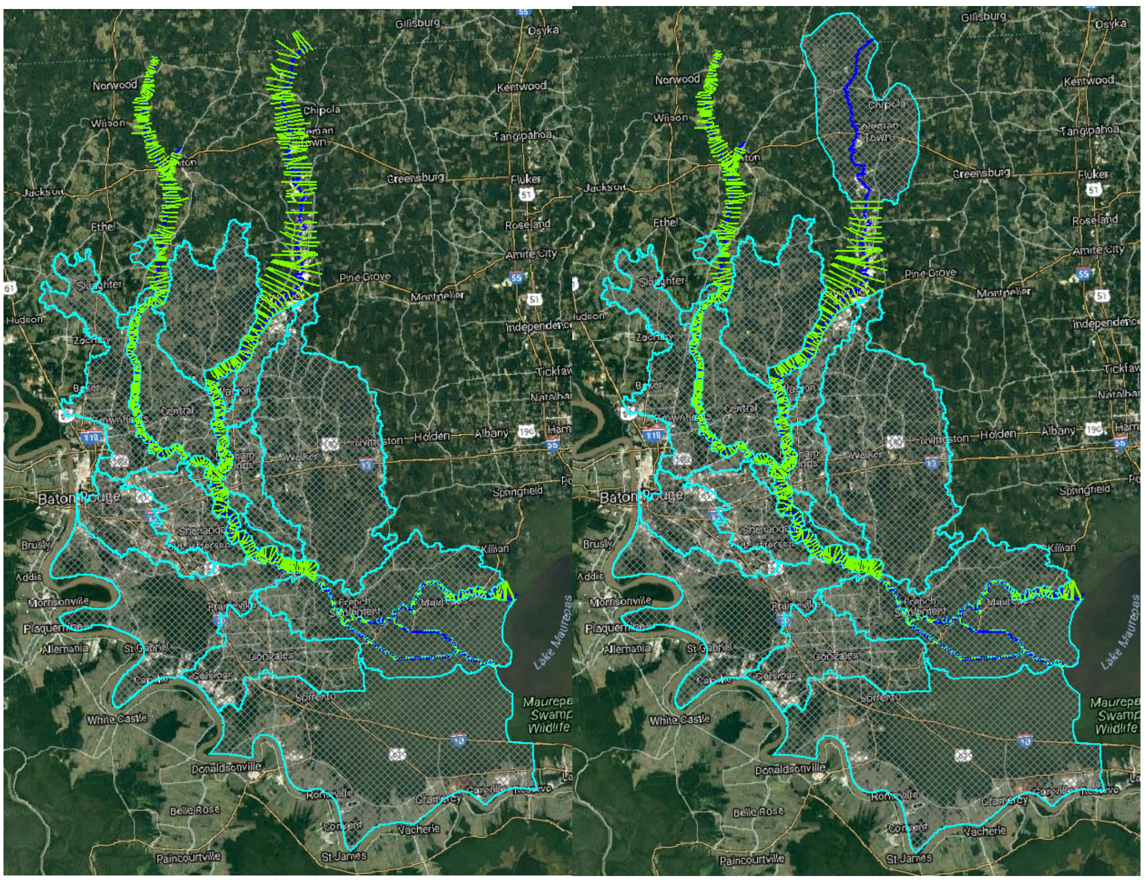



Figure G-12 – Baseline (left) and with Darlington Dam (right) HEC-RAS Model Domains

### 5.2 Boundary Conditions

Inflow boundary conditions to the hydraulic model were imported from results of the hydrologic model. There are three types of inflow boundary conditions in this hydraulic model: 1D inflow hydrographs, lateral inflow hydrographs, and 2D inflow hydrographs. There are two types of downstream boundary conditions in this hydraulic model: 1D stage hydrographs and 2D stage hydrographs.

#### 5.2.1 1D Inflow Hydrographs

The upstream boundaries of the 1D portion of the hydraulic model are the Amite River and the Comite River near the Mississippi-Louisiana border, as well as Pretty Creek approximately 3 miles upstream of the Comite River. Inflow hydrographs are applied at those locations to represent flow from the portion of their basins that are upstream of the boundaries. Figure G-13, Figure G-14Figure G-15 show the locations of the upstream boundaries of the Amite River, Comite River, and Pretty Creek, as well as the upstream inflow hydrographs for those rivers for the 25 year baseline conditions.

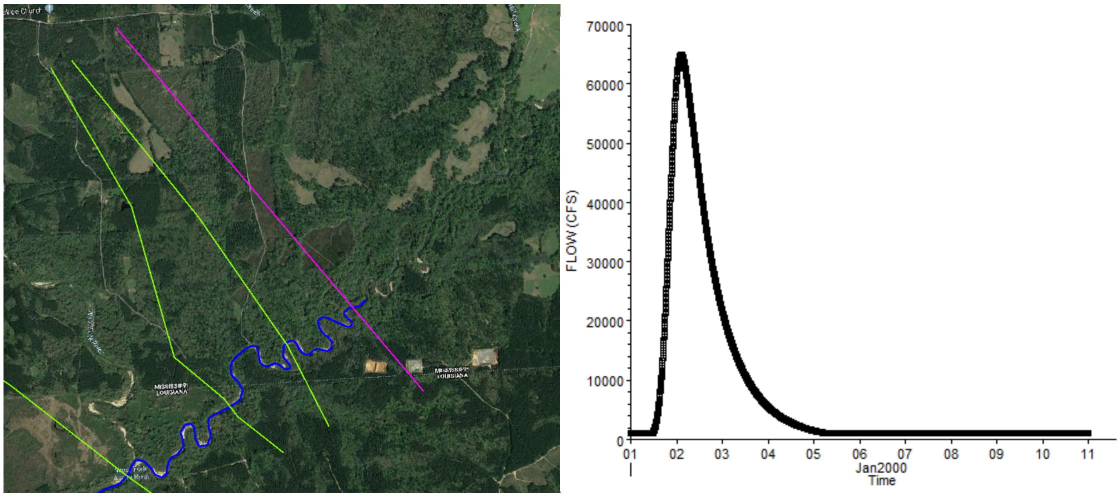



Figure G-13 – Amite River Upstream Boundary Location and 25 Year Baseline Inflow Hydrograph

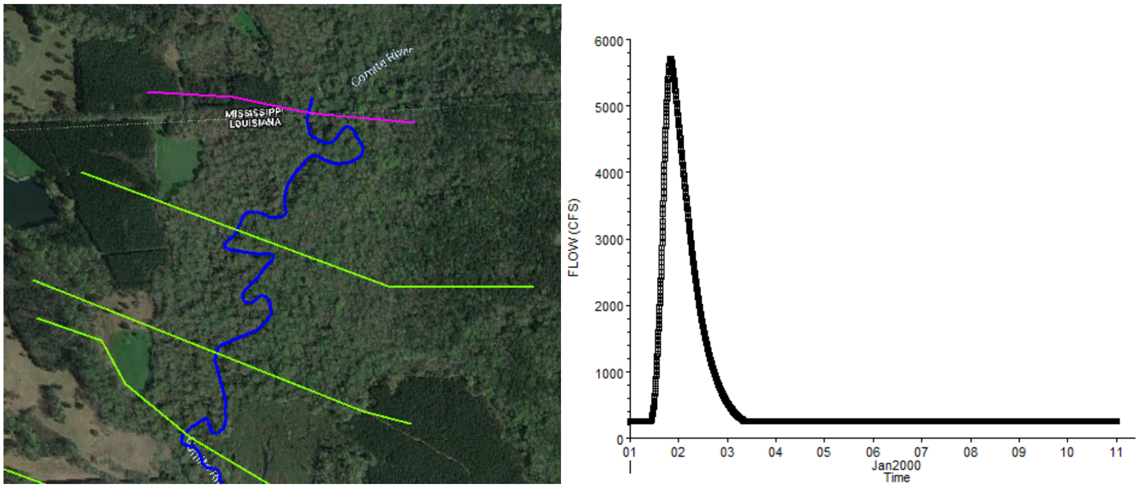



Figure G-14 – Comite River Upstream Boundary Location and 25 Year Baseline Inflow Hydrograph

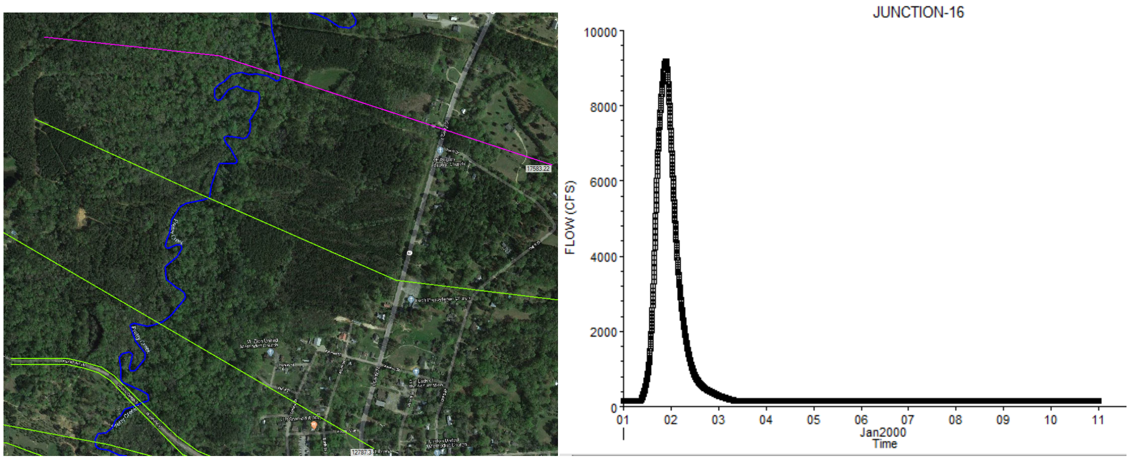



Figure G-15 – Pretty Creek Upstream Boundary Location and 25 Year Baseline Inflow Hydrograph

### 5.2.2 Lateral Inflow Hydrographs

Inflow hydrographs are also applied to 1D portions of the model in the form of lateral inflow hydrographs. These hydrographs represent flow from basins that are either not included in the 2D domain or that are near intersections of the 1D and 2D domains. There are 99 lateral inflow hydrographs in the baseline model, and 91 in the Darlington Dam model. Figure G-16 shows the location of the lateral inflow hydrograph that represents flow from Bluff Creek into the Amite River. Figure G-17 shows the lateral inflow hydrograph for the Amite River at Bluff Creek for 25 year baseline conditions.

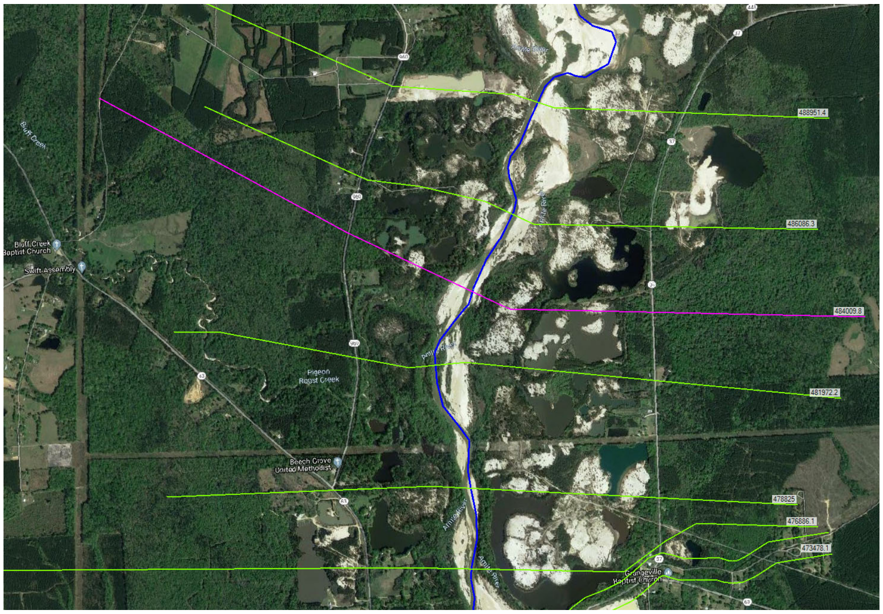


Figure G-16 – Lateral Inflow Location Representing Flow from Bluff Creek into the Amite River

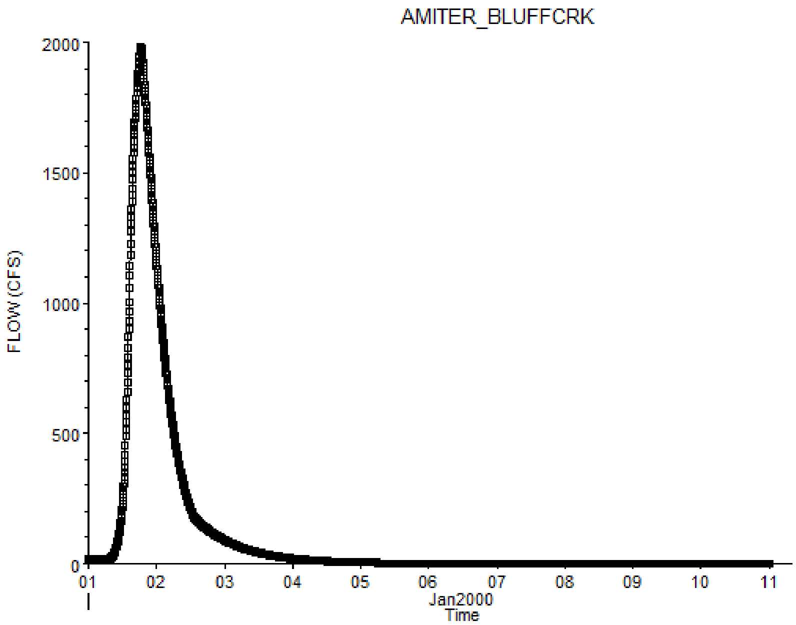



Figure G-17 – Lateral Inflow Hydrograph for the Amite River at Bluff Creek (25 Year Baseline)

### 5.2.3 2D Inflow Hydrographs

Inflow hydrographs are applied to the 2D portions of the model at 2D boundary condition lines. 2D boundary condition lines are located at intervals along tributaries of the Amite and Comite Rivers, as well as smaller streams that flow to those tributaries. These hydrographs represent the runoff from local rainfall, as well as rainfall from areas upstream that is not captured at another boundary condition line. There are 320 2D boundary condition lines in the baseline model, and 328 2D boundary condition lines in the Darlington Dam model. Figure G-18 shows the location of the 2D inflow hydrograph that inputs flow to Claycut Bayou near Airline Highway. Figure G-19 shows the inflow hydrograph for runoff into Claycut Bayou near Airline Highway for 25 year baseline conditions.


Figure G-18 – 2D Boundary Condition Line for flow into Claycut Bayou near Airline Highway

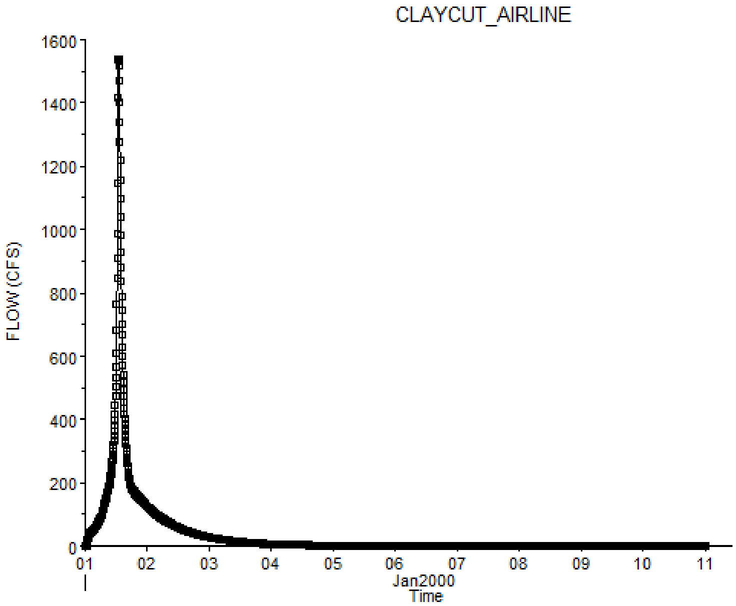



Figure G-19 – 2D Inflow Hydrograph for flow into Claycut Bayou near Airline Highway (25 Year Baseline)

### 5.2.4 Stage Hydrographs

The downstream boundaries of the hydraulic model are stage boundaries that represent the water surface elevation of Lake Maurepas. Stage boundaries are used where the Amite River and Blind River enter Lake Maurepas. Stage boundaries are also used where the 2D domain interacts with Lake Maurepas. For baseline (year 2026) model runs, a high Lake Maurepas was determined from the USACE gage 85420 Pass Manchac near Pontchatoula, which is located in the eastern end of Lake Maurepas. An analysis of that gage for the year 2018 showed a high stage at that gage to be approximately 1.5 feet, as that stage was exceeded approximately 15% of the time. 0.2 feet of sea level rise (from the intermediate sea level rise estimate from 2018 to 2026) was added to that 1.5 feet, to produce a stage boundary of 1.7 ft. For future conditions (year 2076) model runs, 1.9 feet of sea level rise (from the intermediate sea level rise estimate from 2026 to 2076) was added to the Lake Maurepas stage, resulting in a stage boundary of 3.6 feet. Figure G-20 shows the locations of the downstream stage boundaries of the 1D reaches, and Figure G-21 shows the locations of the 2D stage boundary condition lines.

