SKOKOMISH RIVER BASIN
MASON COUNTY, WASHINGTON
ECOSYSTEM RESTORATION

APPENDIX E

MONITORING AND ADAPTIVE MANAGEMENT PLAN

Integrated Feasibility Report and Environmental Impact Statement

US Army Corps of Engineers®
Seattle District

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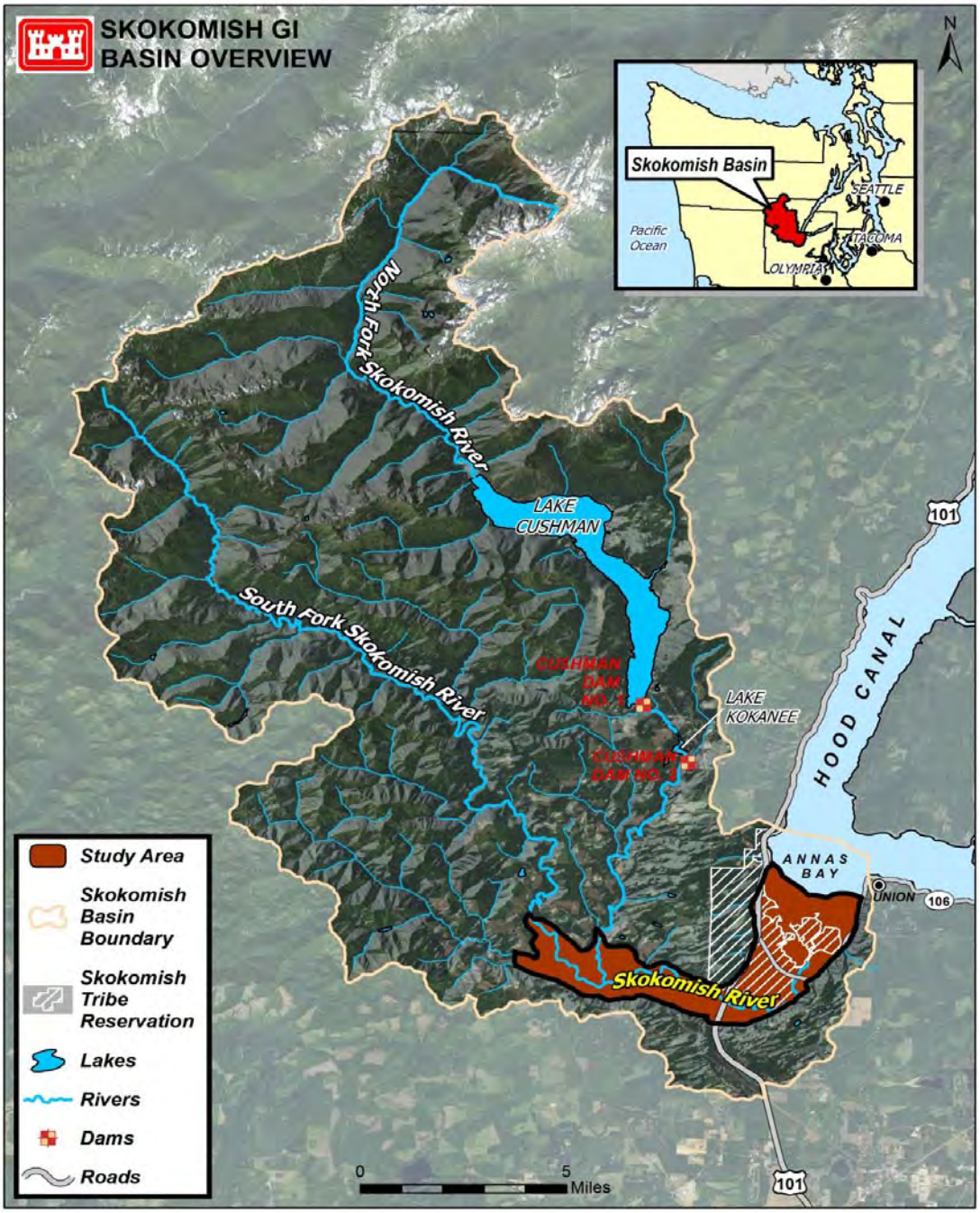
Skokomish River Basin General Investigation

Monitoring and Adaptive Management Plan

Contents

1 Introduction to the Project

The Skokomish River Basin is located on the Olympic Peninsula in northwestern Washington. The study area is approximately 11 square miles comprised of the lower Skokomish watershed, the Skokomish Valley, and Skokomish River estuary (Figure 1). The area is characteristic of the enormous beauty and versatile environment of Hood Canal and Puget Sound.



