Draft Lower Yellowstone Project Monitoring and Adaptive Management Plan

Intake Diversion Dam Modification, Lower Yellowstone Project

U.S. Bureau of Reclamation
and
U.S. Army Corps of Engineers

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Introduction

The proposed Intake Dam modifications described in the action alternatives in the supplemental EA are based on the best available scientific information. Nonetheless, uncertainty exists regarding assumptions about biological response to the alternatives and the relative effectiveness of the alternatives for improving fish passage and minimizing entrainment.

The purpose of this draft monitoring and adaptive management plan (Plan) is to validate assumptions and address project uncertainties through monitoring of physical and biological responses to management actions, assessment of progress towards project objectives, and implementation of potential adjustments to achieve and maintain project performance.

To maximize project success, this draft Plan is intended to evolve as designs are refined, additional information is gathered, and the project is implemented. Information in this draft Plan is preliminary and subject to considerable change as the process moves forward. A final Plan would likely not be developed until after construction is completed.

Adaptive management is a decision-making process that provides for implementing management actions in the face of uncertainty. The purpose of this Plan is to define objectives, metrics, and targets for proposed management actions and potential adjustments that may be warranted based on monitoring. This Plan also describes the cycle for analysis and decision-making that will be used to implement the plan. This approach allows for monitoring and implementation of management scenarios to better understand the effects of operation of the Lower Yellowstone Project and Intake Dam modifications. The Plan is focused on improving passage at Intake and minimizing canal entrainment to avoid jeopardizing the continued existence of pallid sturgeon.

Background

Construction of the Lower Yellowstone Project began in 1905 under the Reclamation Act of 1902. The Intake Diversion Dam is a 12-foot high wood and stone structure that spans the Yellowstone River and raises the water level for diversion of water into the main canal. Intake Diversion Dam has impeded upstream migration of pallid sturgeon and other native fish for more than 100 years.

The Bureau of Reclamation (Reclamation) and the Corps of Engineers (Corps) need to comply with the Endangered Species Act (ESA) for different regulatory reasons. Reclamation must complete consultation under Section 7(a)(2) for operation of the Lower Yellowstone Project. If Reclamation does not successfully complete consultation, then the ability to operate the diversion and headworks to deliver water could be severely constrained or limited in the future. Reclamation has contractual obligations to deliver water needed to continue effective operation of the Lower Yellowstone Project.

The Corps needs to comply with the 2003 Missouri River Amended Biological Opinion, as amended by letters on October 23, 2009, April 7, 2010, and February 6, 2013. Fish passage and minimization of entrainment at Intake are now requirements under the amended biological opinion. Section 3109 of the 2007 Water Resources Development Act authorizes the Corps to use funding from the Missouri River Recovery and Mitigation Program to assist Reclamation with compliance with federal laws, design, and construction of modifications to the Lower Yellowstone Project for the purpose of ecosystem restoration.

Project Features

The supplemental EA describes two action alternatives – the Bypass Channel and Rock Ramp alternatives – in addition to the No Action Alternative.

Bypass Channel

The Bypass Channel Alternative is intended to improve fish passage with a long, low-gradient channel around the diversion dam. A new headworks structure with rotating drum screens has been constructed to control diversion of water into the canal and minimize fish entrainment. The effectiveness of these features will be monitored, and if needed, modifications will be in an effort to achieve project objectives. Figure 1, provided below, depicts the locations of major project features. The following is a summary of the major project features.

1. Bypass channel – the bypass channel would be excavated from the inlet of the existing high flow channel to just downstream of the existing diversion dam. The proposed bypass channel alignment is approximately 15,500 feet long at a slope of 0.0006 ft/ft. The channel cross section has a 40-foot bottom width with side slopes varying from 1V:12H to 1V:3H. The bypass channel would divert on average 15% of the total flow of the Yellowstone River.
2. Upstream control structure – a riprap/concrete sill control structure designed to control discharge into, and stabilize the entrance to, the bypass channel would be situated on the upstream end of the channel.
3. High flow channel diversion – a channel diversion would be constructed in the existing high flow channel to keep most flows in the proposed bypass channel. The channel diversion would have multiple discharge elevations and would be designed to overtop during larger events.
4. Riprap at bends for lateral stability – bank riprap is proposed at two outside bends to minimize the risk of losing the bypass channel planform.
5. Vertical control structures – two vertical control structures (riprap sills) are proposed for maintaining channel slope and allowing for early identification of channel movement.
6. Downstream vertical control structure – a riprap sill is proposed at the downstream end of the bypass channel to maintain channel elevations.
7. Downstream lateral stability structure – riprap bank stabilization would be constructed on the right bank of the bypass channel to prevent downstream migration of the downstream end of the bypass channel.