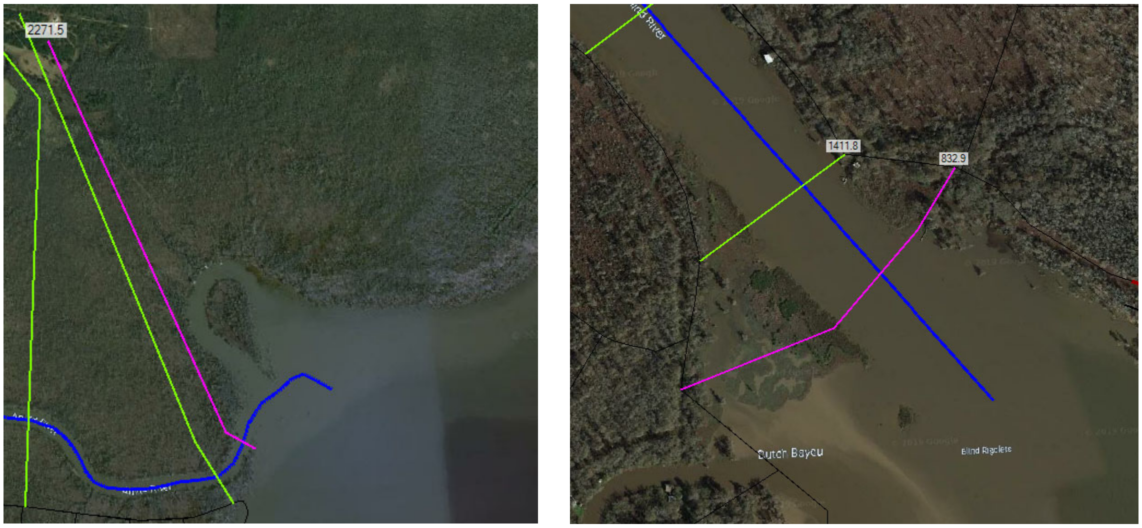



Figure G-20 – Stage Boundary Locations at Lake Maurepas for Amite River (left) & Blind River (right)


Figure G-21 – 2D Stage Boundary Locations at Lake Maurepas

### 5.3 Incorporation of Comite River Diversion and East Baton Rouge FRM Projects

Two other authorized projects in the Amite River Basin are projected to be complete prior to the baseline year of the Amite River and Tributaries FRM project (2026). Those projects are the Comite River Diversion (CRD) project and the East Baton Rouge (EBR) FRM project. The impacts of those projects were incorporated into this hydraulic modeling. The locations of those projects in East Baton Rouge Parish are shown in Figure G-22.

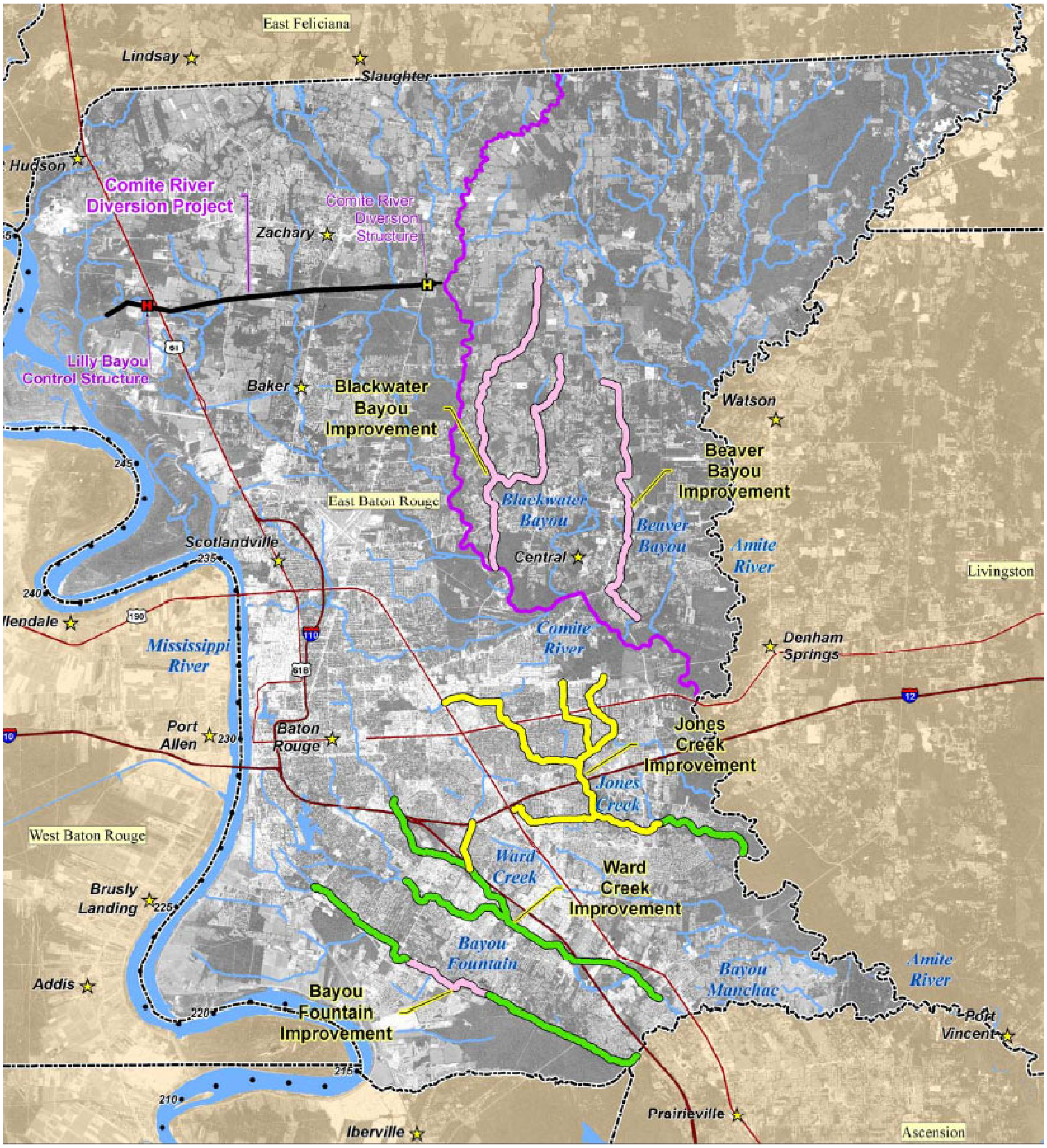


Figure G-22 – Locations of CRD and EBR Projects

### 5.3.1 Comite River Diversion Project

The Comite River Diversion will be located approximately 20 river miles upstream of the confluence of the Comite and Amite Rivers. Figure G-23 shows the expected location of the Comite River Diversion relative to the hydraulic model. The project will divert water from the Comite River west to the Mississippi River, between the cities of Zachary and Baker. The authorized diverted flows are based on flow rates in the Comite River immediately upstream of the diversion. To incorporate the impacts of the Comite River Diversion into this hydraulic modeling, a lateral diversion feature was implemented at the location of the diversion. The lateral diversion removes water from the Comite River based on a flow-flow rating curve. Figure G-24 shows the flow-flow rating curve. At the time of the writing of this HH&C Appendix, construction of the Comite River Diversion project has not been completed.

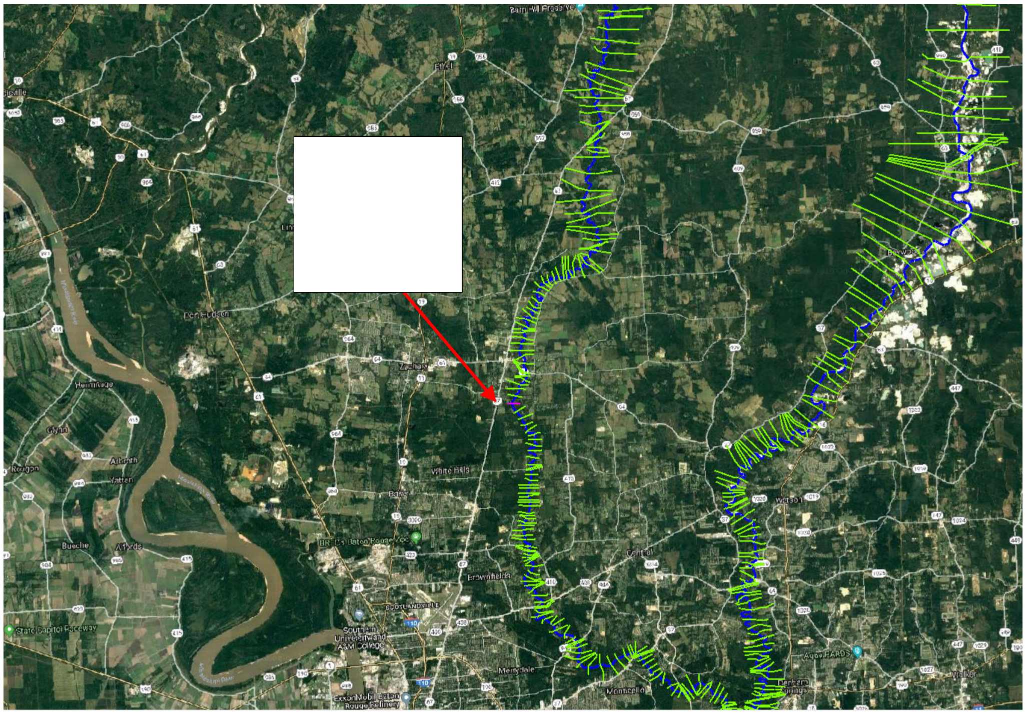


Figure G-23 – Location of Incorporation of Comite River Diversion Project into Hydraulic Model

Outlet Rating Curve

| US Flow | Outlet Flow |
|---|---|
| 0 | 0 |
| 6850 | 4450 |
| 10700 | 6150 |
| 16200 | 9300 |
| 22100 | 12700 |
| 28400 | 16800 |
| 37500 | 20800 |
| 45800 | 23900 |
| 50300 | 24900 |
| 56200 | 25800 |

Figure G-24 – Authorized Flow-Flow Rating Curve for Comite River Diversion

### 5.3.2 East Baton Rouge FRM Project

The authorized East Baton Rouge (EBR) FRM project includes projects on five separate streams: Beaver Bayou, Blackwater Bayou, Jones Creek, Ward Creek, and Bayou Fountain. The feasibility study for the EBR project reported flow rates that are expected at the downstream ends of the five streams with the authorized EBR projects in place. Because updated hydraulic modeling for the EBR projected has not yet been completed, the flow rates from the EBR feasibility study were used in this study's modeling. Figures Figure G-25, Figure G-26, and Figure G-27 show where the inflow hydrographs for the five EBR streams were applied to the hydraulic model. Table 1 lists the location in the hydraulic model where the flow for each EBR stream was applied.

**Table 1**
**Hydraulic Model Locations for Application of EBR Stream Outflow**

| EBR Stream | 1D River and Reach | Cross Section |
|---|---|---|
| Beaver Bayou | ComiteRiver Abv_AmiteR | 22408.94 |
| Blackwater Bayou | ComiteRiver Abv_AmiteR | 52579.85 |
| Jones Creek | AmiteRiver Blw_ComiteR | 258117.4 |
| *EBR Stream* | *2D Flow Area* | *Boundary Condition Line* |
| Wards Creek | BayouManchac | WardsCr_Manchac |
| Bayou Fountain | BayouManchac | BFount_ByuManch |

The EBR feasibility study only reported maximum flows. Unsteady inflow hydrographs were needed for this study's hydraulic modeling. To created inflow hydrographs, HH&C used hydrographs from initial updated EBR modeling for each stream and scaled them to make their maximum flow equal to the flow from the feasibility study. An example of this scaling is shown in Figure G-28 for the Jones Creek 25 year baseline flow.

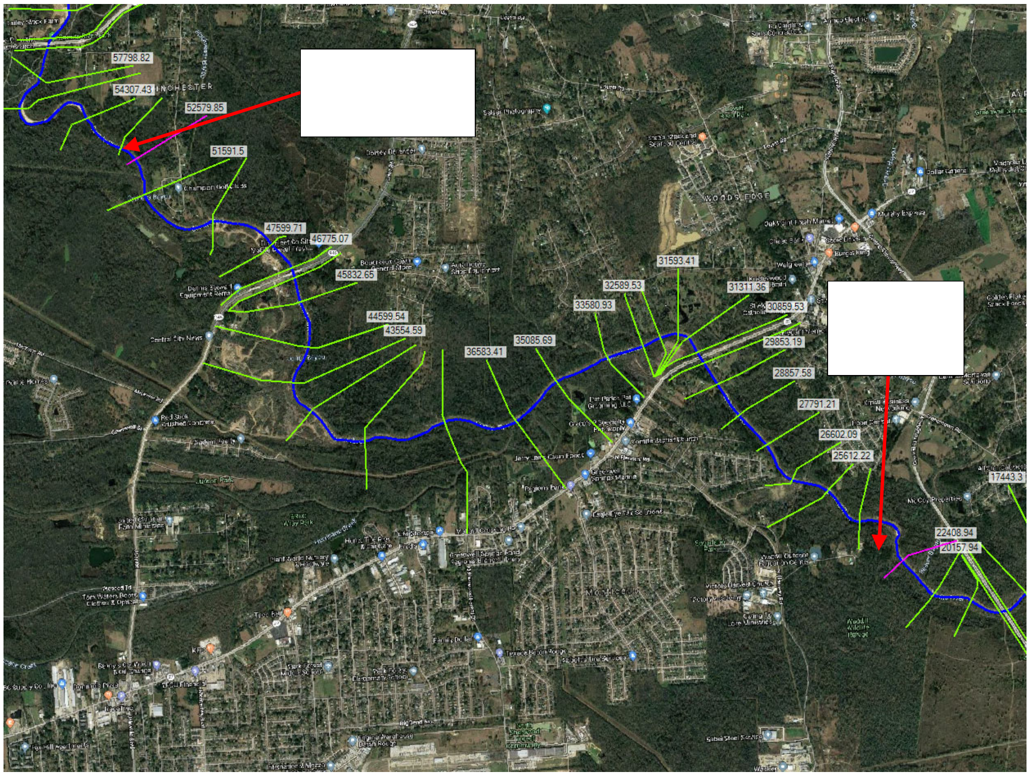



Figure G-25 – Cross Sections where Blackwater Bayou and Beaver Bayou EBR flows were applied