Alteration of the river environment and encroachment on the floodplain by human-made structures have degraded and continue to affect natural ecosystem structures, functions, and processes necessary to support critical fish and wildlife habitat throughout the basin. The degraded stream, wetland, and

riparian habitat cannot support a healthy population of critical fish and wildlife species. Specific anthropogenic impacts to the Skokomish River Basin include the following:

- Removal of large woody debris (LWD) simplified the stream habitat by reducing the occurrence of pools, caused loss of nutrients and substrate to support aquatic insects, and removed the complex rootwad structures that allow juvenile fish to hide from predators.
- Removal of the riparian forest has reduced the supply of LWD, overhanging vegetation that provides food sources for terrestrial and aquatic insects, and shade cover (approximately 62% of the mainstem is sparsely vegetated).
- Intensive logging activities that disturbed and destabilized the stream banks reduced streamside vegetation due to erosion.
- Protection of agricultural lands from erosion led to construction of bank protection measures. Those measures stopped natural channel migration, which reduces the rate of habitat creation in the river and in the floodplain.
- Logging activities in the South Fork and Vance Creek watersheds may have increased the upper basin sediment supply that is accumulating in the river reaches of the study area. This accumulation of gravel in the riverbed has resulted in cutting off access to aquatic habitats in the floodplain.
- The Cushman Dam Project, channel straightening, and levees have, to varying degrees, reduced ecosystem functions and habitat availability for all riverine fish species and the aquatic-oriented mammals such as beaver, river otter, and mink.
- The removal of LWD, disturbance of the stream banks, bank protection, and side-channel closures have all contributed to altering the bedload transport and deposition in the South Fork, Vance Creek, and the mainstem Skokomish River. In addition, flow regulation and reservoirs constructed by the Cushman Project has altered bedload supply from the North Fork, and bedload transport and deposition in the mainstem Skokomish River. A significant problem of the sediment accumulation is that the river dries up for a mile for nearly two months each year in the late summer. This poses a total block for upstream and downstream fish migration, and can prevent salmon from reaching their spawning grounds in time to spawn before dying.
- The U.S. Highway 101 and State Route 106 road embankments disrupt overbank flood flows and reduce habitat connectivity.

1.1 Project Planning Objectives

The project delivery team (PDT) for the Skokomish River Basin Ecosystem Restoration Feasibility Study formulated the following objectives to address some of the problems listed above:

1. Provide year-round passage for fish species around the confluence of the North Fork and South Fork Skokomish River for the 50-year period of analysis.
2. Reconnect and restore the spawning, rearing, and refuge habitats in the study's side channel and tributary networks 50-year period of analysis.

3. Improve the quantity, quality, and complexity of native riparian and floodplain habitats in the study area for the 50-year period of analysis.
4. Improve the quantity, quality, and complexity of pools in the Skokomish River to promote spawning and rearing success, as well as reduce stranding of ESA-listed salmonid species for the 50-year period of analysis.

1.2 Proposed Action

Based on the project objectives listed above, the PDT screened a list of potential management measures, restoration sites, and an array of alternatives. Through this process, the PDT selected a recommended plan that includes the following measures:

- Confluence Levee removal will open the river's largest constriction and redirects flow around the reach that goes dry. This achieves planning objective 1 by providing year-round fish passage via high quality habitat in the lowest reach of the North Fork.
- LWD installation on the South Fork throughout river miles 9 to 11 will create pools and complex habitat. This achieves planning objective 4 with increased number and quality of pools and habitat complexity.
- Reconnection of remnant side channel and associated wetlands will provide high flow seasonal access to rearing and refuge habitat for fish and amphibians by constructing an inlet and outlet. This achieves planning objectives 2 and 3 with the floodplain reconnection and prime over-wintering rearing habitat.
- Floodplain wetland restoration by breaching two agricultural berms and constructing wetland embankments away from the river for a widened channel migration zone and wetland restoration.
- Riparian restoration and re-vegetation in various areas associated with the other measures will improve riparian zone habitat quality. This achieves planning objective 3 with greatly increased native vegetation in the riparian zone.

