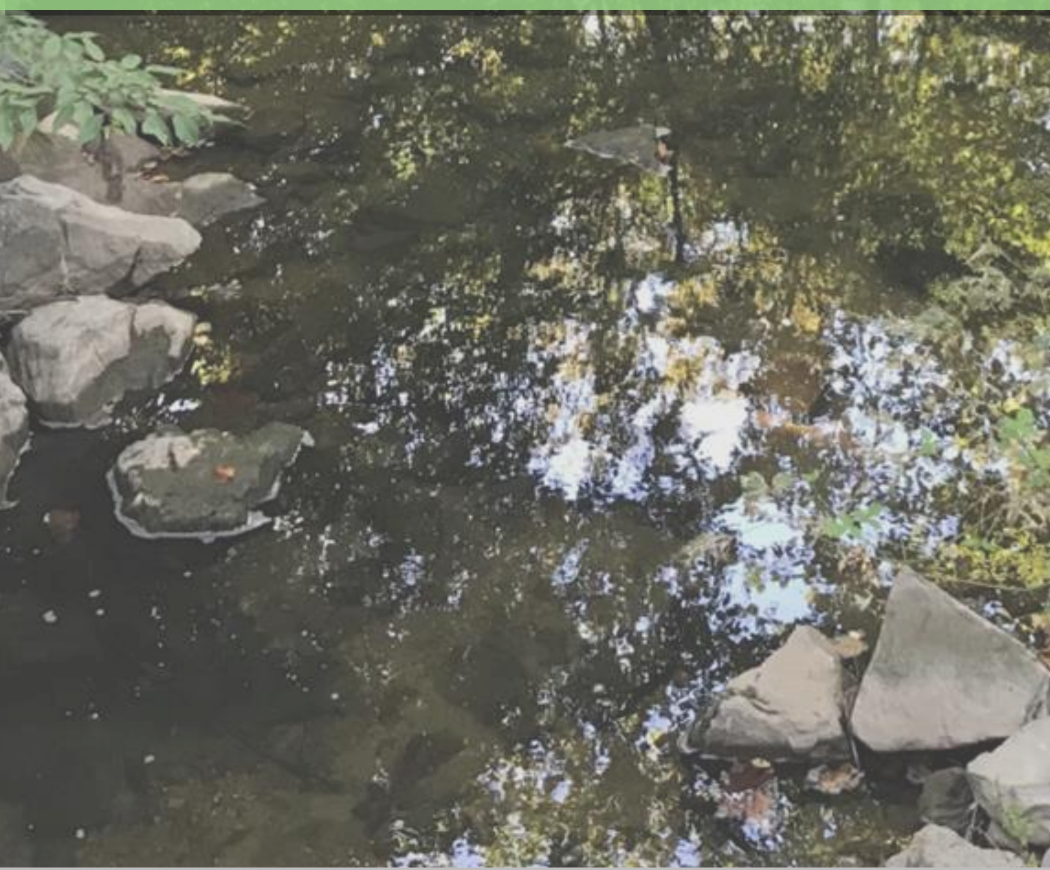
US Army Corps of Engineers

ANACOSTIA WATERSHED RESTORATION MONTGOMERY COUNTY, MARYLAND CONTINUING AUTHORITIES PROGRAM SECTION 206 AQUATIC ECOSYSTEM RESTORATION FEASIBILITY STUDY

DRAFT INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

APPENDIX H: MONITORING AND ADAPTIVE MANAGEMENT PLAN



MARCH 2025

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ANACOSTIA WATERSHED, MONTGOMERY COUNTY MONITORING AND ADAPTIVE MANAGEMENT PLAN

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1 PROJECT BACKGROUND

The U.S. Army Corps of Engineers (USACE) Baltimore District is proposing to restore stream habitat utilizing natural channel design principles and to remove fish blockages in the Anacostia River watershed in Montgomery County, Maryland (Figure 1-1). The Montgomery County CAP 206 study is being completed by USACE Baltimore District in partnership with the Montgomery County Department of Environmental Protection (MCDEP), the non-Federal sponsor for this feasibility study, and the Maryland National Capital Park and Planning Commission (M-NCPPC) in Montgomery County, Maryland. The recommended plan consists of improving stream habitat condition in Bel Pre Creek for a total length of 2.5 miles of the stream extending from Bel Pre Neighborhood Park to 100 feet upstream of the confluence with the Northwest Branch of the Anacostia River and Lamberton Creek for 0.7 miles from the outfall at Yeatman Terrace to 1,000 feet upstream of the confluence with the Northwest Branch of the Anacostia River (Figure 1-2 and 1-3). The recommended plan addresses two fish blockages for resident fish at the culvert on Poplar Run, a tributary of Bel Pre, and at a culvert at Lovejoy Street along Lamberton Creek, resulting in a net increase of approximately 2,600 feet of fish habitat improvements. Both MCDEP and M-NCPPC will serve as non-Federal sponsors for design and implementation.

The study area is in the Anacostia River watershed, which encompasses approximately 176 square miles, located entirely within the metropolitan area of Washington, District of Columbia (D.C.). The drainage within Montgomery County is approximately 61 square miles, accounting for about one-third of the total Anacostia River watershed. The Anacostia River flows through Maryland and then the District of Columbia into the Potomac River; the river ultimately drains to the Chesapeake Bay. Anacostia River sub-watersheds largely within Montgomery County include Sligo Creek, Northwest Branch, Paint Branch, and Little Paint Branch. The watershed in Montgomery County falls primarily within the Piedmont physiographic province. However, along the county's border with Prince George's County, small sections of the streams lie within the Coastal Plain province.

1.1 Planning Goals and Objectives

The goal of this project is to provide a solution in the Anacostia River watershed in Montgomery County that would restore ecological function, structure, and health in selected stream reaches and riparian zones and those areas downstream affected by restoration actions. Stream restoration would reduce sediment transport and combined nutrient loads improving overall water quality within the Anacostia River watershed. Additional goals were identified for each stream segment based on the non-Federal sponsor's goals for the project as summarized below. These goals were used to inform the approach for stream restoration and contributed to objectives for the study.