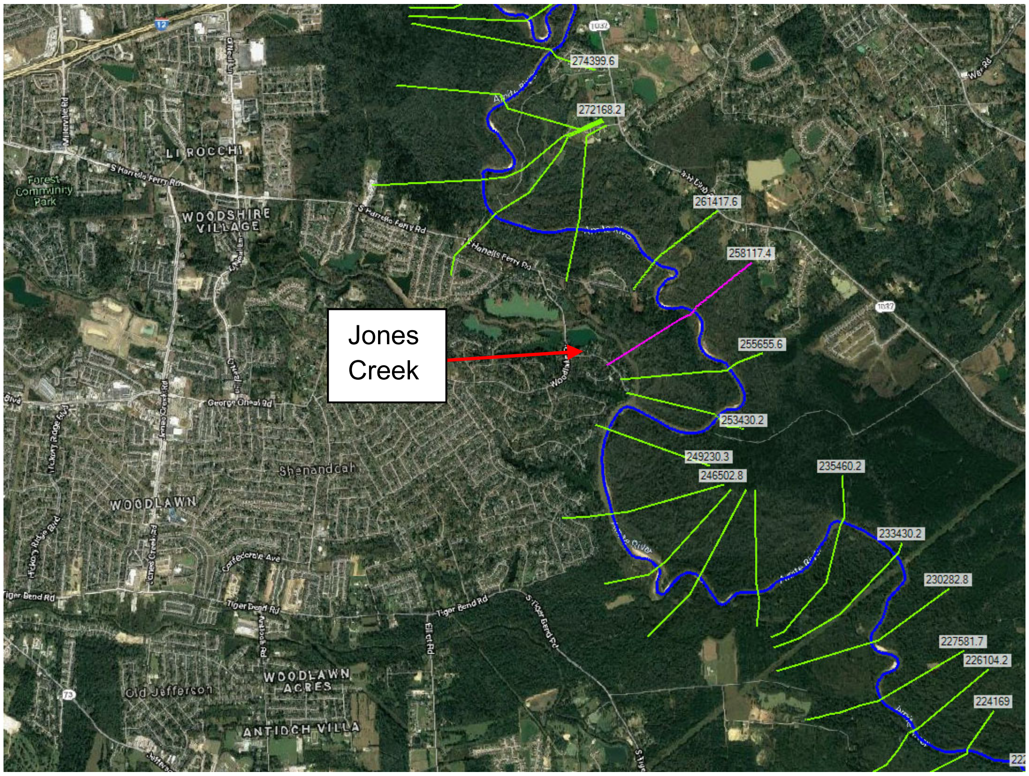



Figure G-26 – Cross Section where Jones Creek EBR Flows were applied

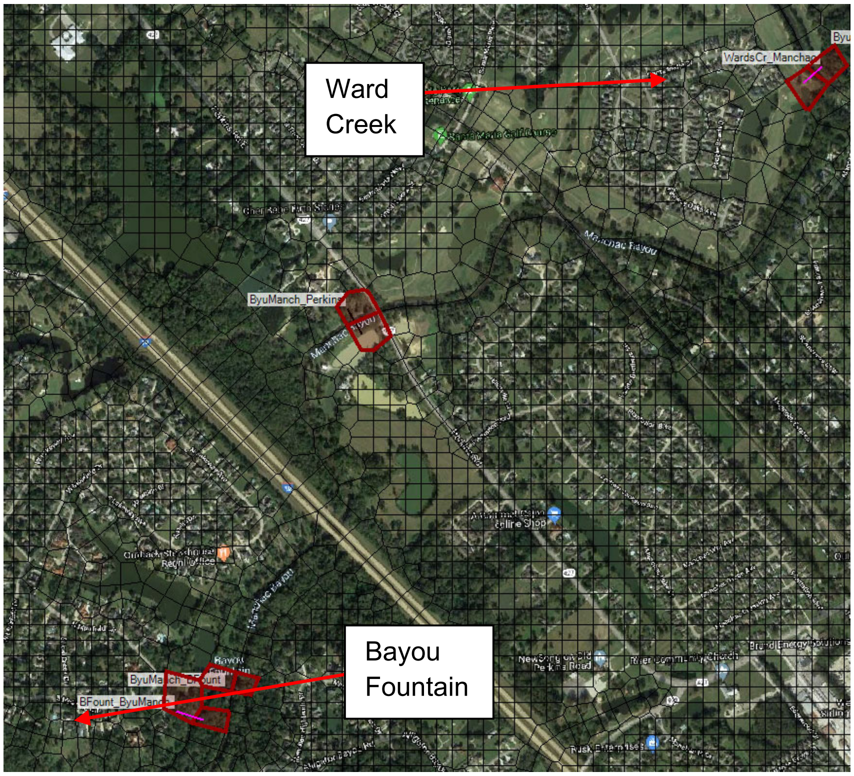



Figure G-27 – Cross Sections where Ward Creek and Bayou Fountain EBR Flows were applied

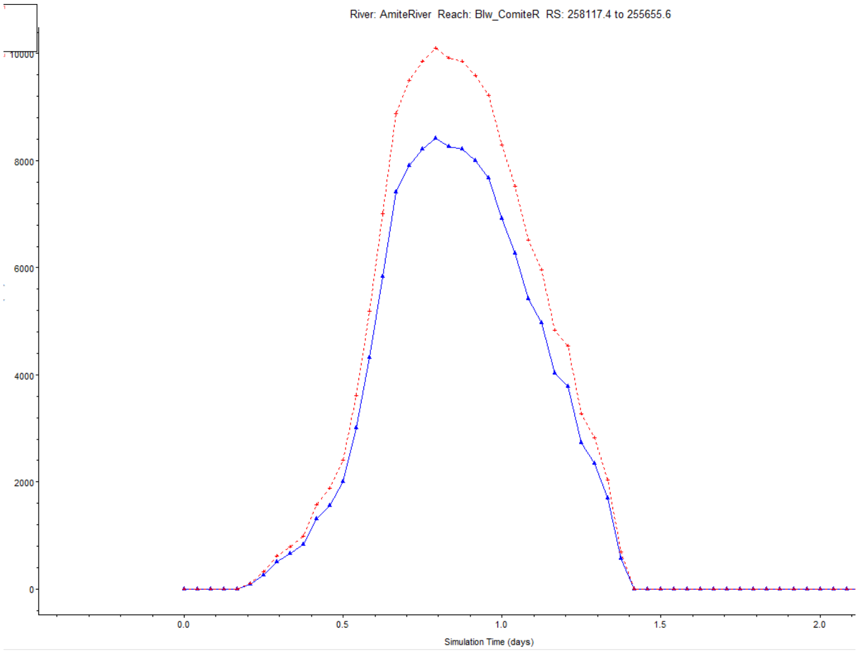



Figure G-28 – 25 Year Baseline Flow from initial Jones Creek H&H modeling (blue), Scaled to Match EBR Feasibility Flow (red)

## 5.4 Alternatives

### 5.4.1 Darlington Dam

Darlington Dam is a proposed dam on the Amite River near Darlington, Louisiana. The dam would provide FRM benefits by attenuating floodwater in its impoundment, and releasing water for an extended time at a lower rate, thus saving downstream areas from the peak flows of the upper Amite River.

This alternative was considered potentially effective for providing significant FRM benefits, so it was selected as an alternative to model. The Darlington Dam was modeled as a Dry Dam, meaning that it began with no water in the impoundment. This allowed for maximum storage capacity for purposes of evaluating potential effectiveness.

The Darlington Dam model obtained from LaDOTD utilized a 100-year dam design. For this modeling effort, HH&C was tasked with modeling the 25-year dry dam. HH&C edited the 2D area connection of the Darlington Dam to represent the 25-year dry dam. Those edits included lowering the dam crest and the emergency spillway elevation. When the water surface elevation in the impoundment is below the elevation of the emergency spillway, water flows through the dam via the low level outlet, which is three 10-ft by 10-ft culverts at the base of the dam. When the water surface is higher than the emergency spillway, the low level outlet is closed. In order to properly represent this operation of the dam outlets in the model, stage-flow rating curves were calculated from model results for both the low level outlet and the emergency spillway. Those curves were combined into a single stage-flow rating curve that was applied to the 2D area connection of the Darlington Dam.

### 5.4.2 Lily Bayou, Bluff Creek, and Darlington Creek Dry Detention Ponds (Alternative 8A)

The Lily Bayou, Bluff Creek, and Darlington Creek dry detention ponds are dams on three tributaries of the upper Amite River. The dams would provide FRM benefits by attenuating floodwater in their impoundments, and releasing water for an extended time at lower rates, thus saving the Amite River Basin from the peak flows of the three streams.

This alternative was considered potentially effective for providing significant FRM benefits, so it was selected as an alternative to model. This alternative was modeled by assuming that all of the flow upstream of each detention pond would be stored in the ponds for every flood event.

### 5.4.3 Sandy Creek Dry Detention Pond (Alternative 8C)

Sandy Creek Dry Detention Pond is a dam on Sandy Creek, a right bank tributary of the Amite River. The dam would provide FRM benefits by attenuating floodwater in its impoundment, and releasing water for an extended time at a lower rate, thus saving the lower Sandy Creek Basin and the lower Amite River Basin from the peak flows of upper Sandy Creek.
This alternative was considered potentially effective for providing significant FRM benefits, so it was selected as an alternative to model. This alternative was modeled by assuming that all of the flow upstream of the detention pond would be stored in the pond for every flood event.

### 5.4.4 Spanish Lake Pump Station and Gate Operation

The Spanish Lake area and surrounding bayous (Bayou Fountain and Bayou Manchac) historically flood due to backwater from the Amite River. A pump station that collects water from the northwest portion of Spanish Lake and pumps to the Mississippi River was originally considered to divert incoming floodwaters flowing upstream up Bayou Manchac. That alternative was modeled with the 100 year event, and it was determined that the influence area of a pump station in that location could not have significant FRM benefits to the Spanish Lake area. A pump station located nearer to the confluence of Bayou Fountain and Bayou Manchac (near the entrance to Spanish Lake) was considered, as that could have a more significant influence area. But that pump station location was several miles from where it would pump water to in the Mississippi River, and thus was screened out due to cost.

This alternative was considered not economically feasible for FRM, and thus was not modeled for all AEP events.

#### 5.4.5 Highway 22

Highway 22 crosses the Amite River Diversion approximately 3 miles downstream from the Amite River. For large events where there is significant flow out of the banks of the Amite River Diversion, Highway 22 acts as a barrier to flow. This causes backup of water upstream of Highway 22. Adding additional drainage underneath Highway 22, or turning Highway 22 into a short causeway, was considered as a way to mitigate the flow blockage. Both of these options were modeled with the 100 year event. Water levels were able to be lowered upstream of Highway 22, but it was determined that there were not enough structures in the region that could see benefit from this project.

This alternative was considered not beneficial enough to be modeled for all AEP events.

#### 5.4.6 Port Vincent Bridge

Highway 42 crosses the Amite River at Port Vincent, Louisiana. The Port Vincent Bridge has several piers and a bridge deck that were assumed to act as a restriction to flow, causing an increase in water levels upstream of the bridge. Replacing the existing bridge with a clear span bridge and raising the bridge deck were considered as an alternative to mitigate the flow blockage. Evaluation of the impacts of the existing bridge for the 500 year event shows that water levels do not reach the elevation of the bridge deck. Several bridge piers are in the flow path, so conceivably a clear span bridge could show FRM benefits. But water levels upstream of the bridge could only be expected to be lowered by approximately one foot at the 500 year event, and by less than that for higher frequency events.

Based on the small expected hydraulic impact of the bridge, this alternative was not modeled for the suite of AEP events.

#### 5.4.7 Amite River Re-meandering

Adding meanders to the Amite River above the Comite River was an alternative suggested recently by other federal agencies. The potential benefit is that there would be additional length in the river, and thus additional storage capacity, and floodwaters would be slowed down on their journey to inundate populated areas downstream. There are potential benefits from this alternative, especially at higher frequency events where the Amite River is still in its banks.

There are design and feasibility challenges with this alternative and the true potential for FRM benefits is quite unclear. At lower frequency events, the Amite River is out of its banks, and mostly flowing as sheet flow across the entire flood plain. In those cases, the shape and length of the river channel is less significant. Also, there would be difficulty in “adding” meanders to the river in a stable way. Man-made shaping of rivers in a “natural” manner requires a thorough understanding of river morphodynamics, and significant erosion control measures would need to be taken.

While this alternative could yield FRM benefits downstream of the re-meandered region, it would likely be significant for only the higher frequency events. For lower frequency events, the potential benefits would be negligible. The total benefits from this project would likely be on a smaller order of magnitude than the benefits from the various dam alternatives. Due to the low expected relative benefits from this alternative, and the significant engineering challenges associated with the restoration of meanders, this alternative was not modeled for the suite of AEP events.

#### 5.4.8 Highway 16

Highway 16 crosses Colyell Creek south of Port Vincent, Louisiana, approximately one mile upstream from the confluence with the Amite River. The Highway 16 Bridge has several piers and a bridge deck that are assumed to act as a restriction to flow, causing an increase in water levels upstream of the bridge. Due to the relative small size of Colyell Creek, the Highway 16 Bridge was not included in the hydraulic model that was used for this modeling effort. Analysis of the potential impacts of this bridge for the 200 year event show that the likely elevation of the bridge deck is above the peak water surface. The bridge deck is likely not a restriction to flow to any of the model events except for the 500 year. In order to model this alternative, a survey of the existing Highway 16 Bridge would be required, as well as further refinement of the hydraulic model.

There is a low density of structures in the region where water backs up behind the Highway 16 Bridge. Based on the low density of structures in the region, the lack of survey data for the bridge, and the small expected hydraulic impact of the bridge deck, this alternative was not modeled for the suite of AEP events.

### 5.5 Results

Hydraulic model runs were made for the full suite of eight 24-hour AEP events (0.5, 0.2, 0.1, 0.04, 0.02, 0.01, 0.005, and 0.002) for baseline without project (2026) and FWOP (2076). Model runs were also made for the full suite of eight 24-hour AEP events for three alternatives: Darlington Dam, Alternative 8A, and Alternative 8C. All alternative model runs were made using the baseline (2026) hydrology. Figures G-29 and G-30 show stages for the six lower frequency events (0.1, 0.04, 0.02, 0.01, 0.005, and 0.002) for baseline and alternative runs at two relevant locations on the Amite River: Denham Springs and Port Vincent.