These proposed measures are the basis for this monitoring and adaptive management plan.

2 Corps Guidance on Monitoring

Monitoring guidance for Corps projects was detailed in ER1105-2-100 in 2000 (USACE 2000). Since then, Implementation Guidance for Section 2039 of WRDA 2007- Monitoring of Ecosystem Restoration (USACE 2007) was issued and supersedes the 2000 guidance. The 2007 guidance states that a plan for monitoring ecological success must be included in the decision document, must include the rationale for monitoring, and must identify key project-specific parameters and how they relate to achieving the desired outcomes for making a decision about the next phase of the project. The guidance also states that the monitoring and adaptive management costs will be included in the project cost estimate and cost-shared accordingly; allowing for a monitoring period of up to, but not exceeding, ten years. The monitoring plan should also identify the criteria for success and when adaptive management is needed.

3 Purpose of the Plan

As described in the previous section on Corps guidance, the purpose of this plan 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 is proposed if the performance targets are not met.

This plan presents the framework for the above methodology, and will be refined in collaboration with the non-Federal sponsors, as well as other stakeholders who may take responsibility for monitoring ecological variables in the watershed.

4 Project Monitoring

As a restoration project, it is expected that this site will be dynamic and evolve. Thus, for some parameters, strict achievement of predetermined performance standards will not necessarily predict the success or reveal the failure of the restoration effort. The monitoring and evaluation will focus on determining whether the overall project objectives of the restoration are being met. 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.

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 the Corps and the non-Federal sponsors for the first 10 years of monitoring. The non-Federal sponsors may choose to monitor beyond this ten-year period, although the cost would be 100% their responsibility. Data collection will be used to determine success of the project with the focus on the development of in-stream and riparian habitats. The Corps and the non-Federal sponsors will use the knowledge gained through this monitoring to adaptively manage the project sites.

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 Evaluation of Specific Objectives

The monitoring metrics listed below are grouped by the project objectives listed in section 1.1.

5.1 Evaluation of Objective 1

Provide year-round passage for fish species around the confluence of the North Fork and South Fork Skokomish River for the 50-year period of analysis.

5.1.1 Monitoring Metric 1: Year-round flow

Methods and Timing: Along the reach where Confluence Levee is removed, measure cross-sectional flows in the North Fork during summer low flows (early July through late September). Walk channel profile at low flow and survey channel bottom and water surface every 100 feet and identify any dry reaches. Include notes on morphological feature extents in profile (pool, riffle, glide). Include field observations of passage barriers (such as dry or shallow areas) and note with GPS coordinates. These parameters will be monitored once per year in years 1, 2, and 5 after construction to verify project success of providing year-round passage, which is at greatest risk of being blocked during summer low flow.

Performance Target: Chinook salmon will be used for this metric since their arrival overlaps the most with the summer low-flow period and they are the largest of the Pacific salmon and therefore require the most water for passage. According to the peer-reviewed literature, Chinook salmon require at least a 0.8-foot depth of water over at least 25% of the wetted channel for upstream passage (Reiser and Bjornn 1979). Raleigh et al. (1986) indicates a minimum depth of 0.4 feet for passage at velocities less than 2 feet per second (ft/s). The more conservative of the two will be used as the performance target. Channel geometry combined with flow affects fish passage, so channel cross-sections and discharges will need to be taken along with depths. Calculations can be done from cross section surveys to determine whether the there is adequate flow to provide 0.8-foot of depth across 25% of the wetted channel (Pacific Northwest Monitoring Partnership 2014).

