Thompson Falls Hydroelectric Project
FERC Project No. 1869

Updated Study Report
Executive Summary

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List of Abbreviations and Acronyms

2D	two-dimensional
3D	three-dimensional
APE	Area of Potential Effect
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
DEQ	Montana Department of Environmental Quality
EJC	Environmental Justice Community
FERC	Federal Energy Regulatory Commission
flow	Project discharge
FWP	Montana Fish, Wildlife and Parks
FWS	U.S. Fish and Wildlife Service
GBT	gas bubble trauma
H-A&E	Historic Architectural and Engineering Properties
ILP	FERC's Integrated Licensing Process
ISR	Initial Study Report
Licensee	NorthWestern Energy
Modified Study Plan	Determination on Requests for Study Modifications for the Thompson Falls Hydroelectric Project, FERC 2022
MW	megawatt
National Register	National Register of Historic Places
NorthWestern	NorthWestern Energy
PAD	Pre-Application Document
Project	Thompson Falls Hydroelectric Project
PSP	Proposed Study Plan
Relicensing Participants	local, state, and federal governmental agencies, Native American Tribes, local landowners, non-governmental organizations, and other interested parties.
RSP	Revised Study Plan
Scientific Panel	Thompson Falls Scientific Review Panel
TDG	total dissolved gas
Thompson Falls Project	Thompson Falls Hydroelectric Project
U.S.	United States
USFS	U.S. Forest Service
USGS	United States Geological Survey
USR	Updated Study Report
ZOP	zone of passage

1. Introduction

The Thompson Falls Hydroelectric Project (Thompson Falls Project or Project) is located on the Clark Fork River in Sanders County, Montana. Preliminary development of the Thompson Falls Project began in June 1912, by the Thompson Falls Power Company. Construction commenced in May 1913 and the first generating unit was placed in service on July 1, 1915. The sixth generating unit was placed in service in May 1917. An order amending the License was issued in 1990 allowing for construction of an additional powerhouse and generating unit, which was subsequently completed in 1995. With the addition of this new (second) powerhouse, the Project has a total generating capacity of 92.6 megawatts.

Non-federal hydropower projects in the United States (U.S.) are regulated by the Federal Energy Regulatory Commission (FERC) under the authority of the Federal Power Act. Montana Power Company acquired the Thompson Falls Project in 1929. The original License for the Thompson Falls Project was issued effective January 1, 1938, and expired on December 31, 1975. The current FERC License was issued to the Montana Power Company in 1979. The Project was purchased by (and FERC License transferred to) PPL Montana in 1999 and then purchased by (and FERC License transferred to) NorthWestern Corporation, a Delaware corporation, d/b/a NorthWestern Energy (NorthWestern or Licensee) in 2014. The current FERC License expires December 31, 2025. As required by the Federal Power Act and FERC's regulations, on July 1, 2020, NorthWestern filed a Notice of Intent to relicense the Thompson Falls Project using FERC's Integrated Licensing Process (ILP). Concurrently, NorthWestern filed a Pre-Application Document (PAD).

The ILP is FERC's default licensing process which evaluates effects of a project based on a nexus to continuing Project operations. In general, the purpose of the pre-filing stage of the ILP is to inform Relicensing Participants about relicensing; to identify issues and study needs (based on a project nexus and established FERC criteria); to conduct those studies per specific FERC requirements, defined in the FERC Study Plan Determination; and to prepare the Final License Application.

1.1 Study Plan Development Process

Before filing a Final License Application with FERC, applicants conduct a pre-license application filing process that consists of 1) presenting the project to Relicensing Participants; 2) consulting with those Relicensing Participants; 3) identifying issues; and 4) conducting studies and gathering relevant information.

Under FERC regulations, NorthWestern was required to submit a PAD 5 to 5.5 years prior to the expiration of the current License (December 31, 2025). As described above, NorthWestern filed the PAD July 1, 2020. In the PAD, NorthWestern identified preliminary issues and studies

based on existing and relevant information, baseline conditions, and current and proposed future operations. NorthWestern identified eight potential studies in the PAD.