8. New diversion weir – to maintain irrigation and by-pass channel diversion capabilities. The new weir would preclude the necessity of adding large rock to the crest of the existing diversion structure to maintain diversion capabilities.
9. Armor layer – the bed of the bypass channel would be armored with sorted sands, gravels and cobbles to reduce the risk of bed degradation. The proposed armor layer would be similar to naturally-formed armor layers in the Yellowstone River.

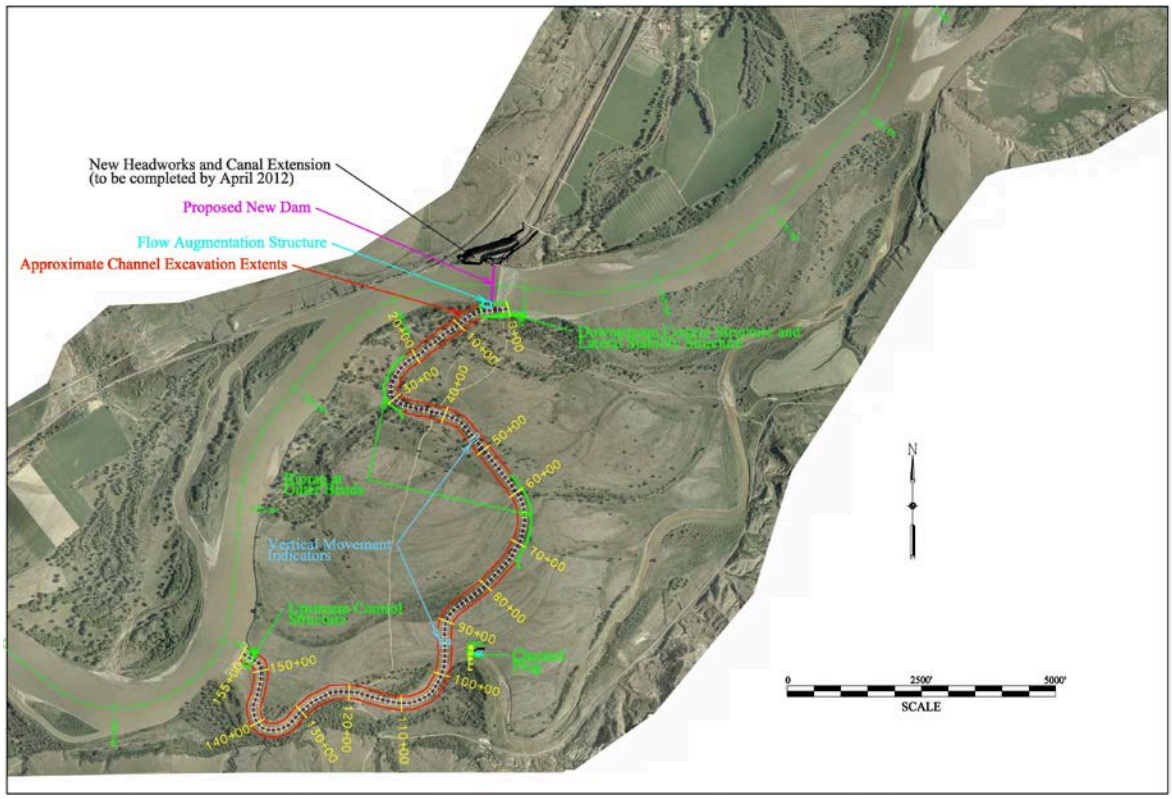

Figure 1: Location of Proposed Project Features

Rock Ramp

The Rock Ramp Alternative is intended to improve fish passage with a shallow-sloped, un-grouted boulder and cobble rock ramp. The rock ramp would be designed to mimic natural river function and would provide lower velocities and turbulence so migrating fish could pass over the dam improving fish passage and contributing to ecosystem restoration. A new headworks structure with rotating drum screens has been constructed to control diversion of water into the canal and minimize fish entrainment. The effectiveness of these features will be monitored, and if needed, modifications will be made in an effort to achieve project objectives. The following is a summary of the major project features.

1. New diversion weir – to maintain irrigation and provide structural stability of the rock ramp a new diversion weir is proposed. The replacement concrete weir would be located downstream of the new headworks to create sufficient water surface elevations to divert 1,374 cfs into the main canal. The concrete weir

would be constructed as a cast-in-place reinforced concrete wedge spanning the Yellowstone River. The upstream, sloping face of the concrete weir would be designed to withstand damage from ice moving up and over the ramp. The historic headworks has been preserved in place and would serve as a weir abutment on the north bank of the river. A new concrete weir abutment would be constructed on the south bank. It would anchor into adjacent ground.

2. Weir Crest – The weir crest would vary in elevation and include at least one low-flow channel for fish passage. The variable crest would offer depth-velocity habitat zones for fish migration under the wide range of flows typical on the lower Yellowstone River. The channels in the weir crest would be designed to provide fish passage during late summer and early fall low flows and would be approximately 1 - 2 feet deep. The downstream side of the weir would tie directly into the rock ramp to provide a seamless transition and unimpeded passage as fish migrate upstream.