Adaptive Management: If target flows for passage in the North Fork are not achieved, then additional removal of ground surface where the levee stood may be needed, more excavation at the small existing breach may be necessary to divert more water to the North Fork, or additional engineered logjams to divert flows may need to be installed. Finally, the design team should have a discussion on "following the channel" if a new channel forms or changes position during the monitoring period. The metric will be met as long as one continuous wetted channel occurs and provides ample flow for fish passage, regardless of its location.

5.2 Evaluation of Objective 2

Reconnect and restore the spawning, rearing, and refuge habitats in the study's side channel and tributary networks for the 50-year period of analysis.

5.2.1 Monitoring Metric 2: Depth and width of opened channels, and seasonal velocity

Methods and timing: Measure seasonal depths and widths in inlet and outlet of restored side channel in winter, spring, summer, and fall. These parameters will be monitored 4 times per year in years 1, 2, and 5 after construction to verify project success.

Performance Target: Seasonal usage of the reconnected side channel by coho salmon will be used for this metric since they tend to spawn and rear in smaller streams and juveniles spend a full year in freshwater before out-migrating to the ocean. Coho are the primary species anticipated to benefit from the Side Channel Reconnection, although steelhead, cutthroat trout, and Chinook salmon will likely use the habitat as well. The following performance criteria apply:

- Rearing capability (to be measured in the spring, summer, and early fall): >30 cm depth, <30 cm/s velocity through the constructed openings at the inlet and outlet channels (Thompson 1972, Nickleson and Reisenbichler 1977)
- Maintenance of at least 80% of design width and depth of post-construction channels (measured in late fall and winter during minimum flows for activation of channels). Design criteria are provided in drawing sheets and monitoring criteria will also use as-built drawings after construction.

Through annual channel change, more valuable habitat will develop as high flows influence the shape of the constructed channels. Locations of measurement may change based on re-arrangement of side channel(s) by floods, increased flow, sedimentation, vegetation growth, etc.

Adaptive Management: If target depths, widths, and velocities are not achieved by the 7th year after construction, or if depth and width are less than 80% of the design criteria, then wood may need to be added to encourage microhabitat or additional excavation may be necessary to route more water through the opened channels.

5.2.2 Monitoring Metric 3: Riparian canopy coverage in areas re-planted after construction disturbance at Confluence Levee removal area and Side Channel Reconnection riparian zones

Methods and timing: Measure percent survival and percent coverage of the riparian corridor during late summer/early fall. The timing assumes that the contractor will be responsible for 100% survival of planted vegetation. Post-construction monitoring will occur in years 2, 3, and 6. The U.S. Fish and Wildlife Service recommends monitoring at least through year 3. Year 6 is included to provide a reasonable amount of time for shrubs to reach maturity so the Corps can determine whether sufficient ground coverage has been achieved or whether an adaptive management measure must be implemented.

Performance Target: It is expected that coverage will increase as planted and volunteer species grow. Planted and desirable volunteer trees and shrubs should be healthy and have a high percentage of ground coverage compared to bare dirt or invasive species. Performance targets include the following:

- Year 2: at least 80% survival of planted species
- Year 3: at least 70% survival of planted species
- Year 6: at least 80% ground coverage of native species

Adaptive Management: If the above targets are not met, then additional plantings could be implemented and/or changes in species planted from original planting plan if survival of certain species

is low. Additional irrigation of plants may need to be provided if they appear to be water stressed during the first three years.

Monitoring for invasive species must occur annually and treatment with monitoring must occur semiannually if invasive plants are detected. The duration of treatment and monitoring for invasive plants must continue until native plants are well established and would be the responsibility of the non-Federal sponsor.

5.2.3 Monitoring Metric 4: Overhanging vegetation and in-stream cover at the Side Channel Reconnection inlet and outlet channels

Methods and timing: Measure percent cover, including overhanging vegetation, boulders, and logs, during late summer/early fall in a standardized section of stream that is adjusted for width. Post-construction monitoring will occur in years 2, 3, and 6.