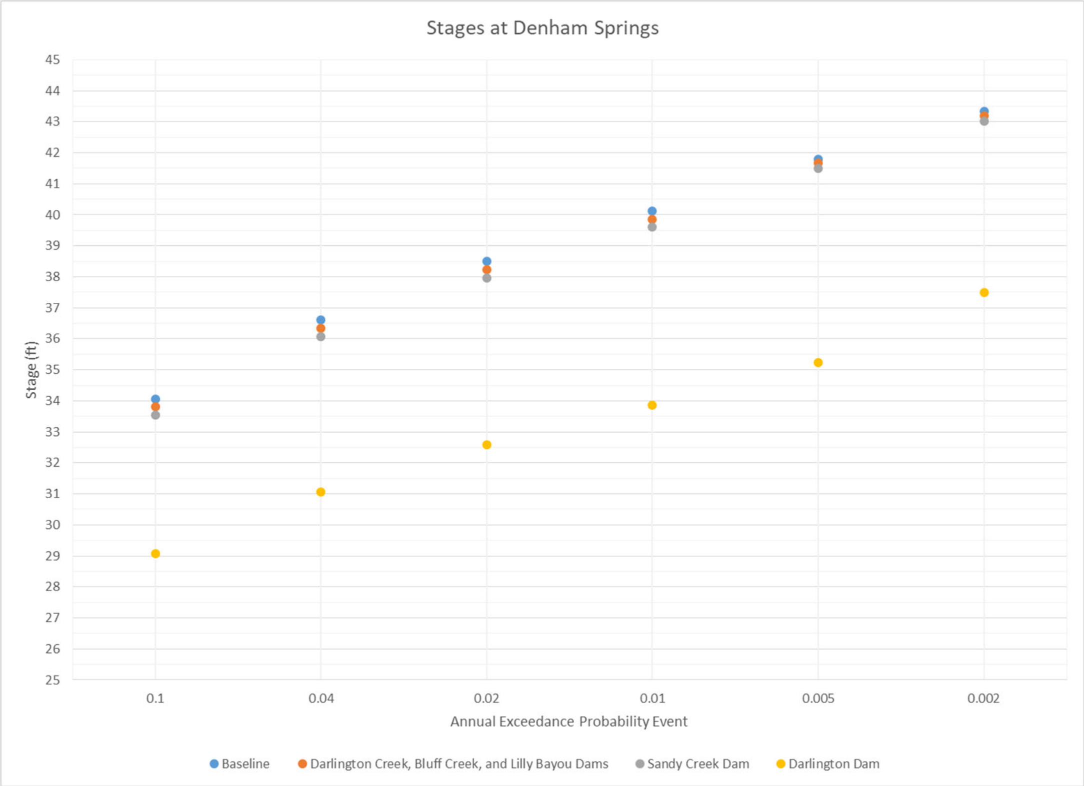



Figure G-29 – Stages at Denham Springs

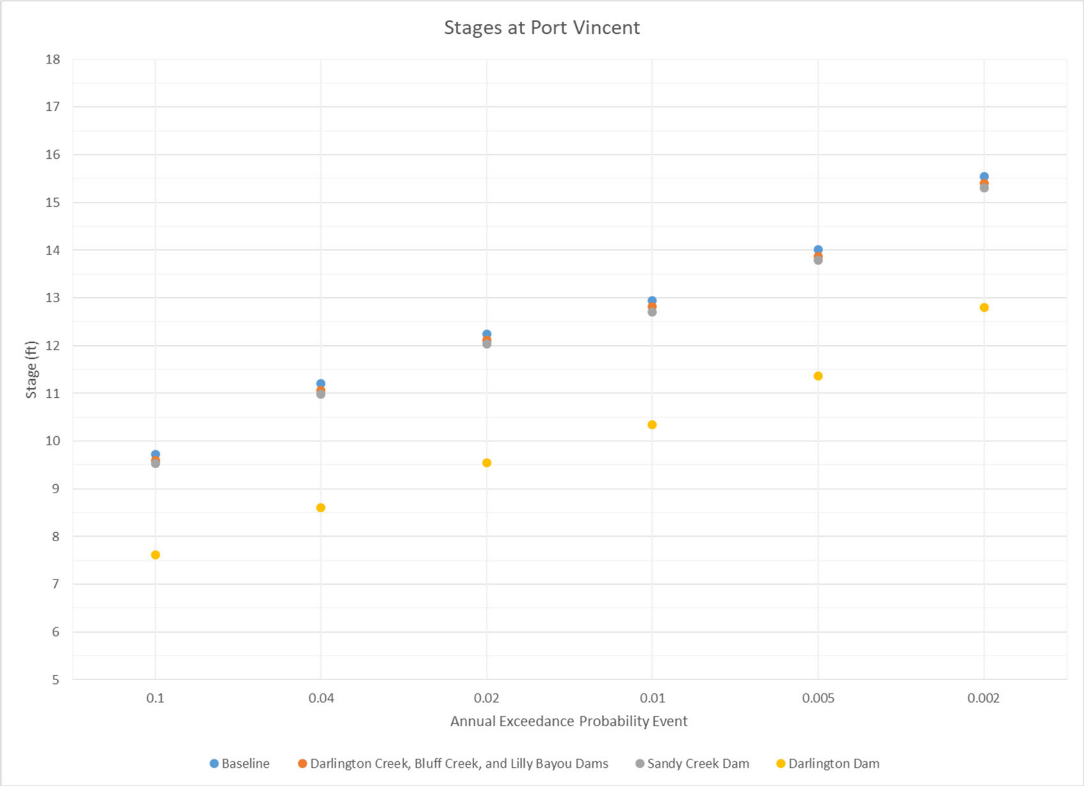



Figure G-30 – Stages at Port Vincent

This section shows results of the 10 year and 500 year model runs for each of the three modeled alternative and FWOP, compared against baseline results. The 10 year (Figure G-29 – Figure G-40) and 500 year (Figure G-41 – Figure G-52) results were selected for presentation in this document because they represent a higher frequency event (10 year) and lower frequency event (500 year). Water surface elevation profiles are shown on the Amite River, because that is where the most significant impacts are seen. Maximum inundation maps for the entire hydraulic model domain are also included.

Results of hydraulic modeling were used to generate water surface elevation and depth grids for every alternative for the full suite of eight 24-hour AEP events. Those results grids were provided to the GIS and Economics branches for use in developing economics analyses.

**10 Year Darlington Dam**
Maximum Water Surface Profile: Amite River above Comite River

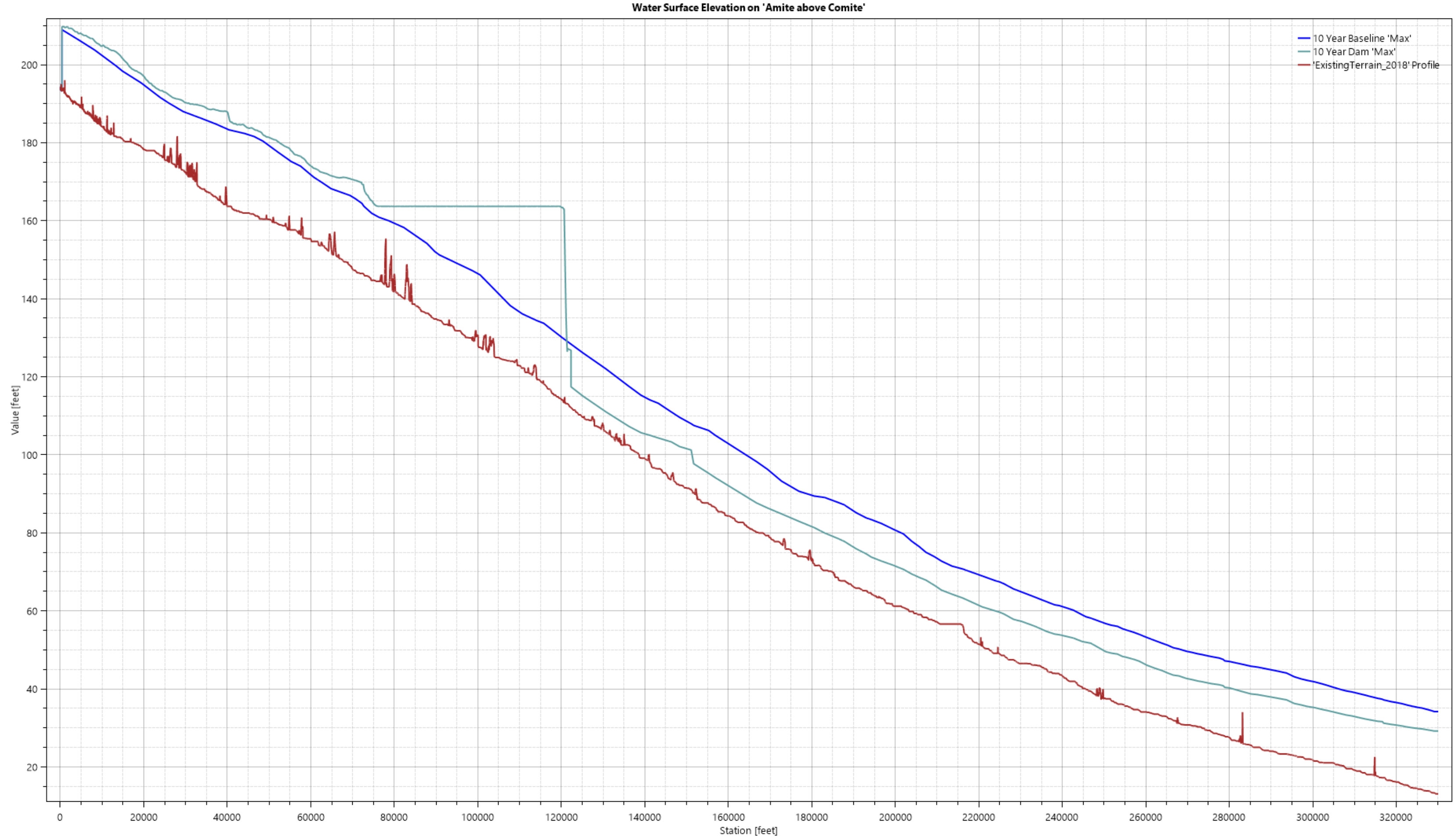



Figure G-29 – Darlington Dam (green) and Baseline (blue) on Amite River above Comite

**10 Year Darlington Dam**
Maximum Water Surface Profile: Amite River below Comite River

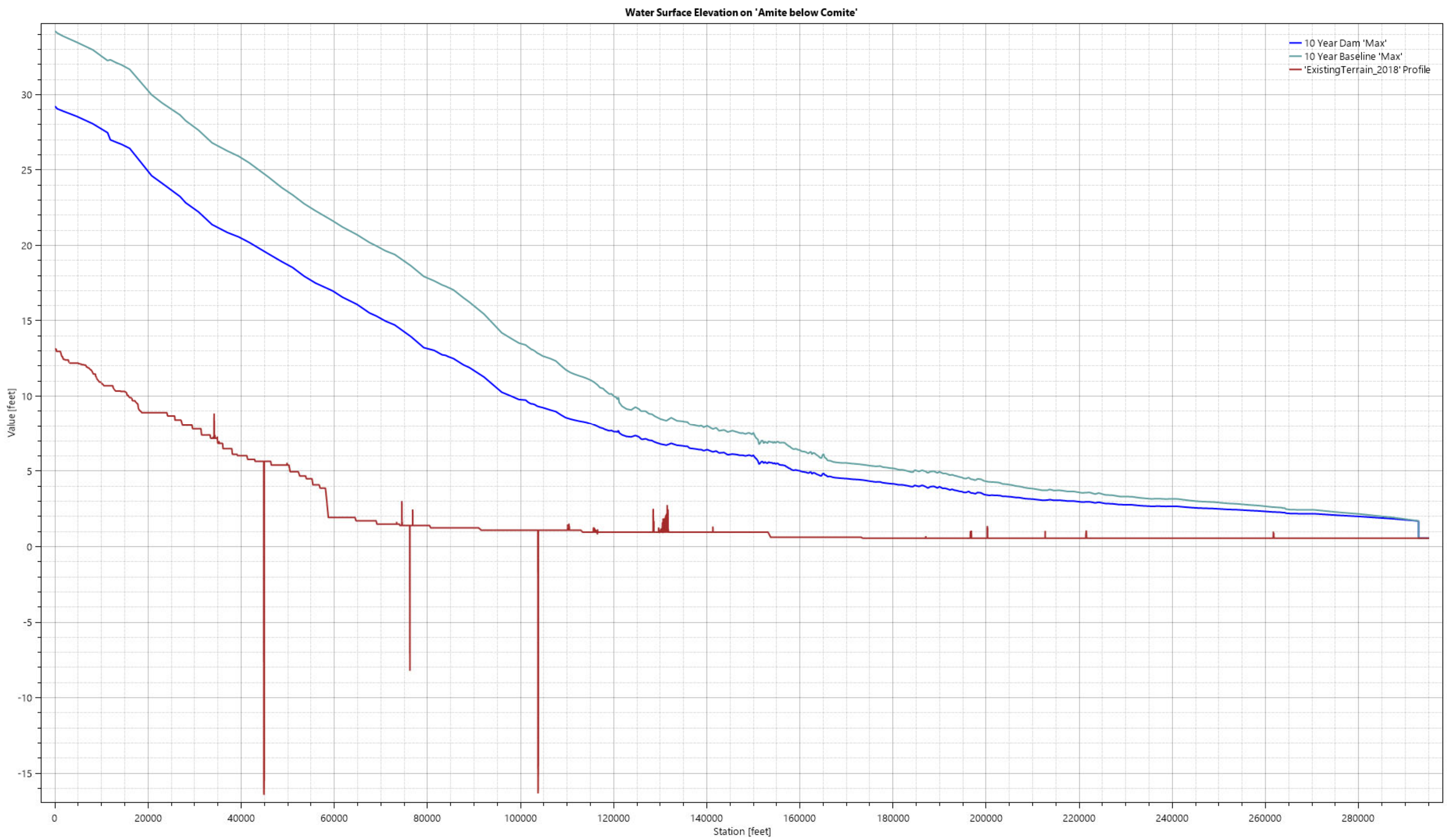



Figure G-30 – Darlington Dam (blue) and Baseline (green) on Amite River below Comite

**10 Year Darlington Dam**
Maximum Inundation

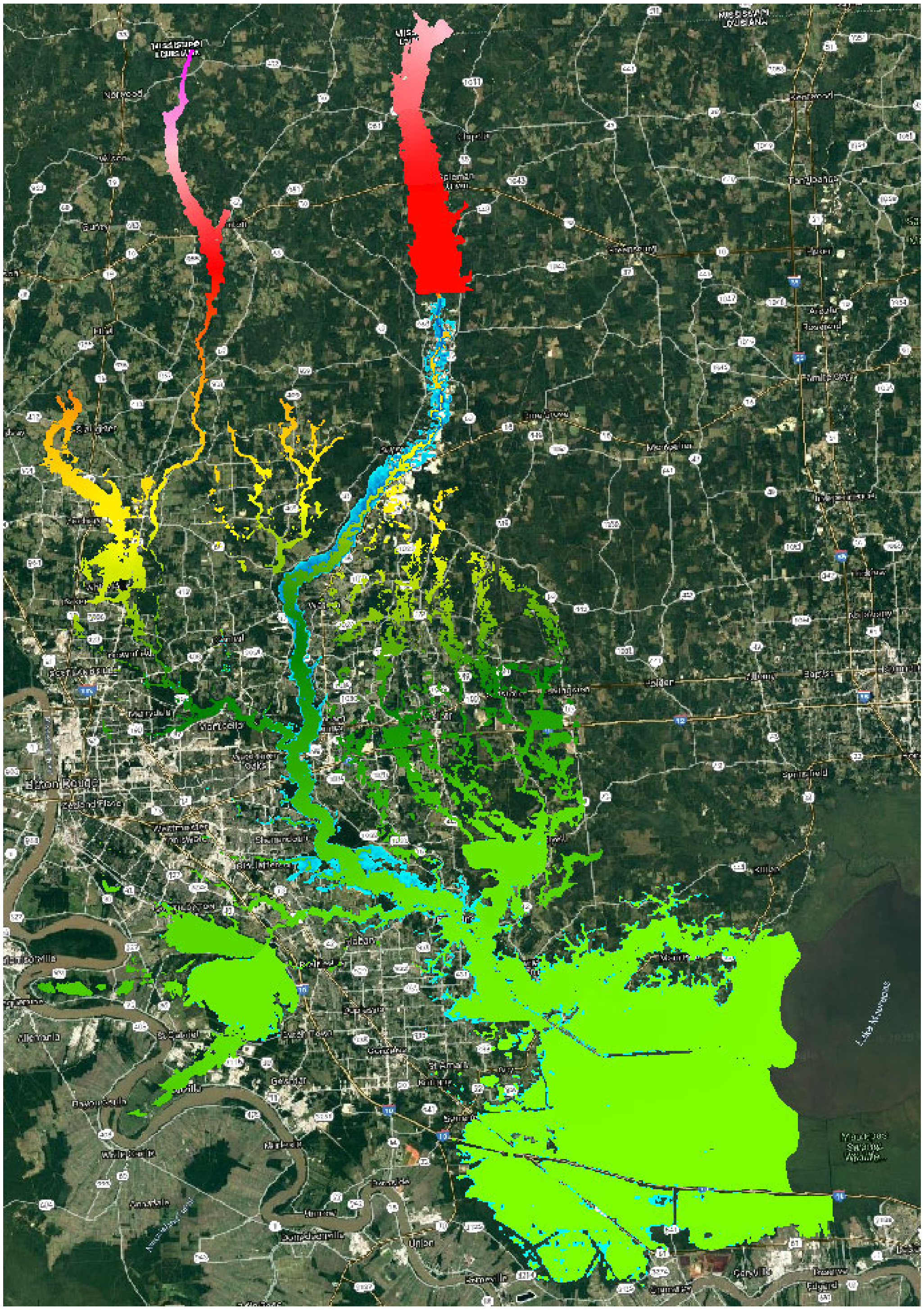


Figure G-31 – Darlington Dam (red-green scale) and Baseline (blue) Maximum Inundation Area