Goals for the Bel Pre Creek Tributary:

- Restore in-stream habitat to provide a self-sustaining diversity of flow, depth, bedform and complex cover conditions that can support a wide range of fish and aquatic macroinvertebrate species.
- Protect the existing Park, school, transportation, and utility infrastructure in the floodplain to ensure that natural channel dynamics do not create future conflicts.
- Increase hydrologic connection to the floodplain and improve groundwater connection to wetlands located in the floodplain.
- Stabilize outfalls and buffer mainstem channels from stormwater runoff using sustainable techniques that extend flow paths, promote infiltration, dissipate water velocity, and add hydrologic capacity.
- Enhance riparian vegetation through native herbaceous, shrub, and tree plantings and NNI management.

Goals for the Lamberton Creek Tributary:

- Restore in-stream habitat to provide a self-sustaining diversity of flow, depth, bedform and complex cover conditions that can support a range of fish and aquatic macroinvertebrate species.
- Improve aquatic passage by removing an existing fish blockage through the culvert at Lovejoy Street.
- Protect the existing utility infrastructure in the stream valley to ensure that natural channel dynamics do not create future conflicts.
- Improve downstream water quality with improved sinuosity, extended flow paths, stabilization of severely eroded banks, and increased channel roughness and heterogeneity to improve the natural buffering capacity of the system.
- Stabilize outfalls and buffer mainstem channels from stormwater runoff using sustainable techniques that extend flow paths, promote infiltration, dissipate water velocity, and add hydrologic capacity.
- Enhance riparian vegetation through native herbaceous, shrub, and tree plantings and NNI management.

Planning objectives for this study include:

1. Restore in-stream habitat and associated ecosystem function in Bel Pre Creek and Lamberton Creek.
2. Restore the natural range of resident fish in Bel Pre Creek and Lamberton Creek.
3. To the extent practicable, re-establish hydrologic connection of the streams to the floodplain along stream restoration reaches.

4. To the extent practicable, restore floodplain wetlands. No wetland restoration opportunities were identified in this feasibility study.
5. Stabilize stream channels to reduce the supply and transport of sediment to downstream receiving waters. This objective is being measured under monitoring completed for Objective 1.

1.2 Proposed Action

The proposed actions includes stream restoration at Bel Pre Creek and Lamberton Creek. This plan captures 82% of aquatic habitat restoration benefits in the project area and will have the greatest impact on habitat improvement in the Anacostia Watershed. Work previously identified for stream restoration in Sligo Creek/Colt Terrace is being implemented by M-NCPPC in coordination with the Washington Sanitary Sewer Commission (WSSC) and is separate from the proposed project.

2 USACE GUIDANCE ON MONITORING

USACE monitoring and adaptive management policy is outlined in the Water Resources Development Act (WRDA) of 2007 and presented in planning guidance (Engineering Regulation (ER) 1105-2-100, Engineering Circular (EC) 1105-2-409, Engineer Pamphlet (EP) 1105-2-58 Continuing Authorities Program, and Memorandum on Implementation Guidance for Section 2039 of WRDA 2007, Monitoring for Ecosystem 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, or whether adaptive management will be needed to attain project benefits. Adaptive management addresses the uncertainties about a project's actual performance that exist when implementation decisions are made to undertake a water resources project. This technique allows decision making and implementation to proceed with the understanding that outputs will be assessed and evaluated and that some structural or operational changes to the project may be necessary to achieve desired results. At the heart of adaptive management is an appropriate monitoring program to determine if the outputs/results are satisfactory, and to determine if any adjustments are needed.

3 PURPOSE OF THE PLAN

The purpose of Monitoring and Adaptive Management Plan (MAMP) is to demonstrate ecological success of the project. This success is determined by monitoring metrics that are specifically tied to project objectives and setting performance targets. In addition, the plan identifies what adaptive management (AM) (contingency) is proposed if the performance targets are not met. This plan presents the framework for the above methodology and will be refined as the project proceeds into design and implementation phase in collaboration with the non-Federal sponsors.