Performance Target: Cover is expected to increase as the vegetation grows and LWD recruits along the banks. The performance target for this metric is based on a suitability index of 0.8 for 10% cover for juvenile steelhead (Raleigh et al. 1984) and a suitability index of 0.8 for 20% cover for juvenile Chinook (Raleigh et al 1986). The targets in a standardized section of stream are the following:

- Year 2: at least 80% survival of planted species
- Year 3: at least 70% survival of planted species
- Year 6: at least 20% in-stream cover

Adaptive Management: If target cover is not met, then more plantings may be necessary and/or the addition of more LWD to achieve the target of 20% in-stream cover.

5.3 Evaluation of Objective 3

Improve the quantity, quality, and complexity of native riparian and floodplain habitats in the study area for the 50-year period of analysis.

5.3.1 Monitoring Metric 5: Maintenance of remnant side channel/wetland to the inlet during high flows and outlet year-round.

Methods and timing: Observe for hydraulic connection of inlet during late fall/early winter, and connection of the outlet in spring, summer, fall, and winter. Measure depths in the side channel inlet and outlet in winter and spring. This parameter will be monitored in years 1, 2, and 5 after construction to verify project success.

Performance Target: Connection at the inlet during typical higher flows that occur regularly October through April and connection at the outlet year-round. Rearing depths >30 cm depth (based on juvenile coho rearing).

Adaptive Management: If connections are not observed during indicated periods, then additional excavation at the inlet and/or outlet may be required. Additional stabilizing logs at the opening may be needed.

5.3.2 Monitoring Metric 6: Establishment of native vegetation at the re-planted areas of Confluence Levee removal and at the wetland embankments for Wetland Restoration at River Mile 9 and Grange

Methods and timing: Measure percent survival and percent coverage of the riparian corridor during late summer/early fall. The timing assumes that the contractor will be responsible for 100% survival of planted vegetation. Post-construction monitoring will occur in years 2, 3, and 6. The U.S. Fish and Wildlife Service recommends monitoring through at least year 3. Year 6 is included to provide a reasonable amount of time for shrubs to reach maturity so the Corps can determine whether sufficient ground coverage has been achieved or whether an adaptive management measure must be implemented.

Performance Target: It is expected that coverage will increase as planted and volunteer species grow. Planted and desirable volunteer trees and shrubs should be healthy and have a high percentage of ground coverage compared to bare dirt or invasive species. Performance targets include the following:

- Year 2: at least 80% survival of planted species
- Year 3: at least 70% survival of planted species
- Year 6: at least 80% ground coverage of native species

Adaptive Management: If the above survival and coverage targets are not met, then additional plantings could be implemented and/or changes in species planted from original planting plan if survival of certain species is low. Additional irrigation of plants may be needed in the first three years if the plants appear to be stressed. The invasive species removal effort may need to increase if they appear to be outcompeting native species.

5.4 Evaluation of Objective 4

Improve the quantity, quality, and complexity of pools in the Skokomish River to promote spawning and rearing success, as well as reduce stranding of ESA-listed salmonid species for the 50-year period of analysis.

5.4.1 Monitoring Metric 7: Number of LWD structures in the wetted areas of the channel

Methods and Timing: Check all installed LWD structures and record the number that still have some of their structure under water during the summer low-flow period (July-September). This metric would be measured annually for 10 years during low flow to capture the most critical period for providing pool habitat for fish. Incidental observations of surrounding riverbank and sediment conditions would be recorded for an overall assessment of habitat changes in the treated reach.

Performance Target: The design target is to have 64 “key” LWD pieces per mile with a minimum of 21 key pieces remaining wetted by mainstem river flow during the driest summer months to mimic nearby less degraded rivers. One of the purposes of LWD is to provide greater complexity of habitat under water, and an important season to achieve this is during warm summer months when juvenile salmonids will be seeking cool water refuge in pools. This objective is balanced with another purpose for the LWD structures, which is to create bar-apex logjams to split the flow around a gravel bar. The number of LWD structures still under water during low flows will depend on their placement and the hydrology of the location. The initial performance target is to have 50% of LWD installed for the purpose of complex pool

habitat to be remaining in the wetted channel at least in the first year after construction. Monitoring of the Upstream LWD installation in river miles 9-11 plus an additional rivermile downstream will occur annually. This will determine whether the performance target has been met and will help determine whether unanticipated reach-scale effects are occurring that may require adjustment of LWD installations. The duration of monitoring will be long enough to capture at least 2 channel-forming flows (approximately 17,000 cfs). Since this flow is equivalent to the 0.5 Annual Chance of Exceedance, it is anticipated that the monitoring end point will be less than 10 years post construction.

