APPENDIX B-1: Environmental Modeling, Monitoring, and Adaptive Management

US Army Corps of Engineers®

Claiborne and Millers Ferry Locks and Dams Fish Passage Study

Appendix B-1: Environmental Modeling, Monitoring, and Adaptive Management

August 2023

This page is intentionally left blank

B.2. Monitoring and Adaptive Management Plan

B.2.1. *Introduction*

August 2009 guidance from USACE Headquarters, implementing Section 2039 of Water Resources and Development Act (WRDA) of 2007, requires that ecosystem restoration projects include plans for monitoring success and adaptively managing ecosystem restoration projects.

Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure, that when conducting a feasibility study for a project (or component of a project) under the USACE ecosystem restoration mission, that the recommended project includes a monitoring plan to measure the success of the ecosystem restoration. This plan identifies and describes the monitoring and adaptive management activities proposed for the project and estimates their cost and duration.

The monitoring plan will identify indicator measures (i.e. performance standards) to monitor, mechanisms on how each measure will be assessed, the length of time that these measures are to be monitored, and success criteria to achieve the study's goals and objectives. The adaptive management plan will describe and justify whether adaptive management is needed in relation to the monitoring results identified. The plan will outline how the results of the project-specific monitoring program would be used to adaptively manage the project, including specification of conditions that will define project success.

The primary intent of this Monitoring and Adaptive Management Plan is to develop monitoring and adaptive management actions appropriate for the project's restoration goals and objectives. The presently identified management actions permit estimation of the adaptive management program costs and duration for the Ecosystem Restoration Project. This plan is based on currently available data and information developed during plan formulation as part of the feasibility study.

Uncertainties remain regarding the exact project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were estimated using currently available information. Uncertainties will be addressed in planning, engineering and design phase (PED).

B.2.2. *Authority and Purpose*

Section 2039 of WRDA 2007 Monitoring Ecosystem Restoration

"(a) In General - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.

(b) Monitoring Plan - The monitoring plan shall--

> (1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and
>
> (2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility."

Purpose of Monitoring. Monitoring of an ecosystem restoration project provides information with which to gauge the success of the restoration. Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, and whether adaptive management may be needed to attain project benefits.

Purpose of Adaptive Management. The USACE implementation guidance for Section 2039 also directs that a contingency plan (an adaptive management plan) be developed for all ecosystem restoration projects. Adaptive management is intended to increase the ability to make timely responses based on new information from monitoring to maximize the objectives of the restoration effort. An adaptive management plan considers the planned restoration activities and establishes a framework for evaluation of the ecosystem performance; and it identifies uncertainties that will be addressed through monitoring. As monitoring data is collected and assessed, the management plan guides decision to a) continue the restoration plan implementation without modification, b) to modify the restoration plan implementation, or c) to change the restoration plan objectives.

The monitoring and adaptive management plan (MAMP) was developed in accordance with the following guidance:

a. USACE. 31 August 2009. Planning Memorandum. Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) - Monitoring Ecosystem Restoration.

b. USACE. 22 April 2000. ER 1105-2-100, Planning, Planning Guidance Notebook.

c. USACE. 01 May 2003. EC 1105-2-404. Planning Civil Work Projects under the Environmental Operating Principles.

B.2.3. *Objectives and Scope*

During the initial stages of project development, the project delivery team (PDT) developed restoration goals and objectives to be achieved by the restoration measures. The goal of the Ecosystem Restoration Project is to reconnect over 230 miles of the Alabama and Cahaba Rivers to the Mobile River Delta. The resulting objective focuses on the importance of connectivity in the study area for migratory fish and the ancillary benefits to freshwater mussels. Specifically, the ecosystem restoration objectives are to

- Increase the spatial distribution of aquatic species while encouraging balanced native populations.
- Reconnect over 230 miles of the Alabama and Cahaba Rivers to the Mobile River Delta into the Gulf of Mexico for migration, spawning, foraging, and nurseries for native fish and mussel species.

- Restore a more natural flow to improve migration and post-spawning life cycle requirements.

B.2.4. *Management and Restoration Actions*

The PDT performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Alternatives were considered, evaluated, and screened to produce a final array of alternatives. Alternative 5d, was identified as the National Ecosystem Restoration plan and was recommended for implementation. Alternative 5d would restore connectivity of the Cahaba River to Mobile Bay and would benefit migratory fish including host fish for federally protected freshwater mussels.

The Recommended Plan includes the following ecosystem restoration components, which would be implemented in two phases on the Alabama River:

- Millers Ferry Natural Bypass Channel;
- Claiborne Natural Bypass Channel;
- Vehicular Bridge Crossing; and
- Control Gate Structures.