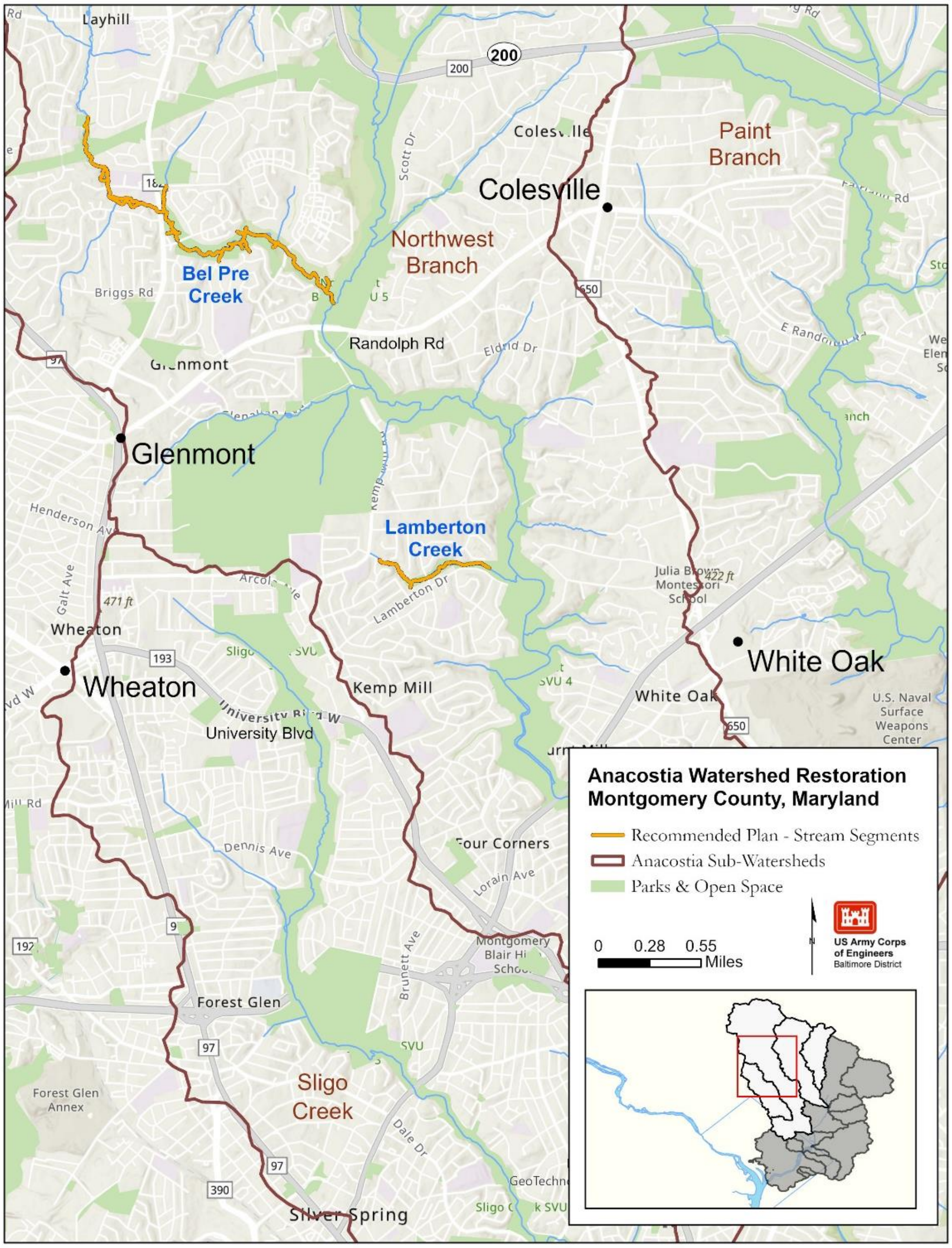

Figure 1-1: Project Areas

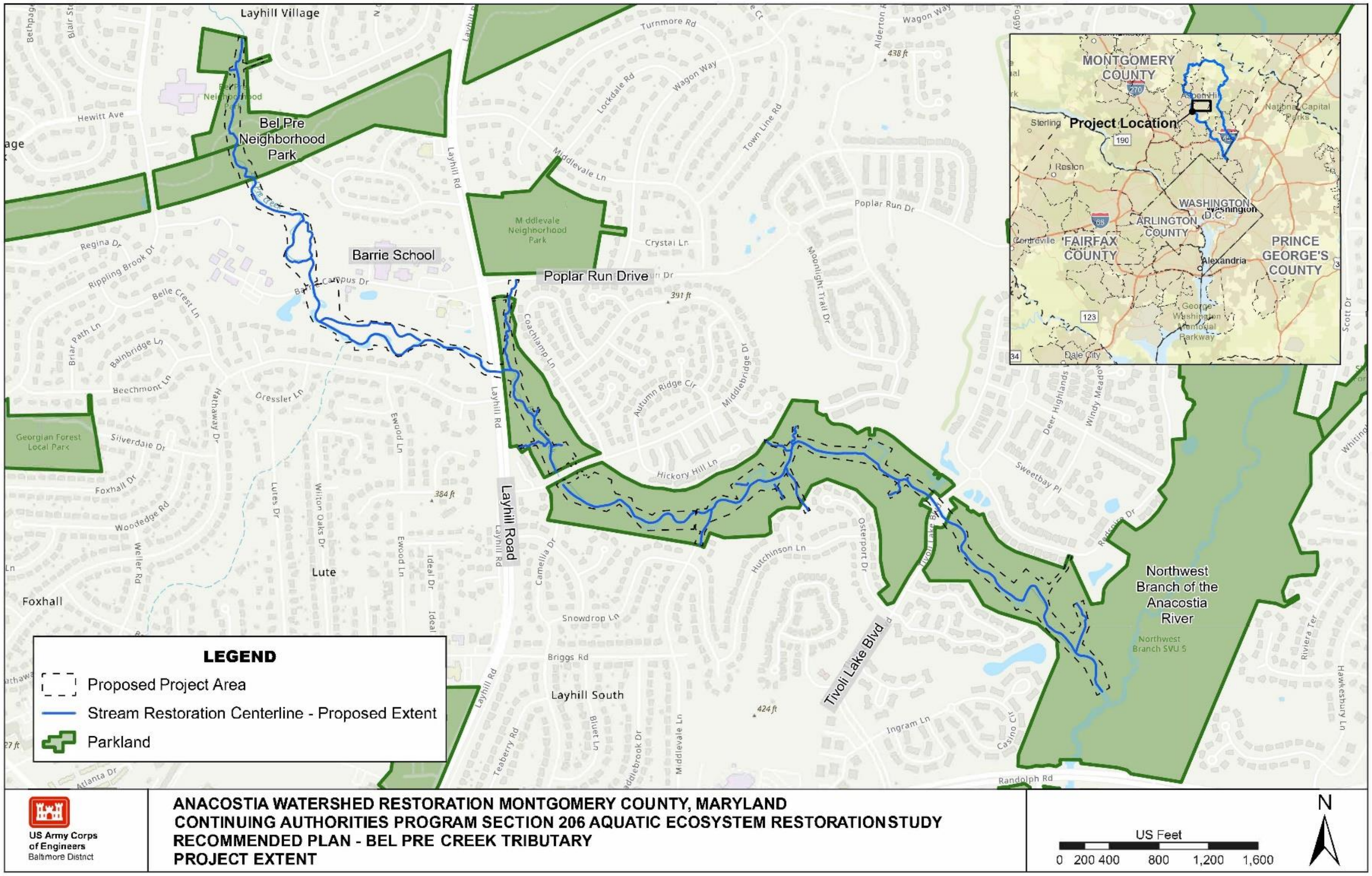

Figure 1-2: Bel Pre Creek Proposed Restoration Extent

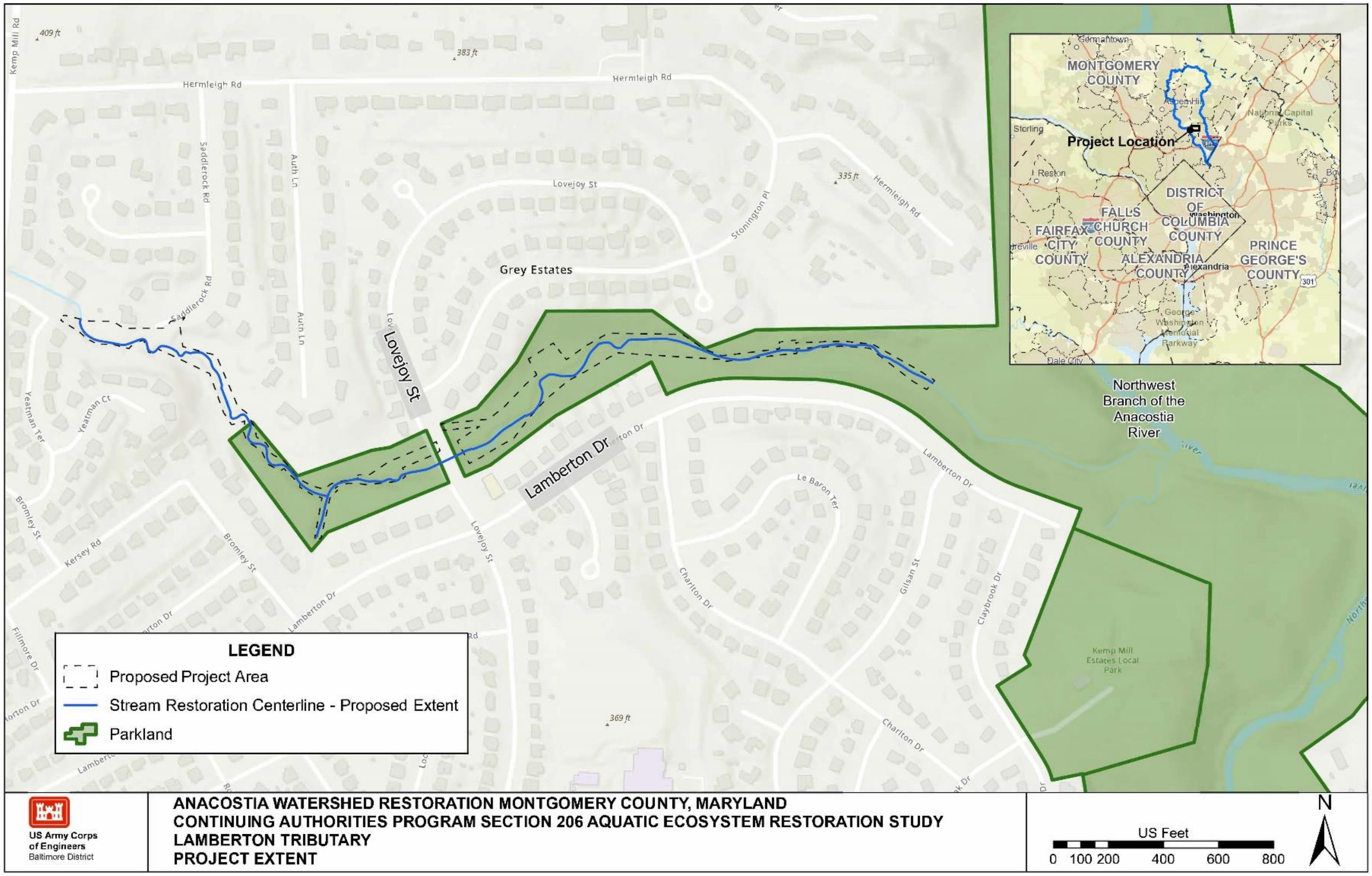

Figure 1-3: Lamberton Creek Proposed Restoration Extent

4 PROJECT MONITORING

Stream restoration is an evolving field, and the urban stream environment presents the possibility for rapid, unpredicted changes in conditions that would affect the success of the project. It is expected that these sites will be dynamic and change over the life of the project. To verify that project objectives are met, it will be necessary to monitor the restored streams following a multi-faceted cost-shared, post-construction monitoring plan. To evaluate the success of the stream restoration measures, collaborative monitoring efforts and information sharing would occur between the USACE team, the non-Federal sponsors – MCDEP and M-NCPPC, and other organizations involved in assessing the health of the stream.

Monitoring efforts will be performed by using monitoring metrics listed in Section 5 (Evaluation of Specific Objectives). All post-construction monitoring will be performed by qualified biologists and hydraulic engineers at MCDEP with support from USACE and M-NCPPC.

Evaluating the evolution of restored habitats will be based on the establishment of the targeted habitat within the restoration site and on the ecological functioning of those habitats. All post-construction monitoring will be cost shared between USACE and the non-Federal sponsors for the project. A maximum of ten years of cost-shared monitoring effort is recommended as allowed per guidance. Stream restoration is still a relatively new science, and it is uncertain how long it will take to assess the ecological success of the project and to make necessary adjustments. Monitoring will be discontinued once ecological success is determined. It is expected that riparian plantings will be established within a five-year period of time and that recolonization of fish and benthic organisms will