**10 Year Alternative 8A**

Maximum Water Surface Profile: Amite River above Comite River

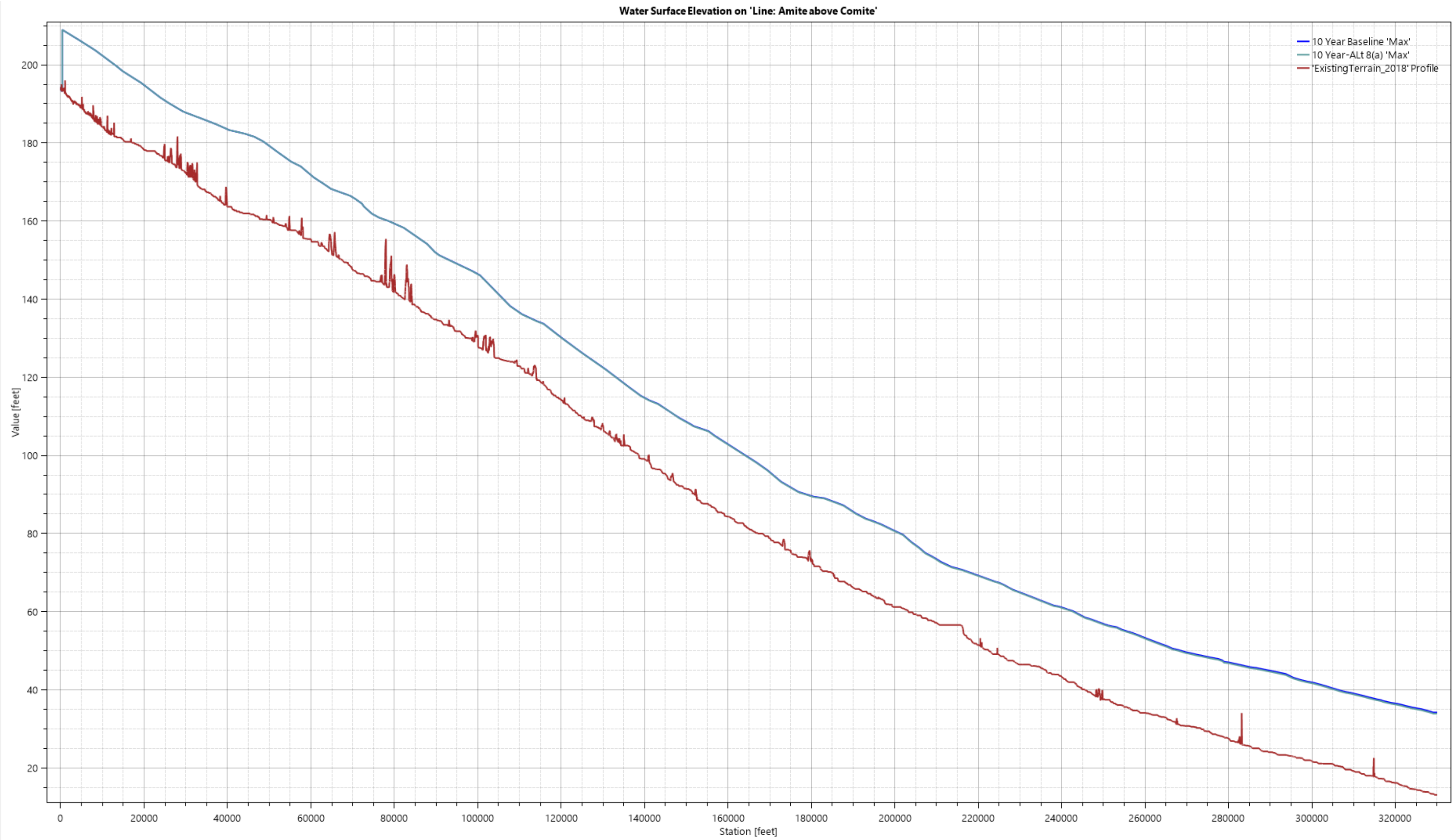



Figure G-32 – Alternative 8A (green) and Baseline (blue) on Amite River above Comite

**10 Year Alternative 8A**

Maximum Water Surface Profile: Amite River below Comite River


Figure G-33 – Alternative 8A (green) and Baseline (blue) on Amite River below Comite

**10 Year Alternative 8A**
Maximum Inundation

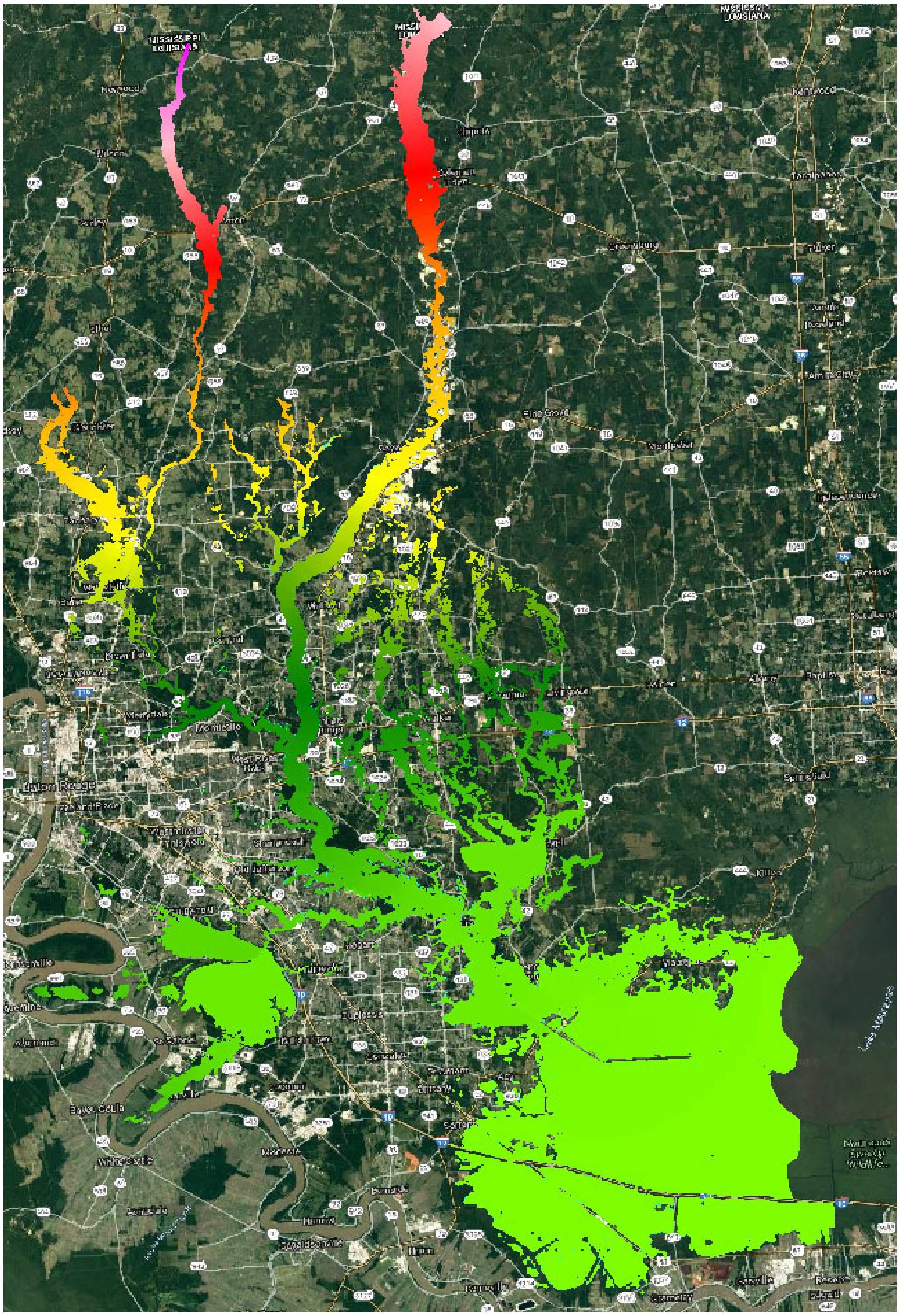


Figure G-34 – Alternative 8A (red-green scale) and Baseline (blue) Maximum Inundation Area

**10 Year Alternative 8C**

Maximum Water Surface Profile: Amite River above Comite River

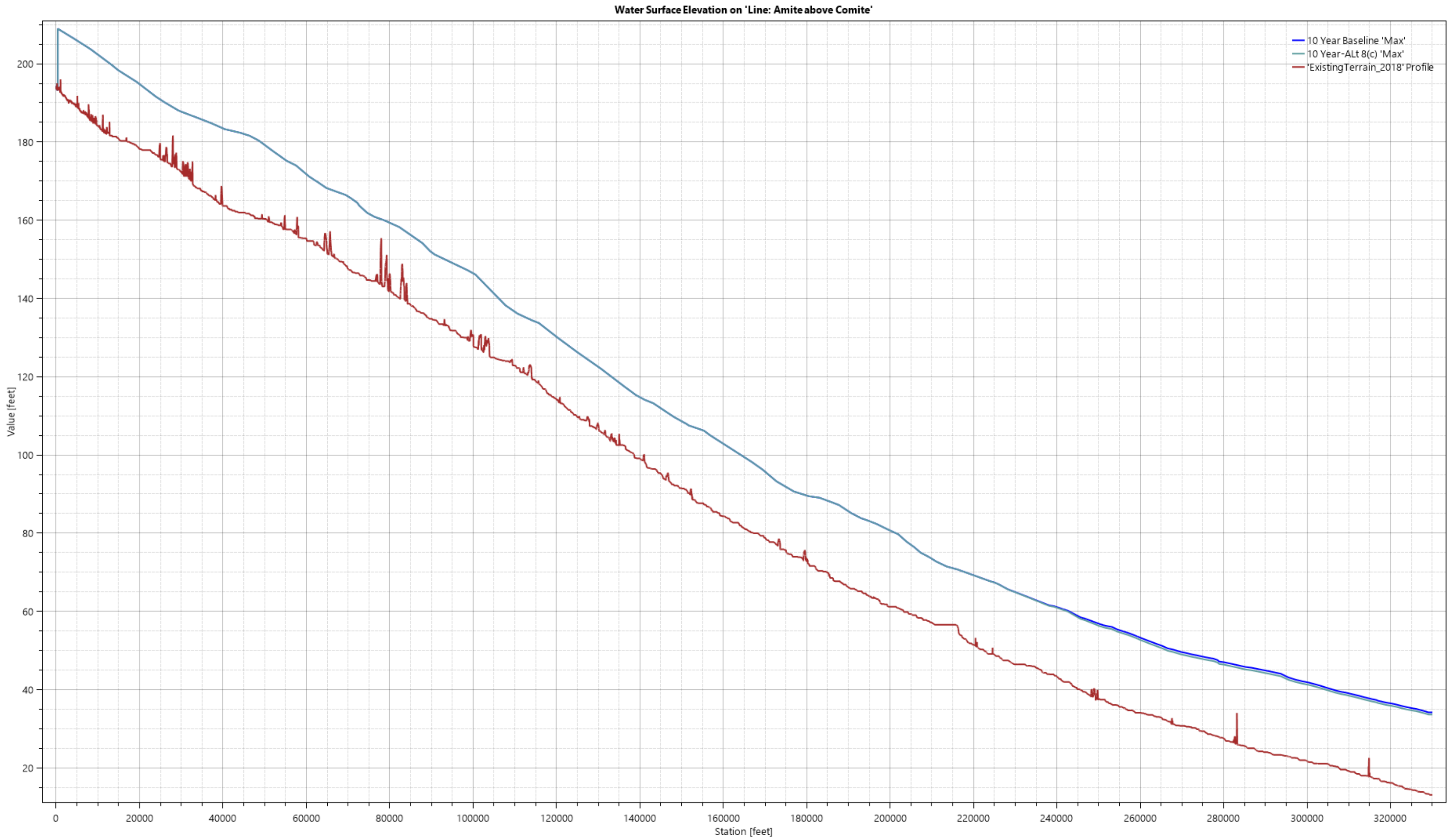



Figure G-35 – Alternative 8C (green) and Baseline (blue) on Amite River above Comite

**10 Year Alternative 8C**

Maximum Water Surface Profile: Amite River below Comite River

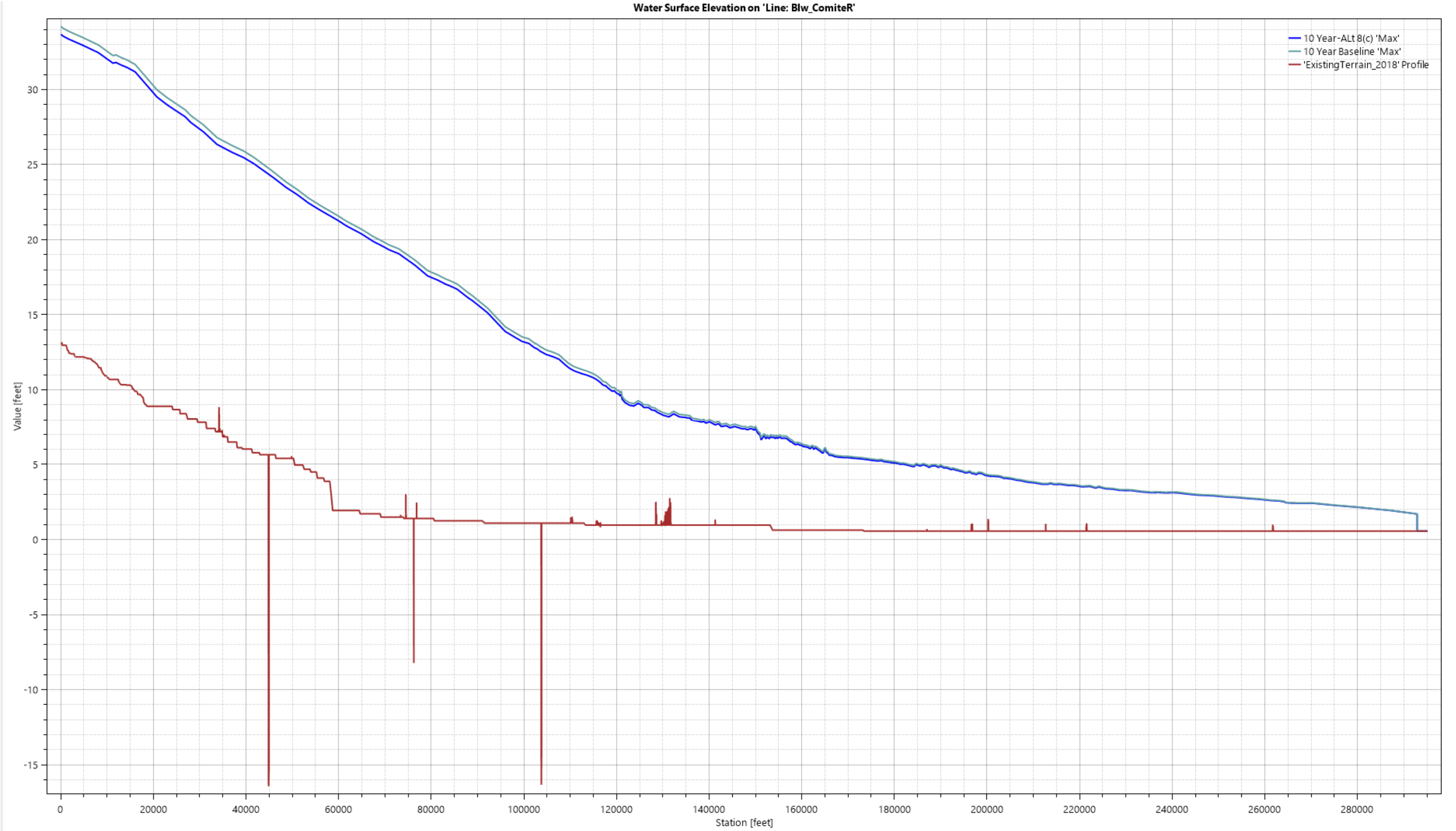



Figure G-36 – Alternative 8C (blue) and Baseline (green) on Amite River below Comite

**10 Year Alternative 8C**
Maximum Inundation

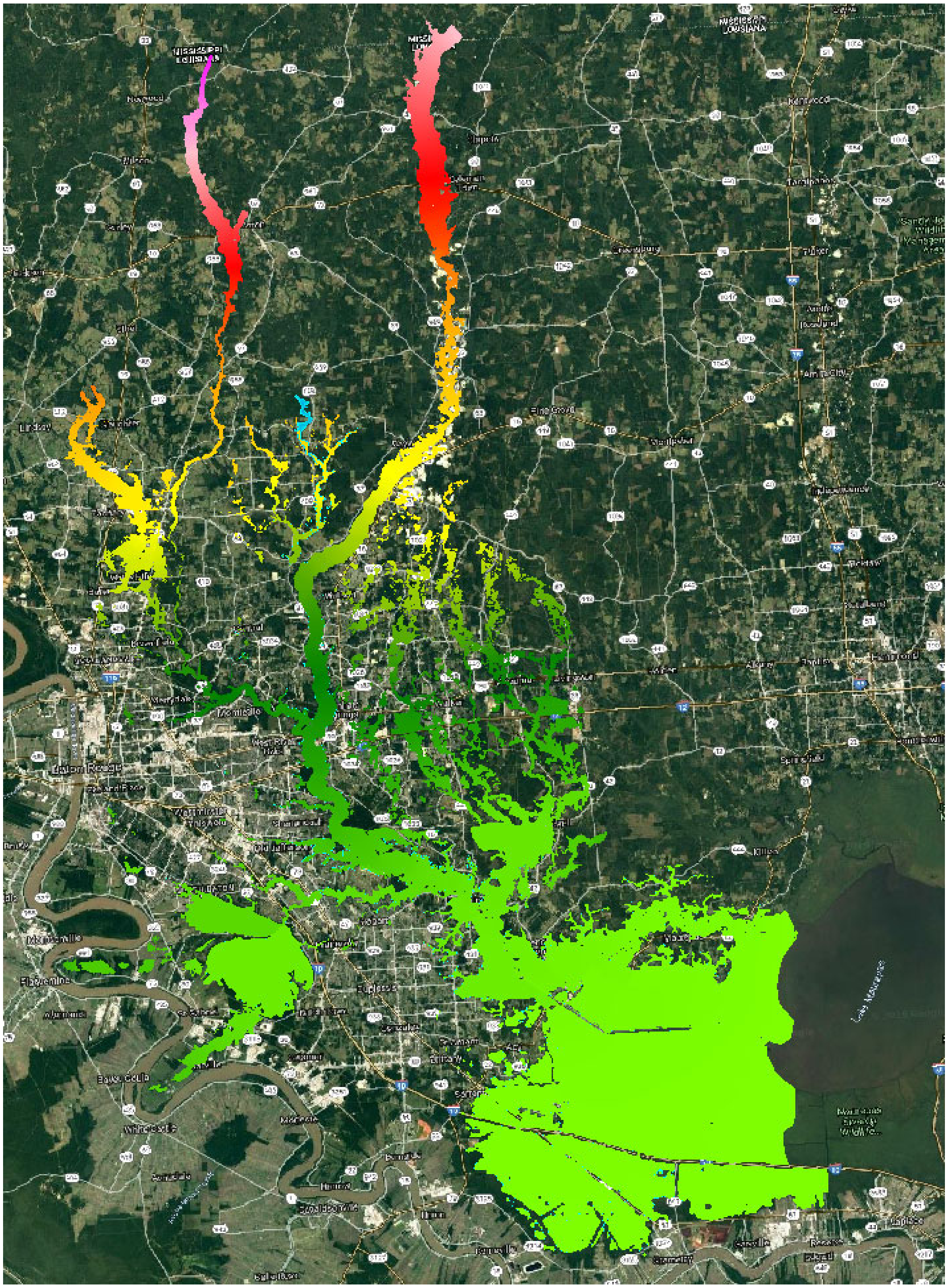


Figure G-37 – Alternative 8C (red-green scale) and Baseline (blue) Maximum Inundation Area