Additional figures of each feature are shown in Appendix H to the Integrated Feasibility Report.

B.2.5. *Implementation*

Pre-construction, during construction, and post construction monitoring shall be conducted by utilizing a Monitoring and Adaptive Management Team (MAMT) consist of representatives of the U.S. Army Corps of Engineers (USACE), NFS, and contracted personnel (if needed).

Monitoring will focus on evaluating project success and guiding if any adaptive management actions should be pursued by determining if the project has met Performance Standards. Validation monitoring will involve various degrees of quantitative monitoring aimed at verifying that restoration objectives have been achieved for both biological and physical resources. Effectiveness monitoring will be implemented to confirm that project construction elements perform as designed. Monitoring will be carried out until the project has been determined to be successful (performance standards have been met), as required by Section 2039 of WRDA 2007. Monitoring objectives have been tied to original baseline measurements and HEC-RAS modeling which can be found in Appendix H to the Integrated Feasibility Report and are summarized in **Table B.2-1**. Adaptive management measures will be considered upon the first instance of failure to meet a performance standard. Metrics and specific adaptive measure triggers will be refined during PED based on finalized design.

Table B.2-1: Modeling criteria, performance standards, and adaptive management

Measurement	Method (examples)	Performance Standard	Timing	Adaptive Management
Temperature	Stream Gage or Conductivity Temperature and Depth (CTD) Gage	60-70 degree F	Daily average throughout year	Maintain operations or implement supplemental measures which could include gate opening, aeration devices, etc.
Dissolved Oxygen		>5 ppm		
Velocity	Remote velocity measurement system	<5 ft/sec	7-day average January - May each year	Maintain operations or perform physical modification to structure through actions which could include debris/sediment removal, rock placement/adjustment, etc.
Pool Sizing	Handheld GPS	>5' depth at Claiborne during GS migration and spawning and >2' depth during normal flow conditions >5<6' depth at Millers Ferry US end with gates open Pool length of >50' for both locations		
Flow volume	Stream gage	500-2,000 cfs at Claiborne 1,500-2,500 cfs at Millers Ferry		
Passage Attempts	Electroshock, sensor arrays and acoustic tagging, gill netting, Missouri trawl netting, etc.	>51% of staged species		Maintain operations or modify gated structures to prevent electrical field interference at Millers Ferry. Modify or maintain slope/pool/tiered dimensions.
Invasive Species (aquatic vegetation and fish)	Fish: Electroshock, sensor arrays and acoustic tagging, gill netting, Missouri trawl netting, etc. Vegetation: LiDAR, ponar grabs, etc.	<10% of total catch within bypass channels		

Temperature

Forecast shows warming temperature. Periods of low flow could lead to higher temperatures within the bypass channels which could increase stress. One gage at the gated structure at Millers Ferry would be installed with continuous monitoring throughout year. A threshold of greater than 70 degrees Fahrenheit during migration seasons would require gate opening. The bypass channel at Claiborne would remain open all year with no adaptive management measures possible.

Dissolved Oxygen

Periods of low flow could lead to decreased oxygen within the bypass channels which could increase stress and prevent fish passage. Maintaining adequate velocity will ensure dissolved oxygen stays within a tolerable range.

Velocity

The modeled benefits were based on limiting bypass channels velocity to below 5 ft/sec during periods of low flow. Not exceeding the velocity will be key to its success for accommodating a variety of critical swimming speeds for several migratory fish.

Pool Depth

The purpose of the pool sizing is to provide resting zones during upstream migration. The modeled pool structure at Claiborne provides a depth of at least 5 feet during spring migration and 2 feet during normal flow conditions for the remainder of the water year. Depth at Millers Ferry would reach between 5 and 6 feet at the upstream end with gates open. This design would accommodate large fish during key migration periods. The pool lengths would be a minimum of 50 feet at both locations. Maintaining the pool size will be key to its success for providing resting zones for a variety of migratory fish.

Flow volume

The Millers Ferry design criteria based minimum volume through the bypass channel at approximately 1,500-2,500 cubic feet per second (cfs). A minimum flow through the Claiborne bypass channel was calculated to be approximately 500-2,000 cfs which is 10% low flow of 5,000 cfs during dry conditions and 10% of typical average flow (20,000 cfs) for year for late migration/spawning season (April – June).

At Millers Ferry during low flow, the gated structure would be closed to maintain reservoir pool elevation and reduce hydropower impacts. Gate closures would prevent upstream passage and monitoring would be necessary to evaluate whether the frequency and duration is facilitating passage. The bypass channel at Claiborne would remain open all year with no adaptive management measures possible.