occur within one to three years following construction. Over time, the structures and streambanks will be stabilized by riparian plantings and sediment accumulation, such that it can be seen whether restoration features are having the desired effect with regards to sediment emplacement or removal for habitat (riffle/pool) restoration. Data collection will be used to determine success of the project with the focus on the development of in-stream and riparian habitats. USACE and the non-Federal sponsors will use the knowledge gained through this monitoring to adaptively manage the project sites. At this time, concept level designs have been prepared, but these do not include the detail of fine features such as the locations of grade control structures, woody debris or root wads, which will be refined during the design and implementation phase.

The following section lists monitoring metrics, performance targets, and potential adaptive management associated with the effectiveness monitoring, which aims to demonstrate how well the habitat is developing according to performance criteria.

5 GOVERNANCE STRUCTURE

The governance structure for implementation of this plan is detailed in Figure 1-4. Note that MCDEP will be primarily responsible for physical and biological monitoring. The technical team members include USACE- Baltimore District, Divisions of Planning and Engineering, MCDEP, and M-NCPPC. USACE biologists will review the monitoring results with MCDEP and M-NCPPC staff. This same team will be used to organize and interpret the data collection to determine if adaptive management actions are needed. The technical team will recommend any adaptive management measures to an Executive Team. The Executive Team will consist of the Baltimore District Engineer, the Director of MCDEP, and the Parks Development Division Chief of M-NCPPC Montgomery County. The executive team's function will be to resolve disputes that the technical team cannot resolve at their level and to approve any adaptive management measures recommended by the technical team.