**10 Year FWOP**

Maximum Water Surface Profile: Amite River above Comite River

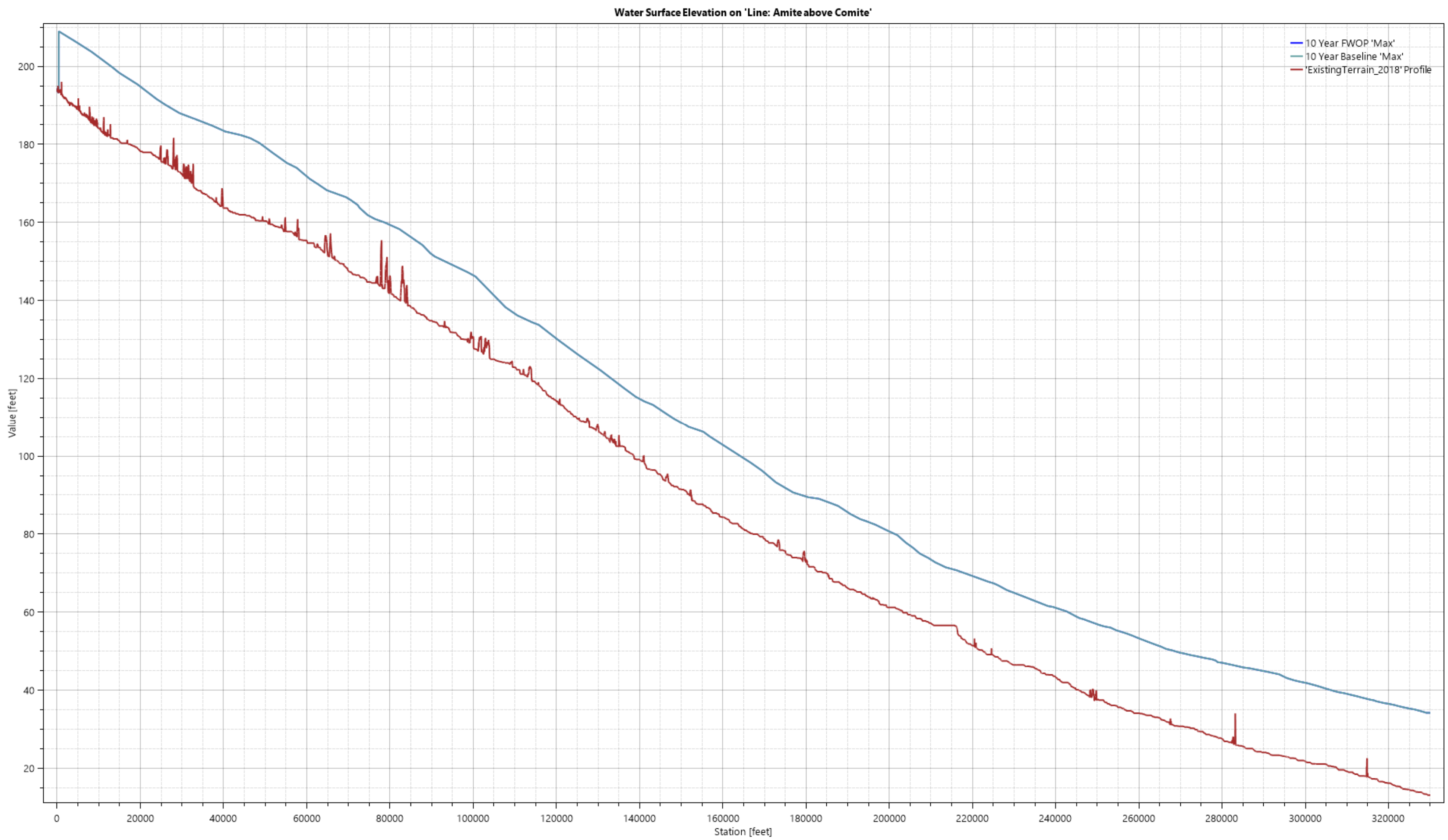



Figure G-38 – FWOP (blue) and Baseline (green) on Amite River above Comite

**10 Year FWOP**

Maximum Water Surface Profile: Amite River below Comite River


Figure G-39 – FWOP (blue) and Baseline (green) on Amite River below Comite

**10 Year FWOP**
Maximum Inundation

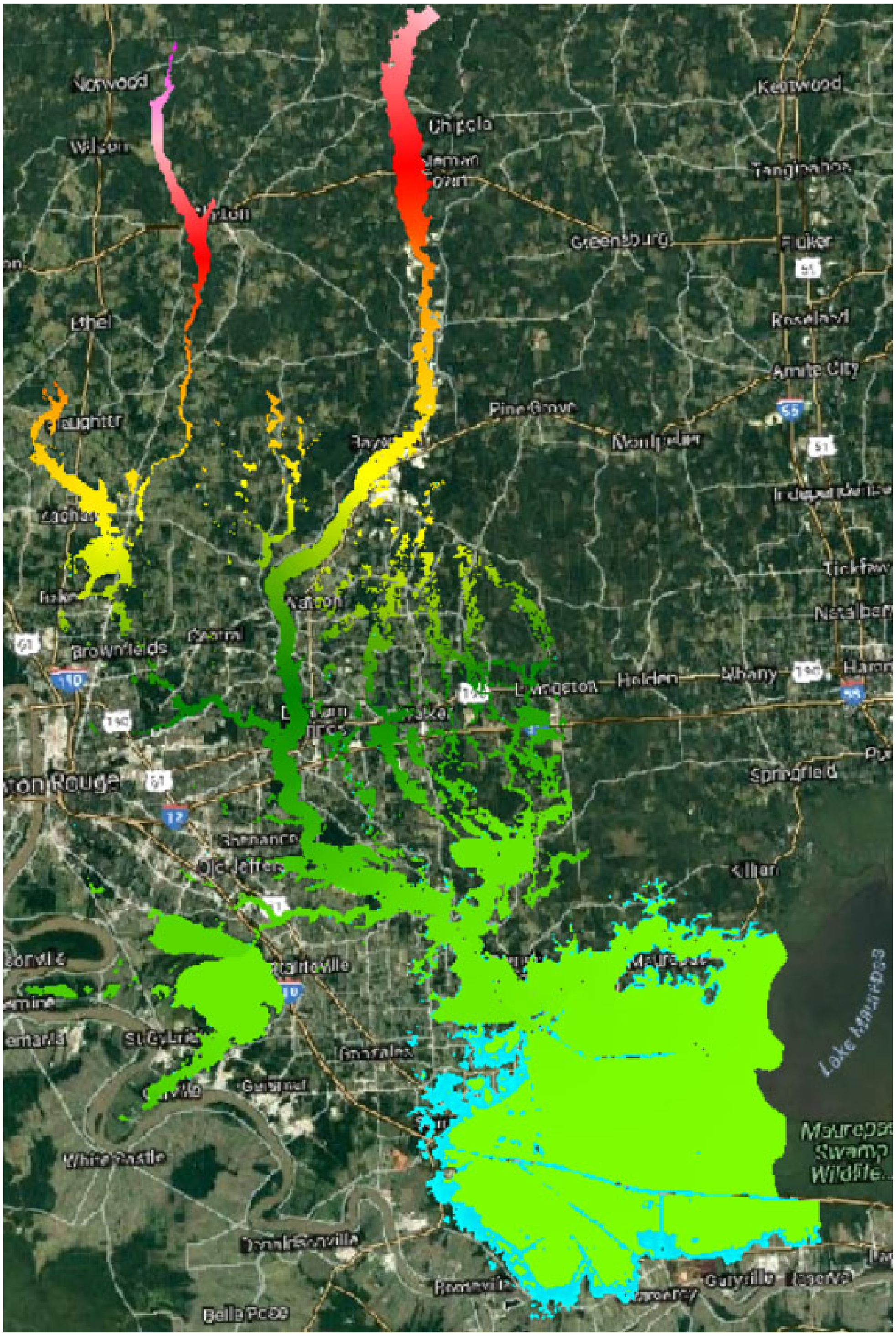



Figure G-40 – FWOP (blue) and Baseline (red-green scale) Maximum Inundation Area

**500 Year Darlington Dam**

Maximum Water Surface Profile: Amite River above Comite River

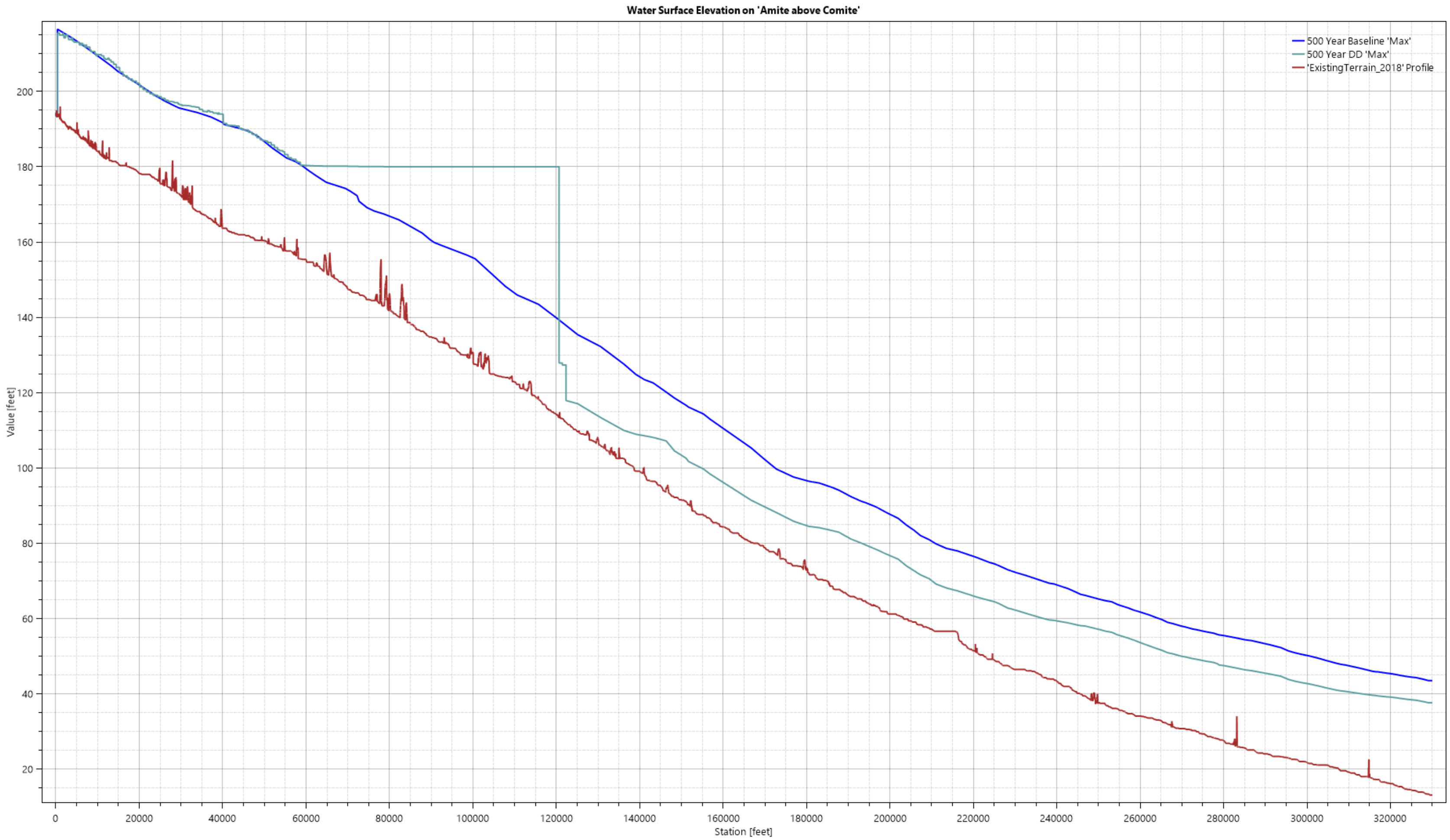



Figure G-41 – Darlington Dam (green) and Baseline (blue) on Amite River above Comite

**500 Year Darlington Dam**

Maximum Water Surface Profile: Amite River below Comite River

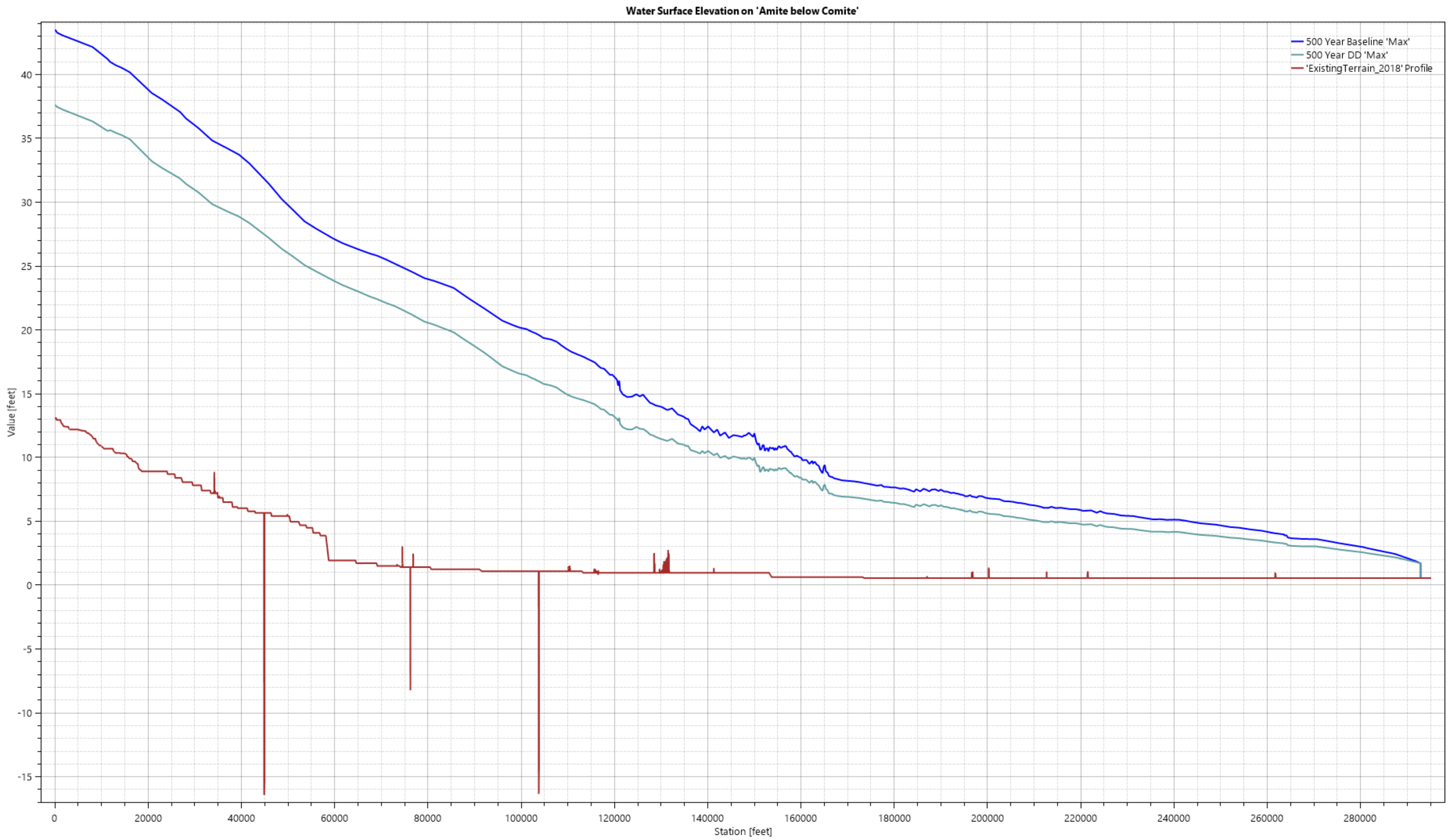



Figure G-42 – Darlington Dam (green) and Baseline (blue) on Amite River below Comite