Project Uncertainties

There are uncertainties related to the design and performance of the proposed action alternatives that could affect their ability to meet stated goals and objectives. Uncertainties associated with each alternative are presented below.

Bypass Channel

1. How will native fish react to complex flow patterns and turbulence associated with the bypass channel?
2. Will the bypass channel produce the desired velocity, depth, and width?
3. Can the bypass channel be maintained to produce the expected velocity, depth and width?
4. Will the screened headworks minimize entrainment of pallid sturgeon greater than 40 mm in total length?

Rock Ramp

1. Will native fish successfully navigate the rock ramp to migrate upstream?
2. Will the ramp design, including crest depth, velocity, and degree of turbulencepermit the passage of native species?
3. How will the ramp hold up to ice conditions?
4. How will boulders that are scoured out be replaced?
5. Will the screened headworks prevent entrainment of pallid sturgeon greater than 40 mm in total length?

Goals and Objectives

The goals of this plan are to ensure that modifications to Intake Dam and canal headworks improve passage for native species and minimize entrainment into the main canal, and contribute to lower Yellowstone River ecosystem restoration.

In 2013, the Fish and Wildlife Service (Service) amended the Corps' 2003 Amended Fort Peck Dam – Intake Montana River Restoration Biological Opinion Reasonable and Prudent Alternative (RPA) element. The amended RPA requires fish passage construction that meets "hydraulic and physical conditions for fish passage…established collaboratively by the projects interagency Biological Review Team." The amended RPA states that meeting the "hydraulic and physical conditions for fish passage" constitutes successful performance. Reclamation presumes that ESA consultation on operation and maintenance of the Lower Yellowstone Irrigation Project with the Service would result in comparable criteria requirements for successful operation and maintenance of the fish passage structure.

Fish passage and entrainment will be monitored, and project features will be modified through adaptive management as needed to meet the following compulsory (Objective 1 and 2 based on existing and anticipated ESA consultation) and validation (Objective 3) objectives:

Objective 1: Achieve the desired hydraulic and physical parameters believed to improve fish passage based on the best available scientific information (i.e., BRT Criteria).