The technical team will meet in the fall (of those years when monitoring is conducted) to analyze monitoring data and develop recommendations for the project. This team will evaluate the data as it is developed annually to determine if environmental benefits and impacts associated with the recommended plan are occurring as expected in the feasibility study, document the findings, and recommend adjustments to the project as necessary. These adjustments may include remedial measures needed to refine the recommended plan to further optimize aquatic ecosystem benefits, and to minimize any unanticipated adverse impacts associated with the recommended plan. This team will collect data or oversee its collection by others, ensure quality control over the data collection, analyze, and make recommendations based on the analysis. Routine technical matters will also be resolved by the technical team including sampling gear changes, sampling protocol changes, reporting mechanisms, time of year changes, etc. The technical team will communicate primarily by email and telephone. Meeting locations are anticipated to occur in either at Baltimore District Headquarters or at MCDEP offices or via teleconference. The USACE will prepare an agenda for these meetings and will document the meeting with a memo for the record for each meeting. After the planned ten years of post-construction monitoring has elapsed and all data collection and reporting has ceased, a final report will be generated by USACE.

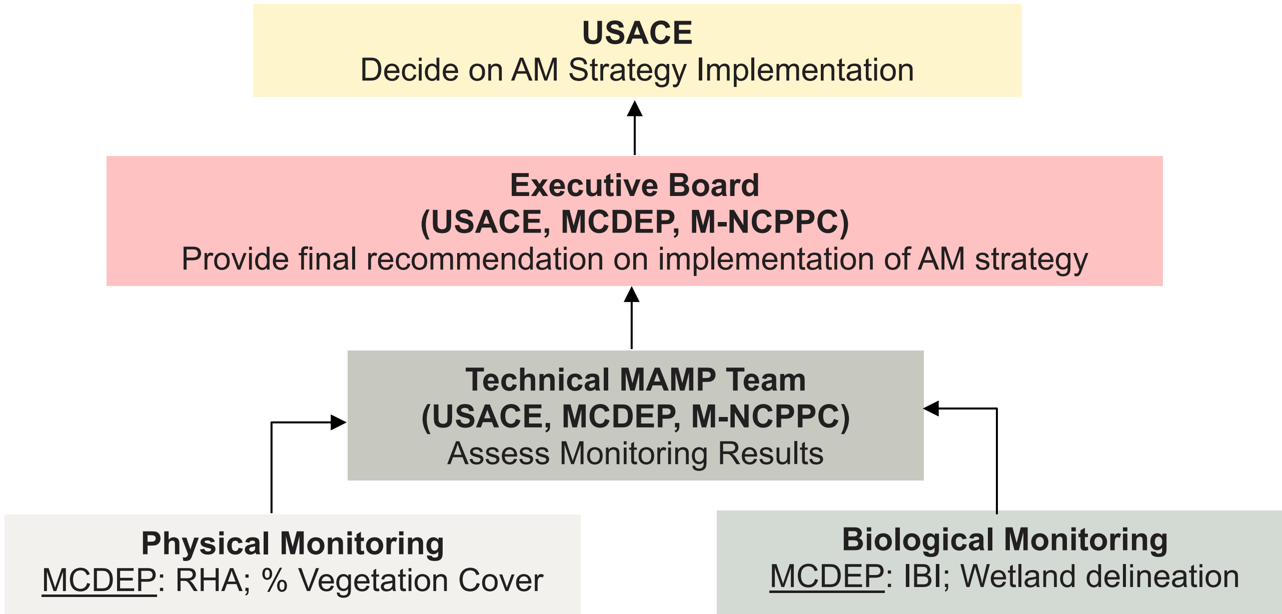

Figure 1-4: Governance Structure for Plan Implementation

6 EVALUATION OF SPECIFIC OBJECTIVES

Pre-project (baseline) physical and biological data were collected in each stream segment in 2014, 2016, and 2022 during the feasibility study and will be collected prior to construction. Data collected includes measurements of in-stream physical habitat and sampling of fish assemblages. However, not all sites were sampled for fish, MCDEP has a 0.5 square mile drainage minimum to sample fish communities. Physical habitat would be assessed using rapid habitat assessment (RHA) designed by the Environmental Protection Agency (EPA) and adapted for use by MCDEP since 1997, as well as a slightly modified version of Maryland Biological Stream Survey (MBSS) Spring and Summer habitat assessment. Following construction, physical habitat and biological condition will be assessed every other year post-construction for 10 years using the metrics outlines in Table 1. Differences between pre- and post-project physical and biological data will be evaluated to monitor changes. At this time, it is expected that monitoring would be led by MCDEP. It is also possible that work could be performed through a contract with private companies, local universities, or non-profit organizations. All data collected will be shared among partners to evaluate project success and performance. Monitoring reports will be developed and circulated among key agencies, as well as posted on the project website.

Table 1: Resources and Monitoring Metrics

Resource	Metrics	Specific Parameters
Rapid Habitat Assessment (RHA)	RHA, including individual habitat metric component scores (MCDEP)	Instream cover, epifauna substrate, embeddedness, channel alteration, sediment deposition, riffle frequency, channel flow status, bank vegetative protection, bank stability, and riparian buffer zone width
Resident Fish	Resident fish abundance and location; Index of Biotic Integrity (IBI)	Number of fish by species above and below removed blockages, classification as native/invasive, tolerant/intolerant, trophic composition, and biomass

6.1 Evaluation of Objective 1

- Restore in-stream habitat and associated ecosystem function in Bel Pre Creek and Lamberton Creek.

The Bel Pre and Lamberton Creeks will be subdivided into reaches representative of the natural and built environmental features and conditions and sampled based on presence/absence of these features/conditions. Within each reach, a representative 75-

meter length measured along the channel thalweg capturing the range of conditions in that reach was field-identified to investigate baseline conditions as per MCDEP procedures.