**500 Year Darlington Dam**
Maximum Inundation

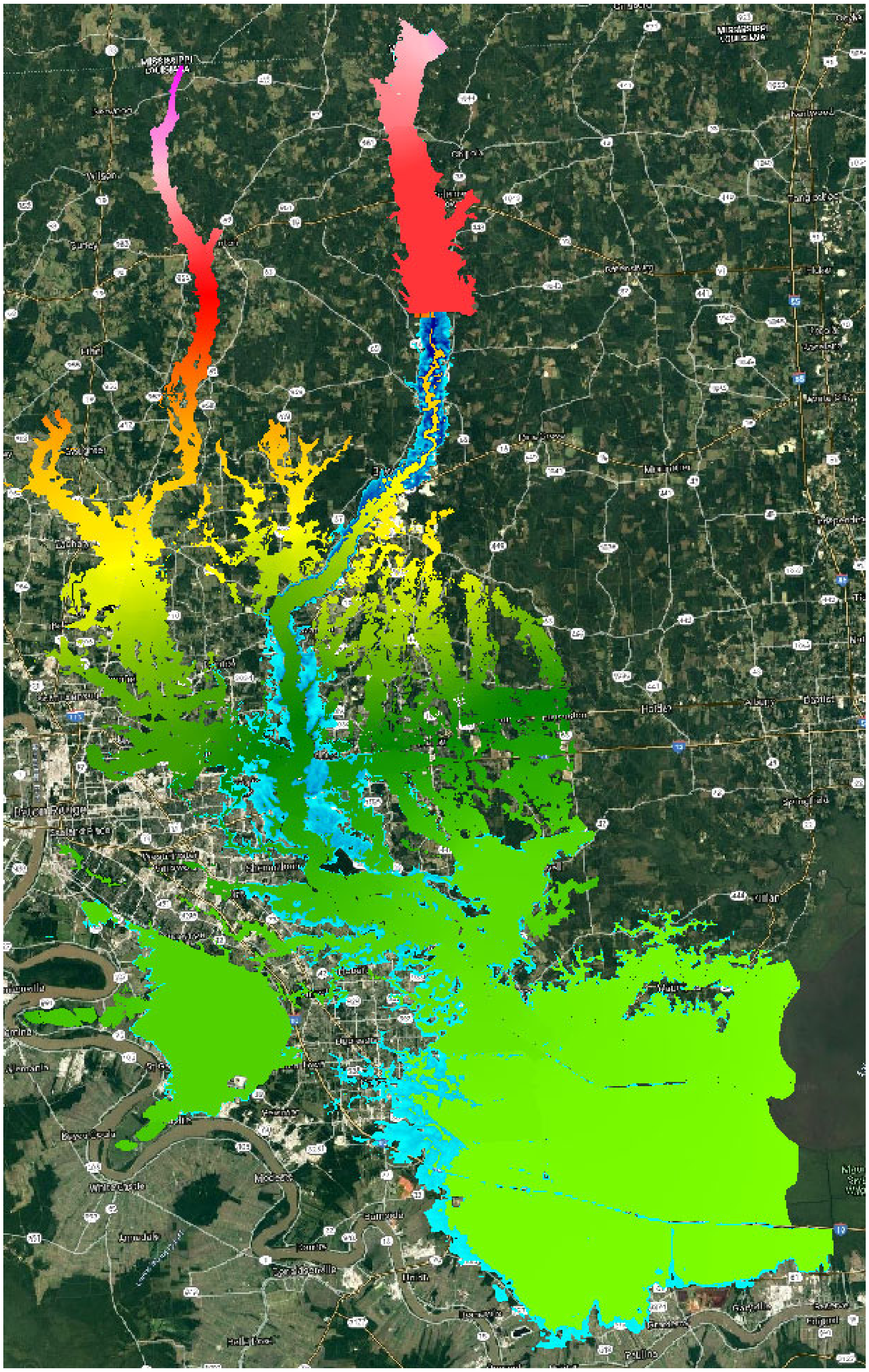


Figure G-43 – Darlington Dam (red-green scale) and Baseline (blue) Maximum Inundation Area

**500 Year Alt 8A**

Maximum Water Surface Profile: Amite River above Comite River

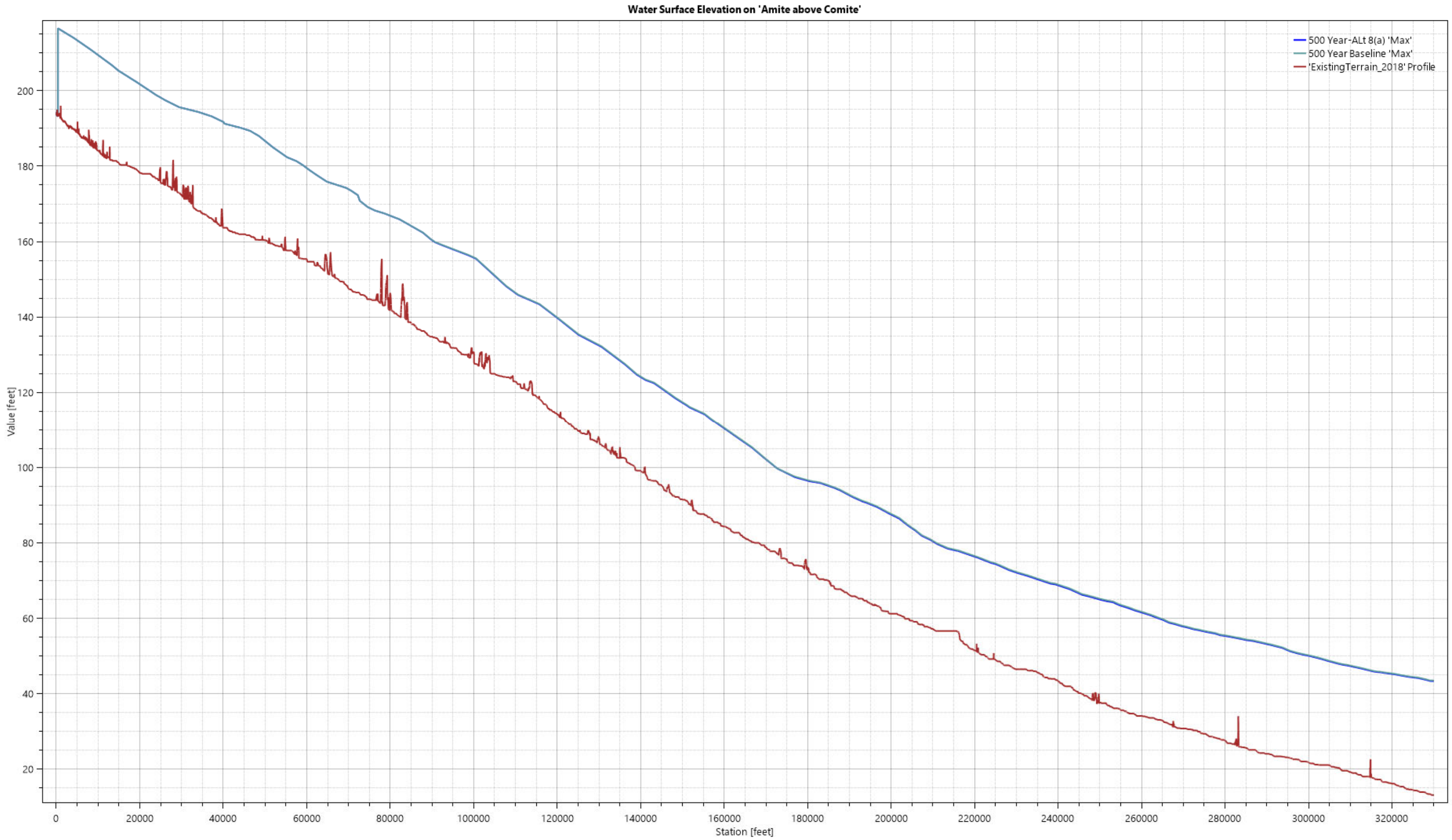



Figure G-44 – Alternative 8A (blue) and Baseline (green) on Amite River above Comite

**500 Year Alt 8A**

Maximum Water Surface Profile: Amite River below Comite River


Figure G-45 – Alternative 8A (blue) and Baseline (green) on Amite River below Comite

**500 Year Alt 8A**
Maximum Inundation

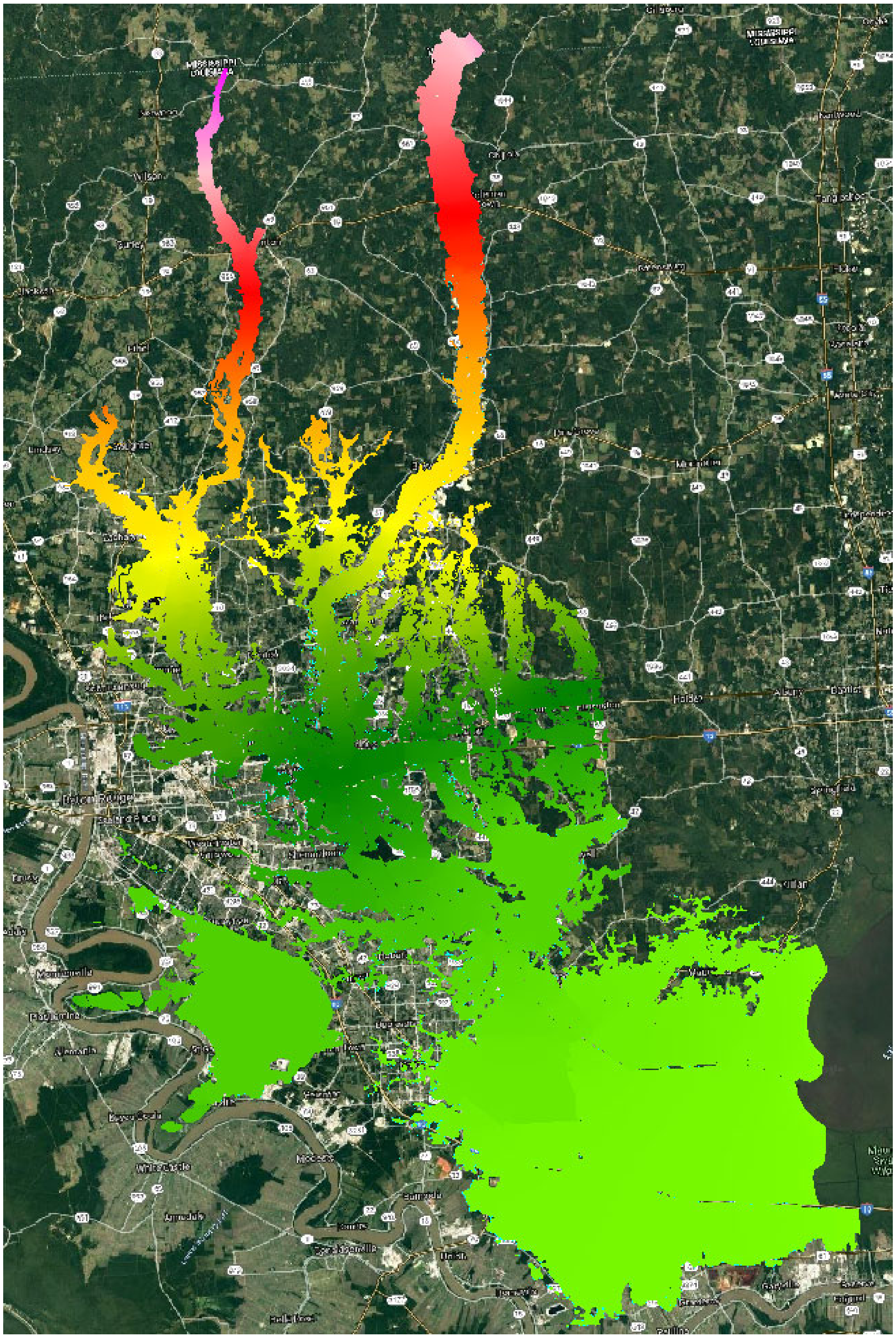


Figure G-46 – Alternative 8A (red-green scale) and Baseline (blue) Maximum Inundation Area

**500 Year Alt 8C**

Maximum Water Surface Profile: Amite River above Comite River

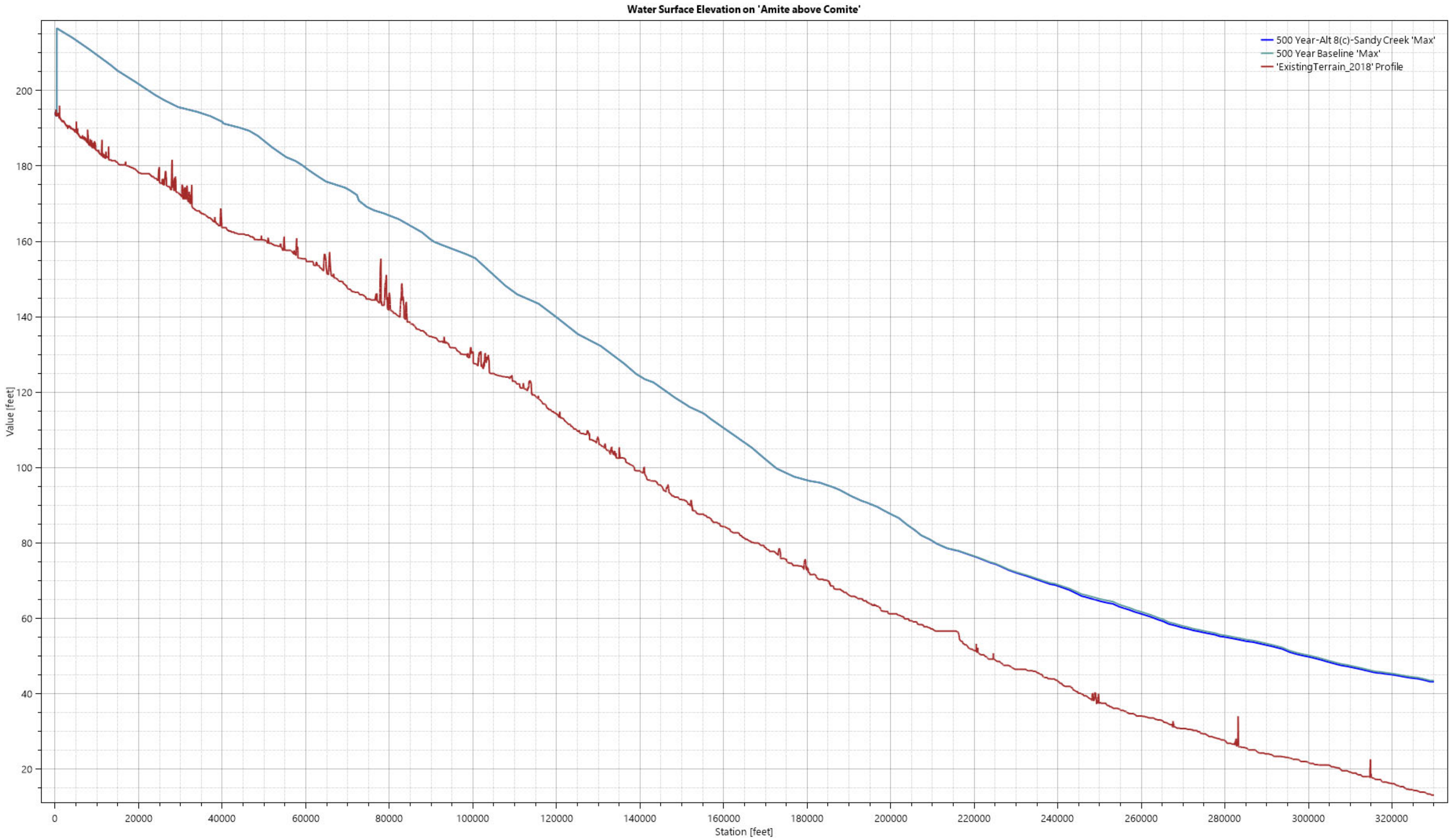



Figure G-47 – Alternative 8C (blue) and Baseline (green) on Amite River above Comite