Passage Attempts

Monitor migratory fish staging at entryways and fish within bypass channels to compare the abundance and diversity of fish staging vs passing. Targeted time periods of critical migration from January – March will ensure greater amount of representation and will coincide with modeled flow requirements. Existing and new sensor arrays will be used to identify tagged fish as they approach and exit the bypass channels. Field collections will verify species diversity and abundance at the downstream entrance of each bypass

channel. Field collections within the channel will verify percentage of passage attempts relative to river staging. Passage attempts above 51% of the staged river population would show success; whereas anything under than the majority may require reevaluation of design.

Invasive Species

Concerns for upstream and downstream access for invasive species would be address through monitoring presence among passing fish. Monitoring for invasive fish species would be conducted within the bypass channels. A presence over 10% of total catch within the bypass channels may trigger the reevaluation of the design to consider ways in which deterrents or physical modification could selectively reduce invasive species migration.

B.2.6. *Reporting*

The Project is expected to be constructed as a phased project over a two and a half year period. Evaluation of the success would be assessed annually until all performance standards are met for each phase of the study. Site assessment would be conducted annually by the MAMT and an annual report would be submitted to the U.S. Fish and Wildlife Service, Alabama Department of Environmental Management, Alabama Department of Conservation and Natural Resources, and other interested parties by January 30 following each monitoring year for up to ten years after the last phase is constructed.

B.2.7. *Monitoring and Adaptive Management Costs*

Costs to be incurred during PED and construction phases include drafting of the detailed monitoring and adaptive management plan. Cost calculations for post-construction monitoring are displayed for a 10-year monitoring period. It is intended that monitoring conducted under the Ecosystem Restoration Project will utilize a centralized data management, data analysis, and reporting functions associated with the USACE data management structure. All data collection activities will follow consistent and standardized processes established in the detailed monitoring and adaptive management plan. Cost estimates include monitoring equipment, photo point establishment, data collection, quality assurance/quality control, data analysis, assessment, and reporting for the proposed monitoring elements (**Table B.2-2**). Unless otherwise noted, costs will begin at the onset of the PED phase and will be budgeted as construction costs.

Also included in Table 2 are estimated costs for implementing adaptive management measures should any of the performance standards not be met. In the line-item *Adaptive Management Program Phase II – Implementation of Adaptive Management Measures,* $3,000,000 is allocated to account for a range of potential adaptive management measure expenses, if needed.

For example, extreme weather events like prolonged drought may reduce increase fish mortalities within the structures due to high temperatures and low dissolved oxygen. This is a moderate risk, however, opening gates is a low-cost adaptive management measure.

Conversely, a redesign and physical changes to the pool structure to achieve the target velocity and depth is considered a very low risk due to the available knowledge of not only the study area's safety and performance constraints, but also the collective engineering knowledge and lessons learned from the construction of similar structures around the country. For example, appropriately sized rocks could be strategically installed to ensure minimal movement during extreme events such as a 100-year flood. This would reduce the likelihood of redesign for this project; however, should they be needed, the costs could be between $2-3 million depending on the nature of the changes.

As shown in **Table B.2-2**, the total estimated cost for Monitoring and Adaptive Management is approximately $11,150,000. The PED Phase is estimated to take two years and construction is estimated for two and a half years. Cost estimates are based on similar adaptive management projects, estimated full-time-equivalent hours, and draft Scopes-of-Work for species monitoring. The estimated total duration of Monitoring is 10 years or until such time as the Secretary determines that the criteria for ecosystem restoration success has been met. If monitoring is required beyond 10 years the costs associated with those activities shall be a non-Federal responsibility.

Table B.2-2: Preliminary Cost Estimates

Category	Activities	PED Set-up & Data Acquisition	Construction	10-year Post Construction	Total
Monitoring: Planning and Management	Monitoring workgroup, drafting detailed monitoring plan, working with PDT on performance measures, equipment,	200,000	200,000	--	**400,000**
Monitoring: Data Collection	Existing and field data collection; Vemco readings	500,000	500,000	5,000,000	**6,000,000**
Data Analysis	Assessment of monitoring data and performance standards	200,000	200,000	1,000,000	**1,400,000**
Adaptive Management Program Phase I	Detailed adaptive management plan and program establishment	100,000		--	**100,000**
Adaptive Management Program Phase II	Implementation of adaptive management measures	--	--	3,000,000	**3,000,000**
Database Management	Database development, management, and maintenance	100,000	50,000	100,000	**250,000**
Total		**1,100,000**	**950,000**	**9,100,000**	**11,150,000**