Monitoring of physical habitat and resident aquatic life (specifically, benthic macroinvertebrates and fish assemblages) would be accomplished using established methods of MBSS that were used in baseline stream assessments and plan formulation (MD DNR 2013). The physical and biological monitoring methods are based on U.S. Environmental Protection Agency (USEPA) methods and have been used for two decades in Maryland. The metrics (Table 2) selected for monitoring were chosen because they are projected to be responsive to project implementation and representative of the physical and biological health of the project sites and stream networks. Desired outcomes are an improvement in RHA score resulting from increased habitat heterogeneity and or stability and improved biological condition resulting from increased species richness and or increase in proportion of specialist/less tolerant species.

Habitat quality in stream reaches is characterized using MCDEP (2013, 1997) rapid habitat assessment (RHA) procedures. Following the RHA procedures and guidance, 10 habitat parameters are scored in the field (Table 2). Each individual parameter can score from 0 to 20 (explanations of procedures are included in Appendix B). The worst possible habitat score is 0, and the best possible score is 20. The data is entered into spreadsheets in the office, and these 10 parameters are then summed to produce a total habitat score for the reach. The RHA procedures divide the total score into distinct narrative classes ranging from excellent to poor. The RHA ranks based on the summed parameters are summarized in Table 3.

Table 2: Guidelines for rating RHA parameters

RHA Parameters	Description
Instream Cover (fish)	Includes the relative quantity and variety of natural structures in the stream, such as fallen trees, logs, and branches, large rocks, and undercut banks, that can be used as functional habitat for aquatic life.
Epifaunal Substrate (macroinvertebrates)	Is essentially the microhabitat diversity or hard substrates (rocks, snags) available for macroinvertebrates. As with fish, the greater the variety and number of available microhabitats or attachment sites, the greater the variety of insects.
Embeddedness	Refers to the extent to which rocks (gravel, cobble, and boulders) are covered or sunken into the silt, sand, or mud of the stream bottom. (>0.5”)
Channel Alteration	A measure of large-scale changes in the shape of the stream channel.
Sediment Deposition	Measures the amount of sediment that has accumulated and the changes that have occurred to the stream bottom as a result of the deposition.
Riffle Frequency	A measure of the sequence of riffles and thus the heterogeneity occurring in a stream.
Channel Flow Status	The degree to which the channel is filled with water.
Bank Vegetative Protection (left and right bank)	Measures the amount of the stream bank that is covered by vegetation.
Bank Stability (left and right bank)	Measures whether the stream banks are eroded (or the potential for erosion).
Riparian Buffer Zone Width (left and right bank)	Measures the width of natural vegetation from the edge of the stream bank out through the floodplain.

Table 3: RHA Ranks

RHAB Score (out of 200)	Percentage	Narrative Ranking
200 – 166	100% - 83%	Excellent
165 – 154	82% - 77%	Excellent/Good
153 – 113	76% - 57%	Good
112 – 101	56% - 51%	Good/Fair
100 – 60	50% - 30%	Fair
59 – 54	29% - 24%	Fair/Poor
53 – 0	23% - 0%	Poor

Source: MCDEP 2013

Methods and Timing: Sampling will be conducted during the index period (Spring or Summer) using protocols in accordance with MCDEP procedures (2013). Sampling would also occur during the state-approved sampling season as well – spring (March 1 to April 30) or summer (June 1 to September 30).

Target: The target improvement range for each parameter is sub-optimal based on initial appraisals of the baseline condition and discussion with the non-Federal sponsor.

The target improvements if met will result in ecological lift equivalent to an RHA score of Good, which represents an improvement from the baseline condition of Fair. The maximum practical improvement in the with-project condition is in the low range of optimal condition for individual parameters for a total RHA score of Excellent. The target improvement range will be refined following updated surveys and RHA during the design and implementation phase.

All habitat scores, with the exception of riparian buffer width, may be affected by a stream geomorphic restoration project. The score, generally, cannot be improved to 200 because the riparian buffer width will likely be unchanged by a project. Note that as both streams in this project are urbanized stream with historic disturbances, it is unlikely that this project would achieve the highest ecological lift in the RHA ranking to Excellent, which is representative of the most pristine, natural streams.

Table 4: RHA Baseline Condition & Maximum Achievable Improvement Metrics for Bel Pre Creek

RHA Parameters	Baseline Condition	Target (Sub-Optimal)	Maximum Practical Improvement
Instream Cover (fish)	9.7	15	16
Epifaunal Substrate (macroinvertebrates)	8.8	15	16
Embeddedness	11	14	16.3
Channel Alteration	11	14	16.7
Sediment Deposition	9.2	14	16
Riffle Frequency	9	15	16.3
Channel Flow Status	11.3	15	16.3
Bank Vegetative Protection (left and right bank)	5.2 (LB); 3.7 (RB)	8 (LB); 8 (RB)	8 (LB); 8 (RB)
Bank Stability (left and right bank)	5.3 (LB); 4.3 (RB)	8 (LB); 8 (RB)	8 (LB); 8 (RB)
Riparian Buffer Zone Width (left and right bank)	5.3 (LB); 4.3 (RB)	5.3 (LB); 4.3 (RB) No change	5.6 (LB); 5 (RB)
Total RHA Score	Fair (98)	Good (143.6)	Excellent (155)

Table 5: RHA Baseline Condition & Maximum Achievable Improvement Metrics for Lamberton Creek

RHA Parameters	Baseline Condition	Target (Sub-Optimal)	Maximum Practical Improvement
Instream Cover (fish)	10.5	15	16
Epifaunal Substrate (macroinvertebrates)	10.5	15	16
Embeddedness	8.75	14	16
Channel Alteration	8	14	16
Sediment Deposition	6.25	14	16
Riffle Frequency	15.75	15	16
Channel Flow Status	7.5	15	16
Bank Vegetative Protection (left and right bank)	3 (LB); 3 (RB)	8 (LB); 8 (RB)	8 (LB); 8 (RB)
Bank Stability (left and right bank)	3.5 (LB); 3.25 (RB)	8 (LB); 8 (RB)	8 (LB); 8 (RB)
Riparian Buffer Zone Width (left and right bank)	5.75 (LB); 3.75 (RB)	5.75 (LB); 3.75 (RB) No change	6 (LB); 4 (RB)
Total RHA Score	Fair (90)	Good (143.5)	Excellent (154)

6.2 Evaluation of Objective 2

- Restore the natural range of resident fish in Bel Pre Creek and Lamberton Creek.