Performance Metric: Bypass channel velocity and depth

Measurement: Achieve and maintain designed hydraulic and physical parameters of the bypass channel/rock ramp:

- ☐ Depth – Depth would be measured using Acoustic Doppler Current Profiler (ADCP) data
- ☐ Width – ADCP data and physical measurements
- ☐ Channel Velocity – ADCP data
- ☐ Entrance Velocity – ADCP data
- ☐ Discharge – ADCP data

Target:

- ☐ Depth – Minimum cross-sectional depth at 95% exceedance flow (7,000 cfs) at any sampled cross-section: 3.28 ft (1.0 meter)
- ☐ Width – Target top-widths vary from 130-250 feet depending on location
- ☐ Channel Velocity – Bypass channel cross-sectional mean column velocity at any sampled cross-section: Minimum 2.4 fps (.73 m/s); maximum 6.0 fps (1.8 m/s)
- ☐ Entrance Velocity – Attraction flows at fish entrance: 3 fps (0.91 m/s)
- ☐ Discharge – Target numbers vary and correspond to design percent diversion. Design percent diversion varies from 15% to 23% depending on total flow and inclusion of flow augmentation structure flows.

Objective 2: Minimize entrainment of pallid sturgeon > 40 mm through the intake structure.

Performance Metric: Entrainment rates of pallid sturgeon > 40 mm

Measurement: Annual sampling would quantify entrainment of pallid sturgeon > 40 mm. Entrainment nets will be placed directly behind the headworks to monitor fish being entrained through the screens. Some larval work will also be conducted from the bridge just downstream from the headworks.

Target: Document entrainment of pallid sturgeon > 40 mm has been minimized over a five-year period following construction.

Objective 3: Maintain or improve the ability of native fish migration upstream and downstream of Intake Diversion Dam; improve ability of pallid sturgeon to migrate upstream and downstream of Intake Diversion Dam.

Performance Metrics: Document movement of native fish upstream and downstream of Intake Diversion Dam.

Measurement: Tracking radio-telemetered native fish tagged below Intake. Monitoring will involve tracking fish moving both upstream and downstream past Intake.

Once fish have moved into the area of Intake, DIDSON (Dual-frequency IDentification SONar) cameras will be used to determine behavior once they encounter the passage alternative, particularly species' ability to overcome complex flow patterns and, in the case of the Bypass Channel Alternative, enter the downstream entrance of the bypass channel.

Target: Document movement of native fish from below Intake Diversion Dam to upstream of the dam over a period of five years following construction at rates equivalent to pre-construction passage; improve pallid sturgeon movement from below Intake Diversion Dam to upstream of Intake Diversion Dam.

Adaptive Management Strategy

Based upon hydraulic and physical modeling, expected velocities and depths should improve upstream and downstream passage of pallid sturgeon and other native fish over a wide range of flows and screening should minimize entrainment. However, actual performance will not be known until construction is complete. Because of these uncertainties, an adaptive management approach will be used to monitor and, as necessary, adjust operation or physical configuration of the bypass channel or rock ramp and screens to achieve project objectives.

Monitoring

The bypass channel, rock ramp, and fish screens were designed to meet pallid sturgeon hydraulic and physical requirements. For example, the design criterion for water velocity was based in part on laboratory studies of pallid sturgeon swimming ability, and the screen design was based on NOAA-Fisheries criteria that appear appropriate for pallid sturgeon based on laboratory studies. Nonetheless, uncertainty remains whether the bypass channel, rock ramp, and/or fish screen will meet their design criteria and whether pallid sturgeon and other native fish will react as predicted. Therefore, a monitoring program would be established to assess whether pallid sturgeon and other native fish passage and entrainment objectives are being met.

Hydraulic and Physical Characteristics Objectives

Methods

Monitoring equipment will be installed at various locations for hydraulic and physical criteria monitoring. Hydraulic properties, including water depth, channel velocity, entrance velocity, discharge and turbulence will be measured over a range of discharges using ADCP data to ensure the constructed project is achieving design criteria.

- Depth, width, velocity, and discharge would be measured using ADCP at a cost of approximately $30,000/year for five years.

Success Criteria

Within five years after completion of the fish passage and entrainment projects at Intake Dam:

- Document whether depths, widths, channel velocities, entrance velocities, discharge, and turbulence improve passage of pallid sturgeon.