Adaptive Management: Adaptive management may involve relocating or adding more wood if the performance target of 50% of LWD installed or 21 key pieces in the river is not met.

5.4.2 Monitoring Metric 8: Pool development around the Upstream LWD installed in river miles 9-11

Methods and Timing: Measure pool depth and size adjacent to LWD installations and any pools that form throughout the treated reach. Note rough quantities of debris accumulation on LWD installations. Measure dimensions of recruited debris. Both of these metrics would be measured annually for 10 years during low flow to capture the most critical period for providing pool habitat for fish. Incidental observations of surrounding riverbank and sediment conditions would be recorded for an overall assessment of habitat changes in the treated reach.

Performance Target: In rivers, the largest and greatest number of pools tend to be associated with LWD (Abbe and Montgomery 1996). Pool development is expected to increase as the river scours the bed surrounding the logjams. The performance targets are as follows:

- achieve 40% pool habitat throughout the treated reach
- each logjam installation has a pool that is equal to the full length of that installation
- pools associated with each logjam installation are at least one foot deep.

Monitoring of the Upstream LWD installation in river miles 9-11 plus an additional rivermile downstream will occur annually. This will determine whether these three performance targets have been met and will help determine whether unanticipated reach-scale effects are occurring that may require adjustment of LWD installations. The duration of monitoring will be long enough to capture at least 2 channel-forming flows (approximately 17,000 cfs). Since this flow is equivalent to the 0.5 Annual Chance of Exceedance, it is anticipated that the monitoring end point may be less than 10 years post construction.

Adaptive Management: Adaptive management may include reorienting LWD or adding more pieces to the structures or to the treated reach of the river. Low water years could inhibit the formation of pools around LWD by limiting scour; therefore, effects caused by weather conditions such as floods or droughts should be considered before adaptive management is undertaken.

6 Contingency Planning and Implementation

Contingency measures (adaptive management) will be implemented if the monitoring program (or any other documented observations by qualified personnel) indicates performance targets are not being met and cannot be explained by extraneous variables. The Corps and the non-Federal sponsor would

then assess monitoring metric parameters and initiate the implementation of corrective actions to address the identified issue. Monitoring and adaptive management activities in this plan will be refined in preconstruction, engineering, and design phase. Additional metrics, methods, performance targets, and adaptive management measures may be added if needs are identified. The overall timeline for meeting performance targets is 10 years after construction. This is estimated to be ample time to determine ecological success through measurement of the physical and biological parameters outlined in this monitoring and adaptive management plan.

7 Cost

The following table summarizes a total cost estimate for the monitoring efforts in this plan:

Table 1. Estimated cost of monitoring effort for the Skokomish GI

Type of Monitoring	**Monitoring Metric**	**Time frame**	**Cost**
Physical Monitoring	MM1: Year round flow	summer	$231,000
	MM2: Depth, width, and velocities	winter, spring, summer, fall	
	MM4: Overhanging vegetation and in-stream cover	late spring	
	MM5: Maintenance of remnant side channel/wetland network	winter, spring, summer, fall	
	MM7: LWD structures in the water	summer	
	MM8: Pool development and recruitment around LWD	spring	
Biological Monitoring	MM3: Riparian Canopy coverage in planted areas	late summer/early fall	20,000
	MM6: Establishment of native vegetation along the river and floodplain	late summer/early fall	
Vehicles and equipment			$4,000
Travel			$23,000
Monitoring Total			**$278,000**
Grand Total	Contingency of 35% added to monitoring total (See Appendix K of the Final FR/EIS for additional information)		**$375,000**

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