In response to requests for studies submitted by the U.S. Forest Service (USFS) and Montana Fish, Wildlife and Parks (FWP), NorthWestern's Proposed Study Plan (PSP) (filed with FERC December 11, 2020) proposed one additional study to the eight proposed in the PAD, a study of Westslope Cutthroat Trout Genetics.

In accordance with 18 Code of Federal Regulations (CFR) § 5.11, NorthWestern held a public study plan meeting on January 6, 2021. At the meeting, NorthWestern presented its proposed studies and provided opportunities for participants to provide input and ask questions. Subsequent to the Study Plan Meeting, during the public comment period, NorthWestern met with representatives of FWP, the U. S. Fish and Wildlife Service (FWS), USFS, and Montana Department of Environmental Quality (DEQ), to discuss the PSP, to resolve any differences over study requests, and inform NorthWestern's development of the Revised Study Plan (RSP) (NorthWestern 2021).

The public comment period on the PSP closed on March 11, 2021. The comments, and NorthWestern's responses, were included in the RSP, filed with FERC April 12, 2021 (NorthWestern 2021). In response to requests for studies submitted by FWP, NorthWestern added one additional study to the nine proposed in the PSP, Study #10 – Updated Literature Review of Downstream Fish Passage. In addition, in response to various comments by Relicensing Participants, NorthWestern modified several of the study plans in the PSP.

On May 10, 2021, FERC issued a Study Plan Determination on studies to be conducted (FERC 2021). The FERC Study Plan Determination directed NorthWestern to conduct seven of the studies proposed in the RSP.

1.2 Studies Conducted

The seven studies included in the 2021 FERC Study Plan Determination (FERC 2021) are described in **Table EX-1**. As described below, an eighth study, the Environmental Justice Study, was added in the 2nd year of studies.

Table EX-1: Thompson Falls Project Study Status

Study	Subject	Status
Operations Study	A study of flexible capacity scenarios and the potential impact of those operational scenarios on Project resources.	Study complete, Final Report included here.
Total Dissolved Gas (TDG)	Study of TDG in the Project area	Study complete, Final Report included here.
Hydraulic Conditions	Hydraulics study to characterize water velocities and depths between the Main Dam and the High Bridge	Study complete, Final Report included here.
Fish Behavior	Radio telemetry study of salmonids to evaluate movement paths/rates and behavior in response to hydraulic conditions, downstream of the Project	Study ongoing, Updated Study Report included here, data from 2023 study will be included in the Final License Application.
Visitor Use Survey	Survey of recreationists at recreation sites related to the Project	Study completed in 2021, Final Report available on project website and included in the Initial Study Report (ISR) available in FERC's eLibrary.
Cultural Resources	Update of the inventory of the Historic Architectural and Engineering Properties (H-A&E), development of a model to identify high probability areas for the occurrence of cultural resources, and field inventory of the Area of Potential Effect (APE)	Study complete, Final Report included here.
Updated Literature Review of Downstream Fish Passage	Literature review of downstream fish passage survival with respect to current Project configuration and operations.	Study completed in 2021, Final Report available on project website and included in the ISR available in FERC's eLibrary.
Environmental Justice	Evaluation of potential Project effects on environmental justice communities.	Study complete, Final Report included here.

Study reports on each of the seven 1st year studies were filed with FERC in an Initial Study Report (ISR) on April 28, 2022 (NorthWestern 2022). The reports are also available on the Project website https://northwesternenergy.com/TFallsRelicensing. The Visitor Use Survey and the Updated Literature Review of Downstream Fish Passage studies were 1-year studies, and thus the ISR contained the final reports for those two studies. The Operations Study was

originally proposed as a 1-year study, but in the ISR, NorthWestern proposed to continue that study for a 2nd year. The remainder of the studies were multi-year studies. The ISR contained the results of the data collected in the 1st year for all the multi-year studies.

NorthWestern held its ISR Meeting on May 5, 2022[1]; and filed its ISR Meeting Summary on June 9, 2022[2]. Section 5.15(c)(4) of FERC's regulations, 18 CFR § 5.15(c)(4), provides that any participant or FERC staff may file disagreements concerning the applicant's study report meeting summary, modifications to ongoing studies, or propose new studies within 30 days of the study report meeting summary being filed (i.e., by July 9, 2022). NorthWestern received comments from FERC staff, the USFS, the FWS, FWP, and the Confederated Salish and Kootenai Tribes, including proposed modifications to ongoing studies and proposed new studies.