Pallid Sturgeon Entrainment Objective

Methods

Instrumentation will be installed on the screens to measure approach velocity. Larval sampling would be used to quantify entrainment of larval fish > 40 mm either directly behind the new headworks screen structures or just down-canal. Baseline monitoring has been conducted to determine larval entrainment prior to screening, and post-construction monitoring would be compared to this baseline to indicate the reduction of larval entrainment afforded by the screens as well as assuring that the success criterion for larval sturgeon is met. Larval sturgeon (*Scaphirynchus* spp.) > 40 mm sampled in the canal would need to be genetically analyzed to determine species.

- Cost Estimate: $150,000 per year (includes genetic testing if needed), for five years.

Success Criteria
Within five years after completion of the fish passage and entrainment projects at Intake Dam:

- Document whether adult and stocked juvenile pallid sturgeon > 40 mm can pass downstream of Intake Dam without being entrained into the irrigation canal.

Native Fish Passage Objective

Methods
The ability of native fish, including pallid sturgeon, to migrate upstream and downstream will be assessed by tracking radio-telemetered by land based radio telemetry stations along the selected passage alternative.

- Montana FWP Cost Estimate: $250,000 per year, for five years

The physical mechanisms and behaviors by which pallid sturgeon (and other native fish) move up and down through the selected passage alternative would be observed visually using DIDSON cameras. The DIDSON cameras would be deployed over a two- to four-week period during upstream migration indicated by the radio-telemetry study. Once radio-telemetered fish were located near Intake, these fish would be targeted with the DIDSON. This technique would also help provide insight to the construction success of the fish passage structure and could be used to diagnose and improve areas of ineffective passage.

- TSC Cost Estimate: $100,000 per year, for five years

Success Criteria
Within five years after completion of the fish passage and entrainment projects at Intake Dam:

- Document whether pre-construction levels of native fish passage are occurring at Intake Diversion Dam.
- Document improvement in pallid sturgeon passage at Intake Diversion Dam.

Potential Adaptive Management (AM) Measures

Data from hydraulic monitors would be evaluated and compared with monitoring of fish movement and modifications would be proposed to reduce hydraulic constraints. Potential AM measures for each alternative include but are not limited to the following (Table J-1):

Bypass Channel

1. Flow Augmentation Structure – Construct and use the flow augmentation structure to increase attractive flow. Flow could be increased to as much as 23% of the main channel flow (during peak spring runoff season). Investigations into this structure are still ongoing. It has not been determined if this structure will be needed in the initial design or if it will be an AM measure.

2. Physical Changes – Modification as needed to the upstream control structures, vertical control structures, lateral stability structures, and downstream structure to address potential depth, velocity, and width issues.
3. Existing High Flow Channel Diversion – Modifications as needed to the channel diversion blocking flows from the existing high flow channel. At this time it is not known how much passage the existing high flow channel provides. If pallid sturgeon are found to use the existing high flow channel, the channel diversion will have to be changed to allow for fish passage. This could include lowering the diversion elevation or turning the diversion into a rock ramp design.
4. Bypass Channel Entrance – Modifications as needed to the channel entrance to allow for adequate attraction flows, alleviate sheer flows and minimize eddy formation near the channel entrance.
5. Intake Diversion Weir Revisions – Modification to the diversion weir as needed to improve passage for other native fish species that may be impacted by the proposed project.

Rock Ramp

1. Physical Changes – If native fish do not pass the rock ramp, physical and hydraulic parameters may need to be addressed.
2. Physical Changes to the Yellowstone River Channel – Modification as needed to main channel training structures and debris field adjustments.
3. Intake Diversion Weir Revisions – Modification to the diversion weir as needed to improve passage for other native fish species that may be impacted by the proposed project.

Implementation of the above measures would be based on results of hydraulic and physical monitoring including: depth, velocity, and width; and observation of native fish migration upstream and downstream of Intake Diversion Dam.

Entrainment

If fish > 40 mm continue to be entrained after the screens are installed, modifications or O&M repairs would be made as needed. Currently, there are no proposed AM measures related to the entrainment objective. O&M activities would ensure that the screens continue to function as designed.