**500 Year Alt 8C**

Maximum Water Surface Profile: Amite River below Comite River


Figure G-48 – Alternative 8C (blue) and Baseline (green) on Amite River below Comite

**500 Year Alt 8C**
Maximum Inundation

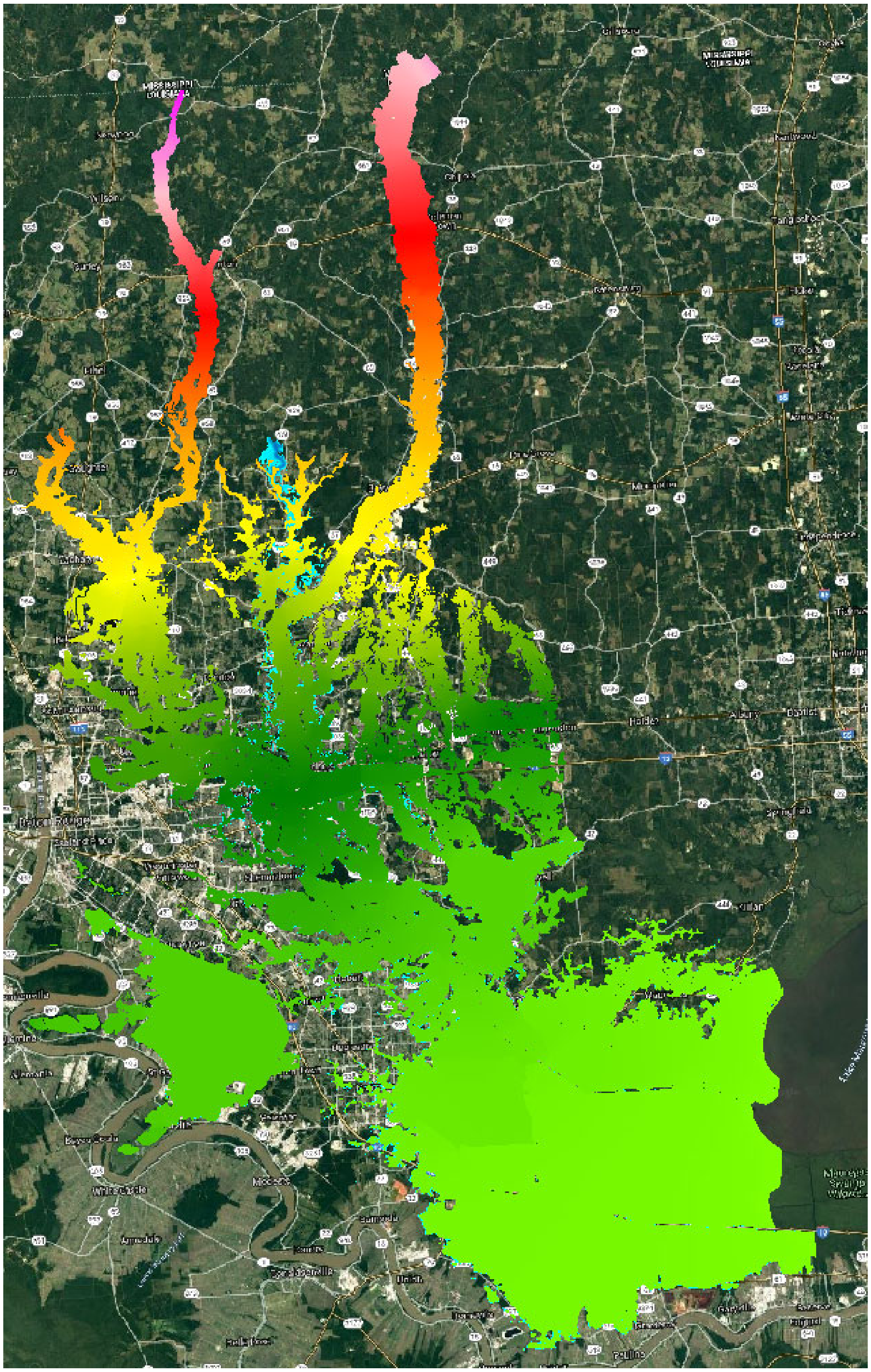


Figure G-49 – Alternative 8C (red-green scale) and Baseline (blue) Maximum Inundation Area

**500 Year FWOP**

Maximum Water Surface Profile: Amite River above Comite River

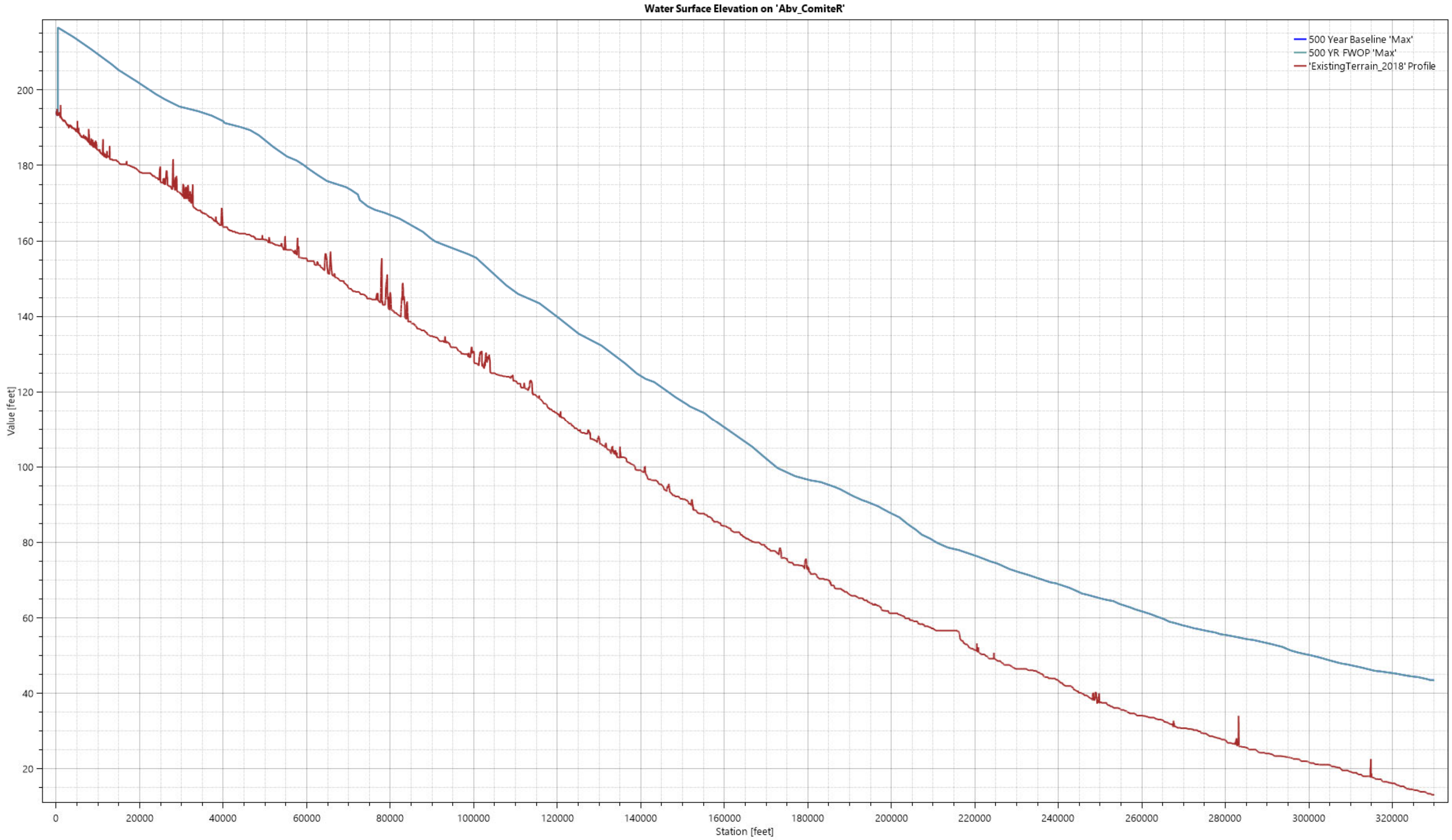



Figure G-50 – FWOP (green) and Baseline (blue) on Amite River above Comite

**500 Year FWOP**

Maximum Water Surface Profile: Amite River below Comite River

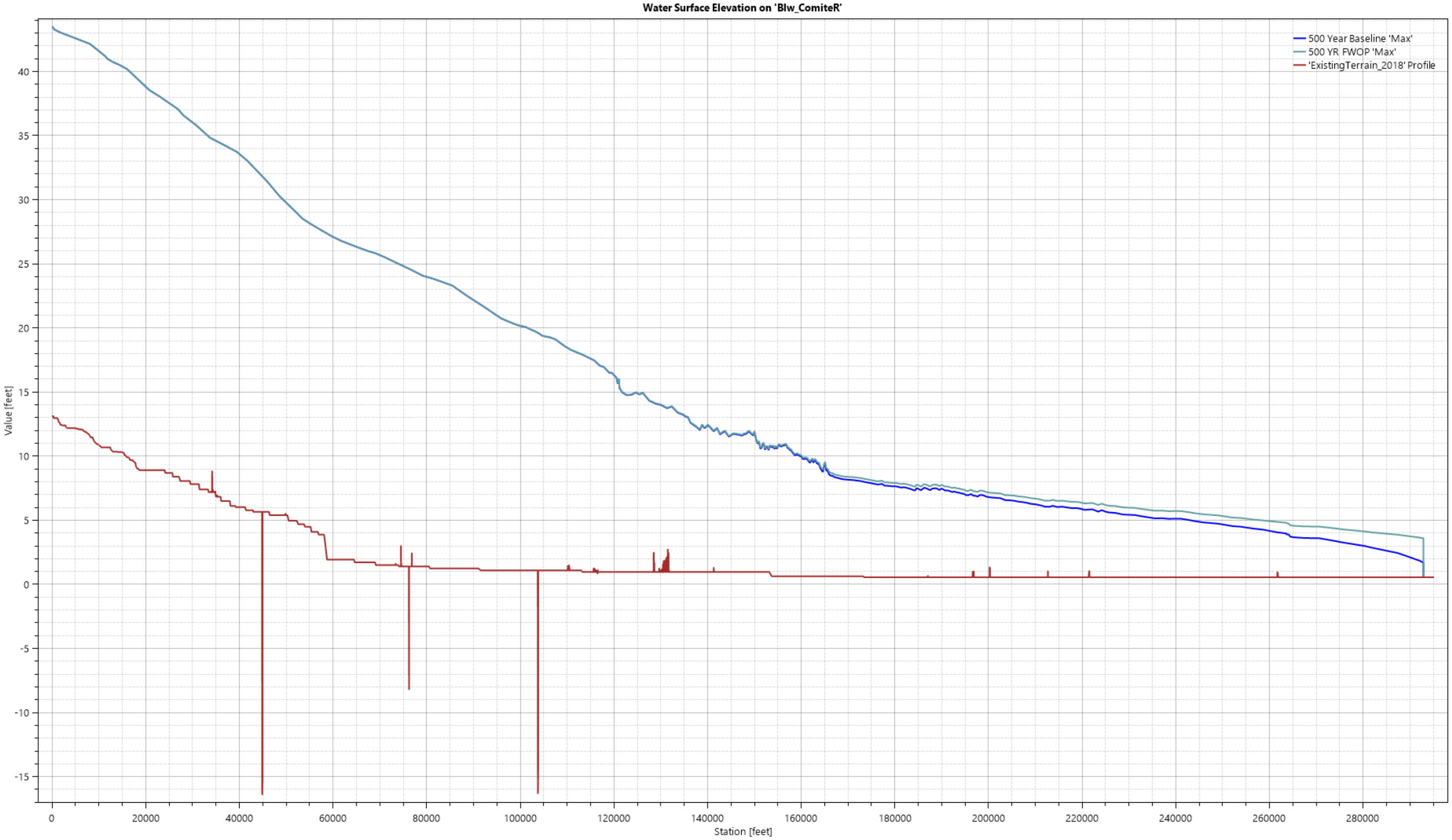



Figure G-51 – FWOP (green) and Baseline (blue) on Amite River below Comite

**500 Year FWOP**
Maximum Inundation

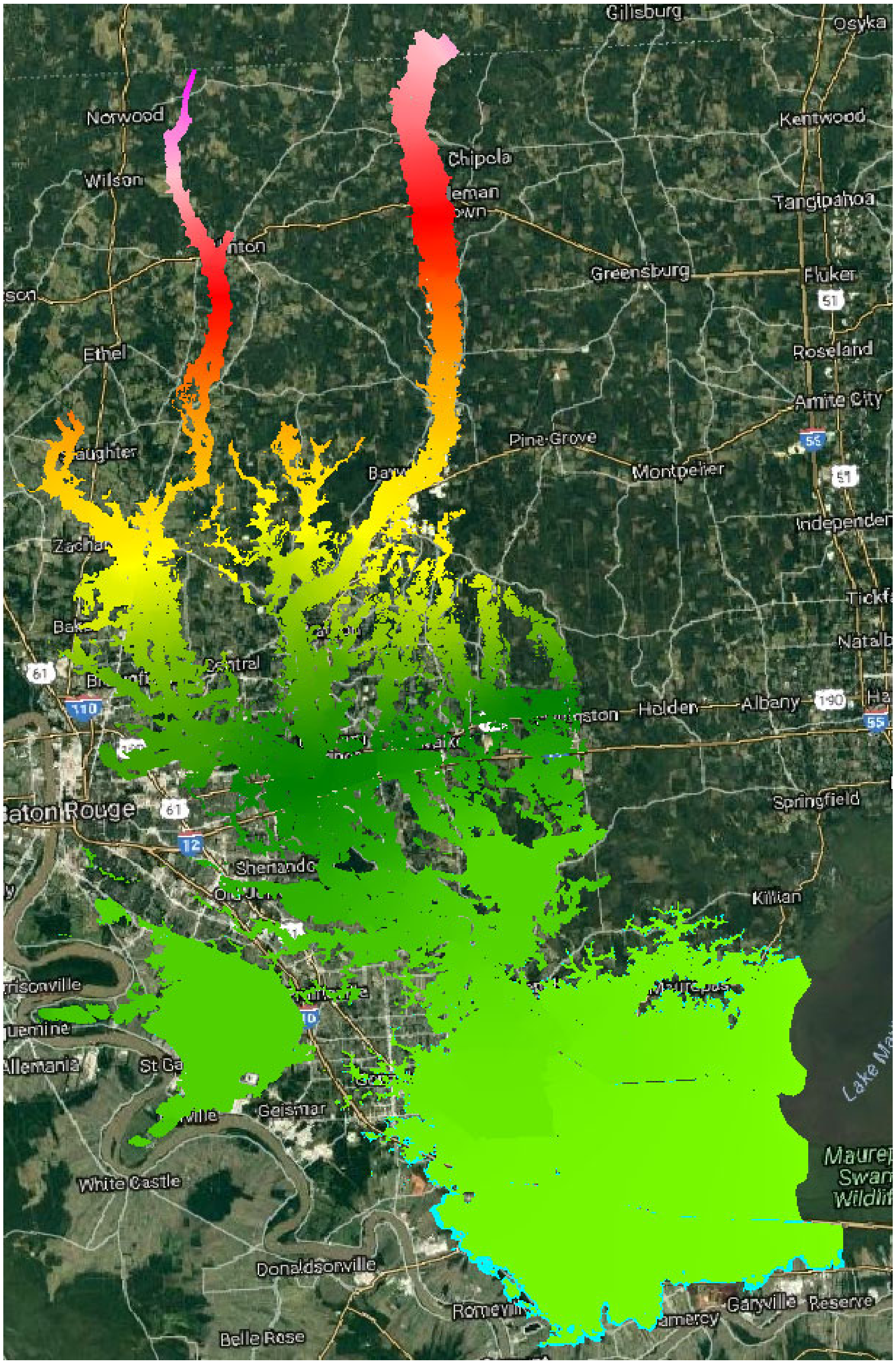



Figure G-52 – FWOP (red-green scale) and Baseline (blue) Maximum Inundation Area