On August 8, 2022, NorthWestern filed a response to the comments received on the ISR, proposing to conduct one additional study and modify one study[3]. NorthWestern proposed to conduct an Environmental Justice Study to provide information that FERC staff stated was needed to assess Project effects. In addition, NorthWestern proposed to modify the Fish Behavior Study to extend the study into a third study season. As described above, NorthWestern also proposed to continue the Operations Study into a 2nd year.

On September 1, 2022, FERC issued their determination on requests for study modifications (Modified Study Plan) (FERC 2022). Modifications to the Hydraulic Conditions Study, which were requested by agencies, were not approved. FERC notified NorthWestern that it approved the proposed Environmental Justice study and the proposed modifications to the Fish Behavior Study and Operations Study.

Study reports on each of the studies which were conducted in the 2nd year of studies are being filed with FERC in this Updated Study Report (USR). The USR is also available on the Project website:
https://northwesternenergy.com/TFallsRelicensing. All studies are now complete, except for the Fish Behavior Study, which is continuing in 2023. Final results of the Fish Behavior Study will be included in the Thompson Falls Project Final License Application, as approved in the Modified Study Plan.

[1] Presentations from the Initial Study Report meeting are available on the Project website https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/initial-study-report-meeting-combined-presentation.pdf

[2] The ISR meeting summary is available on the Project website, https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/initial-study-report-meeting-summary.pdf

[3] NorthWestern's response is available on the Project website https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/northwestern-s-response-to-comments-on-initial-study-report.pdf

1.3 Study Schedule

FERC's rules specify certain milestones in the implementation of a FERC Study Plan Determination, as shown in **Table EX-2**.

One requirement is that NorthWestern hold an Updated Study Report meeting within 15 days of filing the Updated Study Report. Relicensing Participants are invited to attend this meeting to hear presentations on the results of the 2nd year of studies. This meeting will be held Wednesday, May 24, 2023 at NorthWestern's Missoula, Montana Office, 1801 S. Russell Street, from 9:00 AM to 2:00 PM (Mountain Time). The meeting is also accessible remotely via Zoom, https://us06web.zoom.us/j/88577088020. Meeting ID: 885 7708 8020.

An additional USR meeting will be held on May 25, 2023 from 6:00 PM to 8:00 PM (Mountain Time) at the Sanders County Courthouse, 1111 W Main St, Thompson Falls, MT 59873. The Zoom option will be available for the evening meeting, https://us06web.zoom.us/j/89620436330. Meeting ID: 896 2043 6330.

Detailed meeting agendas are available at: https://northwesternenergy.com/TFallsRelicensing

Relicensing Participants, including agency personnel, FERC staff, local residents, and parties interested in the relicensing of Thompson Falls Hydroelectric Project, are invited to attend either or both meetings.

Table EX-2: Thompson Falls Project Study Plan Implementation Schedule
(NorthWestern activities in white, FERC activities in green, Relicensing Participant participation opportunities in orange).

Activity	Comment	Code of Federal Regulations (CFR Title 18)	Date
FERC Study Plan Determination[4]		§5.13	May 10, 2021
Initial Study Season		§5.15	Spring/Summer 2021
Initial Study Season Report	1 year after study plan determination	§5.15	April 28, 2022
Initial Study Report Meeting with Relicensing Participants	Within 15 days of study report	§5.15	May 5, 2022
Initial Study Meeting Summary	Within 15 days of study report meeting	§5.15	June 9, 2022
File Disagreements/Requests to Amend Study Plan	Relicensing Participants may file a disagreement concerning the applicant's meeting summary. This filing must also include any	§5.15(c)(4)	July 9, 2022

[4] Agencies and Tribes with mandatory conditioning authority may request the use of a formal dispute resolution process regarding FERC's Study Plan Determination. No requests for formal dispute resolution were filed.