Adaptive Management/Long-term Operations and Maintenance

Reclamation believes adaptive management and long-term O&M are two intricate pieces to the long-term success of the project. Items that are not outlined in the adaptive management measures are assumed to be long-term O&M.

Table J-1. Potential AM measures

	Proposed Funding Agency	Proposed Agency Conducting Work	Estimated Annual Cost (if applicable)	Estimated Cost
Monitoring				
Depth, width, velocity, and discharge measured using ADCP	Corps (1st year) and Reclamation	TSC	$30,000 per year for five years	$150,000
Tracking radio-telemetered fish to validate passage	To Be Determined[1]	MFWP & TSC & MSU	$250,000 per year for five years	$1,250,000
Dual Frequency Identification Sonar (DIDSON) to observe physical mechanisms and behaviors by which native fish and pallid sturgeon migrate through the channel or over ramp	To Be Determined[1]	TSC	$100,000 per year for five years	$500,000
Monitoring pallid sturgeon entrainment	Reclamation	TSC	$150,000 per year for five years	$750,000
Total Estimated Monitoring Costs				*$2,650,000*
Potential Adaptive Management Measures				
Bypass Channel - Construction of flow augmentation structure to increase attractive flows in the bypass channel	To Be Determined[1]	Reclamation	NA	$4,012,147
Bypass Channel - Bypass channel structure modifications for hydraulic and physical success – Modification as needed to the channel diversion, lateral stability structures, vertical control structures, upstream and downstream control structures (assumed rearranging of 1,000 cubic yards of material over 5 years)	Corps During One Year Warranty; To Be Determined in Subsequent Years[1]	Corps (1st year) and Reclamation	$25,560 per year for five years	$127,800
Bypass Channel - Physical Changes to Yellowstone River channel for hydraulic and physical success – Modification as needed to the main channel training structure and debris field adjustments (assumed rearranging of 10,000 cubic yards of material over 5 years)	Corps During One Year Warranty; To Be Determined in Subsequent Years[1]	Reclamation	$67,963 per year for five years	$339,815
Bypass Channel/Rock Ramp - Intake Diversion Weir Revisions to improve passage for native fish species	To Be Determined[1]	Reclamation	NA	$256,075
Rock Ramp – Physical modifications to the rock ramp as needed to achieve hydraulic and physical success criteria	Corps During One Year Warranty; To Be Determined in Subsequent Years[1]	Corps (1st year) and Reclamation	NA	$2,000,000

[1]Reclamation, the State of Montana, and the Lower Yellowstone Irrigation Project intend to work cooperatively to identify funding sources for this measure.

Assessment and Implementation of Adaptive Management

Assessment of the selected passage alternative will be conducted by Reclamation. Reclamation will review data from monitoring physical parameters. It will be Reclamation's responsibility to determine whether or not the passage alternative is

meeting the physical parameters established in this document and provide recommendations to remedy potential problems.

Reporting

Reclamation will provide annual reports documenting monitoring results and previous management actions. Recommendations for changes to monitoring or management actions will be proposed as necessary.

For each monitoring element, the report will document the methods and results. Results will be evaluated with respect to the goals and objectives of the adaptive management program, and may indicate that changes in monitoring priorities and management activities are warranted.

Decision-making

The Montana Area Office Area Manager will be the decision maker for the Lower Yellowstone Project Adaptive Management Program.

Data Management and Project Closeout Plan

The monitoring and assessment activities identified in the Adaptive Management Plan will continue for five years following completion of construction of the bypass channel or rock ramp. The program or elements of the program may be terminated early through a decision by Reclamation if success has been clearly demonstrated. Likewise, the program, or elements of the program may also be extended if it is determined that the project has not yet been successful.

All monitoring data will be stored electronically on a secured server maintained by MTAO and will comply with Reclamation's proposed data stewardship guidelines. All data collected by contractors will be provided to MTAO in an agreed upon electronic format. Additionally, contractors will provide hard copies of any field notes or data sheets. Upon completion of the Adaptive Management Plan, all data, results of analyses, and reports will be archived.