The project objective includes enhancing stream access for resident fish and to the extent practical, migratory American eel, within the project area. To assess the fish assemblage present in the stream segments, fish sampling was conducted for the baseline sampling performed in 2016 and 2022. This included fish identification and counts.

Methods and Timing: Sampling every other year following construction for 5 years including in Year 1, Year 3, and Year 5 during the index period (Spring or Summer) and at Year 10. Differences between pre- and post-project physical and biological data will be evaluated to monitor changes. Sampling will be used to estimate the Index of Biotic Integrity (IBI) for fish species.

Target: Presence of resident and migratory fish species above existing fish blockages at Poplar Run and Lovejoy Street above pre-construction baseline. Improvement of IBI above baseline.

6.3 Evaluation of Objective 3

- To the extent practicable, re-establish hydrologic connection of the streams to the floodplain along stream restoration reaches.

The project objective includes raising the channel bed to re-establish the hydrologic connection of the stream to the floodplain and floodplain wetlands throughout the length of the project. This objective is represented by acreage of non-tidal, floodplain wetlands with hydrologic connection restored. Hydrologic reconnection with the floodplain could improve moisture in hydric soils restoring conditions for wetland plants. Soils data, hydrologic data, and inventory of wetland plants would be collected to determine increase in floodplain wetlands with restored hydrologic connection. The metric would include estimation of floodplain wetlands with restored hydrologic connection adjacent to the stream in Year 5 and Year 10. Floodplain wetlands with restored hydrologic connection would be approximated through a wetland delineation, visual assessment, and documentation.

Methods and Timing: Analysis of wetland acres in the baseline year (pre-construction), 5 years and 10 years after construction during the index period (Spring and Summer). Differences between pre- and post-project physical and biological data will be evaluated to monitor changes.

Target: Increase in floodplain wetlands with restored hydrologic connection adjacent to project reaches above the baseline.

6.4 Vegetation Monitoring

It is expected that the proposed project will be eligible to be considered under the general and regional terms and conditions of Nationwide Permit #27 (NW27), *Aquatic Habitat Restoration, Establishment, and Enhancement Activities*. The proposed project is focused on ecosystem restoration and providing a demonstrated functional lift to the targeted habitats. Therefore, as long as the terms and conditions of the NW27 and MDE's permit requirements are met, no additional Clean Water Act Section 404(b)(1) analysis is required. Additionally, a Parks Construction Permit would need to be obtained prior to construction.

The project construction will result in an overall improvement to the stream habitat and adjacent floodplain and floodplain wetlands, removal of non-native invasive species, and replanting with native vegetation. To ensure that these gains are realized, in addition to instream physical habitat monitoring for the project objectives, vegetation monitoring will be performed. This monitoring is summarized in Table 6.

Table 6: Vegetation Monitoring Measurements and Criteria

Parameter	Measurement	Success Criteria	Monitoring Years
Vegetative cover	Percent cover of vegetation in target area	>85% cover *	1,3,5, 7, 9, 10
Invasive species	Percent cover invasive species of invasive species in target area	Less than baseline	Design and implementation, 1, 3, 5, 10

*Physical extent of NNI management and vegetation monitoring would be refined further in the design and implementation phase.

7 ADAPTIVE MANAGEMENT

7.1 Adaptive Management for Objective 1

Recently completed projects have demonstrated that improvements in RHA are achievable with geomorphic stream restoration. Physical characteristics of the project such as the type of substrate, height of structures, presence of rootwads, and depth of riffle/runs can be controlled during construction, but colonization with epibenthics and embeddedness is much less certain. Monitoring will determine if ecological success has been achieved, while adaptive management actions are the contingency plan that allow for post-construction adjustments to project features. Typical adaptive management actions for stream restoration projects are summarized in Table 7. Note that a Parks Construction Permit will be required prior to adaptive management actions and will be coordinated with M-NCPPC.

It is anticipated that minimal adaptive management measures would need to be taken due to the type of structures within the design. The designs are intended to aid in the re-establishment of a new dynamic equilibrium for the stream, and not necessarily to lock the stream into its channel. Likely measures that may be needed are changes to elevation of structures or minor changes to structure locations. Most adaptive management actions that stem from normal conditions are anticipated to be minimal in effort; however, an unusually strong storm that occurs prior to establishment of vegetation and project features could cause damage to a project site that would need to be ameliorated. Following storm events, site visits will be performed by visual inspection to assess the stability and location of the structures.

Adaptive management activities may necessitate re-accessing the streams in order to adjust the lateral position or height of structures installed in streams to ensure proper hydrologic conditions. Similarly, if hydrologic profiles result in scouring, erosion, or sediment deposition that result in poor RHA scores, structures, bank profiles, or other constructed features will require adjustment. Poor RHA scores will need to be evaluated on a case-by-case basis to determine what has influenced them and what actions will be required for a remedy.

For Objective 1, the triggers for adaptive management are defined by targets set for the metrics described in Section 5. Adaptive management triggers will be defined during the design and implementation phase and could include consideration for habitat stability, epibenthic substrate and productivity, presence/absence of woody debris, increases in erosion extent or severity, and degradation of channel stability among other factors. It is also possible that post-restoration adjustments made by the stream could result in temporary decreases in some metrics; therefore, individual metrics will need to be evaluated in total, and related to the calculation of the overall RHA score.

Depending on a visual assessment of the integrity of in-stream structures, the scope of the adjustment or repair will be determined. Undesirable changes in the physical habitat metrics would likely result in a minor adjustment (shifting the location or height or height of parts of a structure) to induce favorable conditions. More substantial adjustments could be made if structures are undermined, or the stream shows signs of instability. The designs are geared toward functional stream channel dimensions that do not promote excessive aggregation or degradation during normal and high flood flows, but allow sediment to accumulate where desired. The proposed in-stream structures will provide grade control (bed stability) and bank stability. Cross sectional measurements and evaluation of erosion extent and severity will indicate whether instability is present. If instability is present, adaptive management actions may be needed. This will be determined on a case by case by the technical team. Adaptive management actions could be necessitated by flooding during large storm events. Structures will be visually assessed following extreme storm events. Storms have the potential to undermine structures by inducing scour around tie-in points with the bank, and by dislocating parts of the structure in the center of the channel. Furthermore, if there are significant problems with the performance and function of the project, the design would be revisited.