Activity	Comment	Code of Federal Regulations (CFR Title 18)	Date
	modifications to ongoing studies or new studies proposed by the FERC staff or other participant.		
File Responses to Disagreements/Amendment Requests	Responses to any filings requesting modifications to ongoing studies or new studies.	§5.15(c)(5)	Aug 8, 2022
File Responses to Disagreements/Amendment Requests[5]	Responses to any filings requesting modifications to ongoing studies or new studies. None were filed.	§5.15(c)(6)	Aug 8, 2022
FERC Determination on Disagreements/Amendment Requests	FERC Director resolves the disagreement and amends the approved study plan as appropriate	§5.15(c)(7)	Sept 1, 2022
Second Study Season		§5.15	Spring/Summer 2022
Updated Study Report (this report)	2 years after study plan determination	§5.15	May 10, 2023
Updated Study Report Meetings with Relicensing Participants	Within 15 days of study report	§5.15	May 24 and 25, 2023
Updated Study Meeting Summary	Within 15 days of Study Report meeting	§5.15	June 9, 2023
File Disagreements/Requests to Amend Study Plan	Within 30 days of study report meeting summary	§5.15(f)	July 9, 2023
File Responses to Disagreements/Amendment Requests	Within 60 days of study report meeting summary	§5.15(f)	August 8, 2023
Issue Director's Determination on Disagreements/Amendments	Within 90 days of study report meeting summary	§5.15(f)	September 7, 2023
Draft License Application		§5.16	August 3, 2023
Comment period on Draft License Application	90 days after Draft License Application	§5.16	Nov 1, 2023
Filing of Final License Application	No later than 2 years prior to license expiration	§5.17	Dec 31, 2023

NorthWestern will file an Updated Study Report meeting summary by no later than June 9, 2023.

In accordance with 18 CFR § 5.15(d), Relicensing Participants can file a proposal to modify an ongoing study. The criteria for modification of a study include, as appropriate to the facts of the case, a showing of good cause why the proposal should be approved, as well as a demonstration that:

[5] Relicensing Participants may also file reply comments

(1) Approved studies were not conducted as provided for in the approved study plan; or

(2) The study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.

In addition, Relicensing Participants can file new study requests as part of their comments on the USR. However, FERC's regulations under 18 CFR § 5.15(f) require any request for a new study to be accompanied by a demonstration that "extraordinary circumstances warrant[] approval" of the proposed new study. In addition, under 18 CFR § 5.15(f), any new study request must satisfy the study criteria at 18 CFR § 5.9(b).

In accordance with 18 CFR § 5.15(f), Commission staff's decision on any request for a modified or new study is expected by September 7, 2023.

Concurrent with the USR process, NorthWestern is in the process of preparing a Draft License Application for review and comment by all Relicensing Participants, in accordance with 18 CFR § 5.16 and the above process schedule. The Draft License Application will be filed by August 3, 2023.

NorthWestern recognizes that FERC's ILP regulations at 18 CFR § 5.16 require only that an applicant prepare a Preliminary Licensing Proposal. The ILP regulations at 18 CFR § 5.16(c), however, allow the applicant to "elect to file a draft application which includes the contents of a license application required by § 5.18 instead of the Preliminary Licensing Proposal," so long as the applicant notifies the Commission and Relicensing Participants at the USR stage of its intent to file a Draft License Application. Accordingly, NorthWestern, in accordance with the ILP regulations at 18 CFR § 5.16(c), hereby notifies the Commission and Relicensing Participants of its intent to file a Draft License Application in lieu of a Preliminary Licensing Proposal.

A study specific schedule is in **Table EX-3**.

