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, assess progress towards project objectives, and identify 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 change as the project 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 monitoring and improving passage at Intake to avoid jeopardizing the continued existence of pallid sturgeon, and addressing uncertainties associated with the proposed alternatives.

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 made 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 reduce 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.

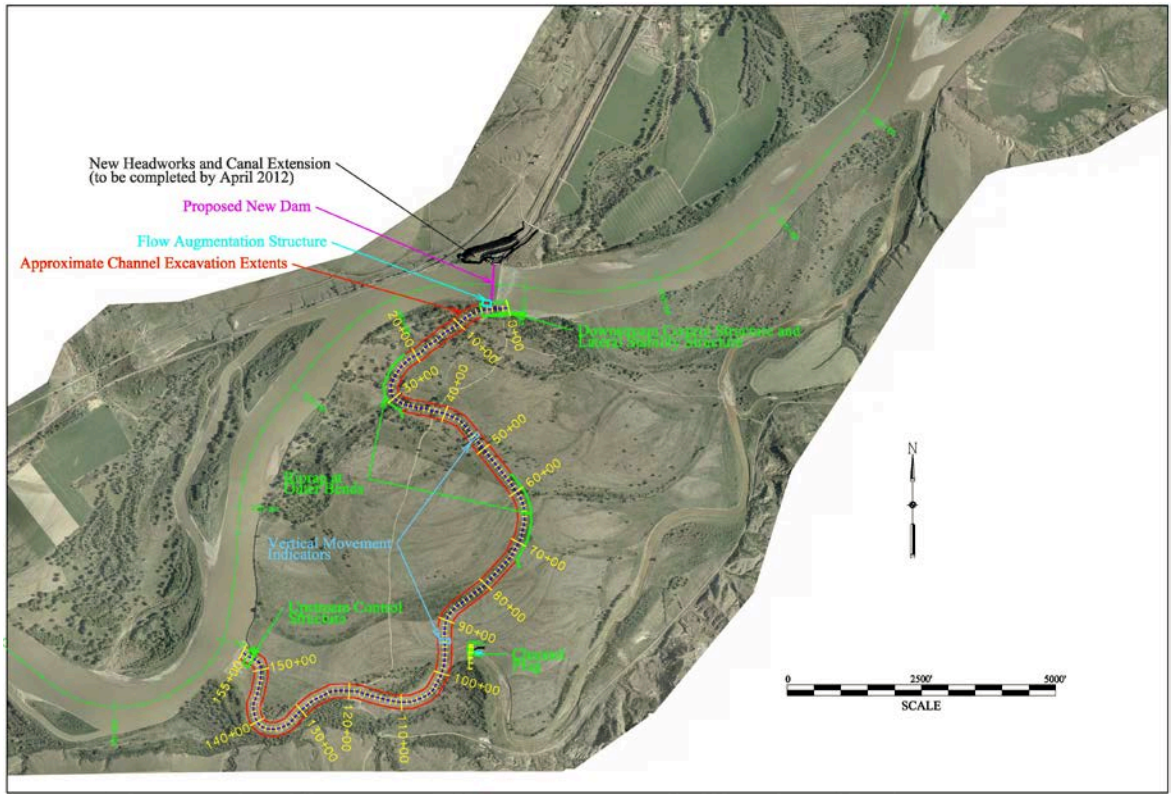

Figure 1: Location of Proposed Project Features

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. How will the bypass channel entrance hold up to ice conditions?
4. Can the bypass channel be maintained to produce the expected velocity, depth and width?

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 turbulence permit 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?

Goals and Objectives

The goals of this plan are to ensure that modifications to Intake Dam improve passage for pallid sturgeon (ESA driven) and maintain current native fish passage (NEPA driven)

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 will be monitored, and project features will be modified through adaptive management as needed to meet the following compulsory (Objective 1 based on existing and anticipated ESA consultation) and validation (Objective 2) 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 velocities, depth and flow split

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
☐
☐ **Channel Velocity** – ADCP data
☐ **Entrance/Exit Velocities** – ADCP data
☐ **Discharge(flow split)** – ADCP data

Target:

- **Depth**
  - Minimum cross-sectional depths measured at the lower discharge range of 7,000 cfs to 14,999 cfs at any sampled cross-section must be greater than or equal to 4.0 ft across 30 contiguous feet of the measured channel cross section profile.
  - Minimum cross-sectional depth over the discharge range of 15,000 cfs to 63,000 cfs at any sampled cross-section must be greater than or equal to 6.0 feet across 30 contiguous feet of the measured channel cross sectional profile.
- **Main Channel Cross-sectional Velocities**
  - Mean bypass channel cross-sectional velocities at all sampled locations must be equal or greater than 2.0 feet per second or 0.61 meters per second, but less than or equal to 6.0 ft/s over the discharge range of 7,000 cfs to 14,999 cfs.
  - Mean bypass channel cross-sectional velocities (measured as mean column velocities) at all sampled cross-sections must be greater than or equal to 2.4 ft/s, but less than or equal to 6.0 ft/s over the discharge range of 15,000 cfs to 63,000 cfs.
- **Entrance and Exit Velocities**
  - To provide sufficient attraction flows, the downstream fish entrance should have a mean cross sectional velocity of greater than or equal to 2.0 ft/s (measured as mean column velocity) through the lower discharge range of 7,000 cfs to 14,999 cfs.

- The entrance should have a mean cross-sectional velocity greater than or equal to 2.4 ft/s (measured as mean column velocity) through the range of discharges from 15,000 cfs to 63,000 cfs.
- Mean cross-sectional velocities (measured as mean column velocity) at both the upstream and downstream channel openings should be less than or equal to 6.0 ft/s for river discharges ranging from 7,000 cfs to 63,000 cfs.

o **Flow Split**

- At least a 12% flow split over the discharge range of 7,000 to 14,999 cfs; 13% to greater than 15% over the discharge range of 15,000 cfs to 63,000 cfs.

Table 1: Tabular Summary of Design Criteria

Criteria	7,000 – 14,999 cfs	15,000 – 63,000 cfs
Bypass Channel Flow Split	≥12%	13% to ≥15%
Bypass Channel Cross-sectional Velocities (measured as mean column velocity)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Depth (minimum cross-sectional depth for 30 contiguous feet at measured cross-section)	≥4.0 ft	≥6.0 ft
Bypass Channel Fish Entrance (measured as mean column velocity)	2.0 – 6.0 ft/s	2.4 – 6.0 ft/s
Bypass Channel Fish Exit (measured as mean column velocity)	≤6.0 ft/s	≤6.0 ft/s

Objective 2: Maintain native fish migration 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. 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 to achieve project objectives.

Monitoring

The bypass channel and rock ramp 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 was based on NOAA-Fisheries criteria that appear appropriate for pallid sturgeon based on laboratory studies. Nonetheless, uncertainty remains whether the bypass channel and rock ramp 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.

Pallid Sturgeon Fish Passage 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 eight years.

Success Criteria

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

- Document whether depths, channel velocities, entrance velocities, and discharge are meeting the BRT criteria established above.

Native Fish Passage Objective

Methods
The ability of native fish to migrate upstream and downstream will be assessed by tracking radio-telemetered fish 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 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. 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.
2. 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.

3. 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.
4. 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.

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, 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
Total Estimated Monitoring Costs				*$1,900,000*
Potential Adaptive Management Measures				
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 eight 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.