7.2 Adaptive Management for Objective 2

If desired fish species are not recorded above the corrected passage additional visual inspections would be undertaken to determine that no blockage still remains. If a constructed structure prevents fish movements, corrective action will be needed. The structure may need to be reset, stones or logs moved, a notch added, or other actions taken. These would constitute minor actions. Other factors, particularly regional population trends of the migratory species, may limit the numbers of fish migrating upstream, and will be considered. Adaptive management triggers for this objective will be further refined in the design and implementation phase.

7.3 Adaptive Management for Objective 3 Floodplain Connectivity and Vegetation

Monitoring for the hydrologic connection of wetlands and floodplain function include vegetation monitoring and evaluation of floodplain wetlands with improved floodplain connectivity. Adaptive Management for floodplain wetlands may require adjustment in stream banks including regrading of banks or adjustment to structures to improve the connectivity of the stream and adjacent floodplain and floodplain wetlands. Vegetation monitoring, including monitoring for cover and invasive species at all disturbed locations, will indicate whether a desirable plant community is being maintained. Because of the prevalence of invasive species in the project areas, it will be necessary to actively manage the establishment of riparian vegetation. This will be done through the planting contract, which will include a warranty for plant growth and survival for a five-year time period. Plants that are not in a live and healthy condition shall be replaced by the contractor during this period, and a prevalence of native plants will be ensured. An analysis of the source of plant mortality and stressors will be made. Different species could potentially be planted that have a better chance of survival based on cause of mortality. Adaptive management triggers for this objective will be refined in the design and implementation phase.

Table 7: Example Scenarios and Typical Monitoring & Adaptive Management Actions

OBJECTIVE	EXAMPLE SCENARIOS	TYPICAL MONITORING ACTIONS	TYPICAL ADAPTIVE MANAGEMENT ACTIONS
Objective 1 – Restore in-stream habitat and ecosystem function	Monitoring metrics are not continuously met in a stream segment because of ongoing scouring or bank erosion.	Complete field investigation and site survey to determine the cause of the change in stream morphology. Monitor to determine if stream reaches new equilibrium. Monitor to determine if stream structures result in adverse changes in channel geometry.	Changes to elevation of structures or minor changes to structure locations, modify lateral position or height of structures.
Objective 2 – Restore range of resident and migratory fish	Target resident fish species are not observed upstream of fish blockage	Conduct additional sampling during spring or summer. Complete field investigation and survey to determine if fish blockage is the result of changes in stream geometry induced by built infrastructure, storm effects, or other factors.	Raising of streambed upstream or downstream of fish blockage; reset of structures (riffles, stones, logs) to improve fish passage and connect stream segments
Objective 3 – Re-establish hydrologic connection of the streams to the floodplain	Wetland vegetation is not continuously present in the floodplain along a stream segment	Monitor to determine if channel incision is occurring. Evaluate soil conditions (pH, composition, hydric characteristics) to determine if soil is unsuitable for wetland vegetation.	Regrading of banks; adjustment of structures; planting of native vegetation.
Vegetative Cover	Riparian vegetation in the project area does not meet minimum success criteria for vegetation coverage	Assess the potential for external factors to influence vegetation cover (weather patterns, drought, contaminants) in stream segment. Complete remote imaging of study area to determine vegetative coverage of the site as a whole.	Change the composition of species recommended for planting. Recommend additional planting of vegetation if in the contract guarantee period.

8 COST

The costs associated with implementing the monitoring and adaptive management plans are estimated based on currently available data. Given refinements that will be made in advancing the engineering designs from concept level designs, the costs for adaptive management may need to be adjusted in the design and implementation phase.

Per Memorandum on Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007, Monitoring for Ecosystem Restoration (USACE 2007), the estimated cost of the proposed monitoring program will be included in the project cost estimate and cost shared accordingly. Cost shared monitoring can for a period of up to 10 years or when ecological success is determined by the technical team. Costs were estimated based on the assumptions listed under Table 8 and similar work completed for the Anacostia Watershed Restoration - Prince George's County and the Paint Branch CAP 206 Project. Monitoring and adaptive management costs are summarized in Table 8. Monitoring is planned for a 10-year period following project construction depending on the metric being assessed as defined in this plan. The total cost for monitoring is $164,000. The total costs for adaptive management are $100,000. Contingency of 10 percent is included in the total costs for monitoring and adaptive management. The total cost for this effort is estimated at $290,400. Costs will be refined further in the design and implementation phase.

Table 8: Monitoring & Adaptive Management costs for the Recommended Plan

		Post-Construction Years										
Goal	**Activity**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Subtotal**
Objective 1	RHA Monitoring, Reporting	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$100,000
Objective 2	IBI Resident Fish Surveys	$5,000		$5,000		$5,000					$5,000	$20,000
Objective 3	Wetland Delineation					$10,000					$10,000	$20,000
Reporting											$12,000	$12,000
USACE Review		$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$2,000	$12,000
Adaptive Management												$100,000
Contingency (10%)												$26,400
Total												$290,400

*RHA Monitoring – Assumes 50 RHA forms, 30 minutes a form, 2 staff members = 50 hours * $200/hour = $10,000.
**IBI Resident Fish Surveys – 10 sampling locations (i.e. 1 sampling location every 0.5 km), 1 hour a location, 2 staff members = 20 hours.= * $200/hour = $4,000 + Reporting $1,000 each period.
***Wetland Delineation – Assumes delineation of wetlands proposed for restoration, to be identified during design and implementation. Maximum area estimated up to 1 acre of wetland restoration in Bel Pre Creek. 2 staff at 25 hours each; 50 hours * $200/hour = $10,000. No wetland restoration opportunities were identified in Lamberton Creek.
Final Reporting - $10,000.
Adaptive Management costs – $100,000 (~1% of total construction costs). Note that adaptive management costs are being revised in coordination with MCDEP.

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