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Table EX-3: Detailed Study Implementation Schedule

Activity	1-Operations Study	2-Total Dissolved Gas	3-Hydraulic Conditions	4-Fish Behavior	5-Visitor Use Survey	6-Cultural Resources Inventory, Evaluation, and Examination of Potential Effects	7-Updated Literature Review of Downstream Fish Passage	8- Environmental Justice[6]
Preparatory Work	Baseline Shoreline Condition Assessment, Fall 2020	Set up of monitoring equipment, Spring 2021	None	Planning, acquiring equipment, testing equipment and procedures Jan–May 2021	Finalize survey schedule, survey technician training, April–May 2021	None	None	None
FERC Study Plan Determination on May 10, 2021								
First Study Season	Test and monitor operational scenarios, Jul–Sep 2021	High flow TDG monitoring, May–Jun 2021	Bathymetry and Phase 1, 2D Modeling Aug–Nov 2021	Radio telemetry, Jun–Oct 2021	Conduct survey, May–Sep 2021	Inventory H-A&E properties. Development of archeological model, Jun–Sep 2021	Prepare literature review	None
Interim Reporting	None	None	Phase 1 Modeling Report and Phase 2 Modeling Plan Feb 15, 2022	None	None	Archeological model report filed with FERC January 26, 2022[7]	None	None
Initial (or Final) Study Report, 1 year after FERC Study Plan Determination	Results of operations study	Results of 2021 monitoring	Phase 1 modeling results and scenarios for Phase 2 modeling	Results of radio tracking to-date	Final Report - Results of data collected in 2021, and comparison to previous surveys	Results of re-inventory of H-A&E properties	Final Report - Addendum to 2007 Literature Review	None
Study Report Meeting on May 5, 2022								
Study Report Meeting Summary, filed by May 20, 2022[8]								
FERC Determination on Disagreements/Amendment Requests September 1, 2022								
Second Study Season	Monitor and evaluate operations May–Oct 2022	TDG monitoring during high flows, May–Jun 2022	Phase 2 modeling Jun–Dec 2022	Radio telemetry, Mar–Oct 2022	None	Inventory phase of Prehistoric and Historic Archaeological Properties	None	Assess potential impacts to environmental justice communities

[6] The Environmental Justice Study was proposed by FERC staff after the completion of the 1st year of study. Therefore, this study was conducted in the 2nd year of study.

[7] The Interim Study Report, Cultural Resource Predictive Model contains sensitive information related to cultural, archeological, and historic resources. Pursuant to 18 CFR § 388.112(b), NorthWestern requested FERC to designate this information as Privileged material, and to maintain this information as non-public.

[8] https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/initial-study-report-meeting-summary.pdf

Activity	1-Operations Study	2-Total Dissolved Gas	3-Hydraulic Conditions	4-Fish Behavior	5-Visitor Use Survey	6-Cultural Resources Inventory, Evaluation, and Examination of Potential Effects	7-Updated Literature Review of Downstream Fish Passage	8- Environmental Justice[6]
						(PAP and HAP) identification		
Updated Study Report (USR), 2 years after FERC Study Plan Determination (this report)	Final Report - Results of operations evaluation	Final Report - Results of TDG monitoring	Final Report - Results of Phases 1 and 2 modeling	Updated Study Report - Radio telemetry	None	Final Report - Results of PAP and HAP inventory	None	Final Report – Results of environmental justice study
USR, due by May 10, 2023 (this report)								
USR Meeting, May 24 and 25, 2023								
USR Meeting Summary, due by June 9, 2023								

2. Summary of Second Season Operations Study

The Thompson Falls Project is operated to provide baseload and flexible generation within the authorized reservoir elevation and minimum Project discharge (flow) requirements of the FERC License. During flexible generation operations, NorthWestern may use the top 4 feet of the reservoir while maintaining minimum flows.

NorthWestern, in its relicensing application, will seek to continue to provide baseload generation and flexible capacity needs during the new license term using 2.5 feet of the reservoir. During normal operations, the reservoir would be maintained between 2396.5 and 2394.0 feet. While an authorized use of 2.5 feet is substantially less than the current authorized use of 4 feet, it will provide NorthWestern with important operational flexibility that is needed for grid stability and reliability.

During the 2021 study season, NorthWestern conducted an Operations Study of the Project, including evaluating generation changes at multiple reservoir elevations and durations, allowing the resulting reservoir fluctuations to be observed and studied for potential impacts on Project resources. Operational scenarios for the Operations Study were within the proposed 2.5 feet of flexible reservoir elevation while maintaining minimum flows.

The goal of the 2021 Operations Study was to understand the effects of proposed Project operations, and to evaluate possible impacts on Project resources. The study was designed to test the extremes of proposed operational limits, including using the maximum generation resulting in the rapid reduction in the reservoir elevation to the maximum drawdown of 2.5 feet. It was important to identify and understand the limitations of the facility and potential impacts on the Project resources. The results of the 2021 Operations Study were reported in detail in the ISR, available on FERC's eLibrary system as well as on NorthWestern's Project relicensing website: https://northwesternenergy.com/TFallsRelicensing

NorthWestern continued the Operations Study into the second study season, to assess the real-time effects of flexible operations. The focus of the second season to the Operations Study was those resource areas where impacts were identified in the first study season and where further monitoring would refine the extent of impacts, particularly impacts on Project resources during transmission grid regulating operations.

The objectives of continuing the study into a second season were to better understand the current required frequency and magnitude of increases and decreases of generation, and to assess shoreline stability, riparian habitats, fisheries, recreation and aesthetics, and wetlands under real-world application of grid stabilizing operations.

2.1 Conclusions

2.1.1 *Operations*

The study found that the Thompson Falls Project is well suited to provide flexible capacity in the form of generation increases and decreases to support grid stability and meet grid reliability requirements. Provision of this support is limited by available reservoir volume, river baseflows, and plant configuration. The current plant controls and automation programs successfully calculated available capacity and duration with all needed inputs and the Project performed well in all aspects of providing flexible capacity while maintaining reservoir elevation and minimum flow requirements.

2.1.2 *Shoreline Stability*

The study found that the amount, type and cause of erosion varies greatly on the reservoir shoreline depending on slope, soils, vegetation, land use, and location within the reservoir, as well as other factors. Fluctuating water levels due to operations do not appear to increase shoreline erosion or instability. Other factors such as spring runoff, uprooted trees from windstorms, boat wakes, and wildlife/human paths appear to be the cause of shoreline erosion and instability.

2.1.3 *Riparian Habitats*

Fluctuating water levels due to operations appear to have decreased submergent aquatic vegetation in the 0- to 18-inch depth water depth zone.

2.1.4 *Fisheries*

No stranding was observed during the second study season; either as part of surveyed transects or during other times of general observation. Stranding within the bounds of the 2022 study elevations and rates of elevation change does not appear to be an issue in Thompson Falls Reservoir.

All components of the upstream fish passage facility worked as designed during the March through October timeframe. Annual fish captures were within the mean range of previous years, and 2022 reservoir operations did not appear to have an impact on operations of the upstream fish passage facility nor on catch rates.

2.1.5 *Recreation and Aesthetics*

Thompson Falls Reservoir has public docks at Wild Goose Landing Park and Cherry Creek Boat Launch. There are two docks at Wild Goose Landing, a floating dock and a stationary dock. The dock at Cherry Creek Boat Launch is a floating dock.

During the 2022 recreation season, all these public docks remained usable during flexible capacity operations. As demonstrated during the 2021 operations study, public docks remain usable at pool elevations down to 2.5 feet below full pool, the lowest elevation that NorthWestern seeks to retain for flexible operations purposes under the new license. During periods that the reservoir level is reduced to 2.5 feet below full pool (observed in 2021 only), the water level was noticeably low at the stationary dock at Wild Goose Landing, which makes boat access to and from the stationary dock more challenging, but the floating dock remained watered and provided access. The public floating dock at Cherry Creek became pitched at the lowest elevations due to grounding of near-shore floats, but was still usable at this elevation.

With regard to privately owned docks, for the majority of the 2022 recreation season, flexible capacity operations fluctuated the reservoir elevation 1 foot or less. At those elevations, access to moored boats from private, stationary docks was only slightly impacted and no other impacts occurred. At elevations of 1.8 ft below full pool, slight or moderate recreational access impacts to private, stationary docks were observed with the greatest impact being to access to boats and the waterway from stationary docks. However, since stationary docks account for only 20 percent of all docks on Thompson Falls Reservoir, less than one-quarter of private recreational access to and from all docks combined were impacted by reservoir fluctuations resulting from flexible capacity operations in 2022.

Impacts to aesthetic qualities (visual and olfactory) from fluctuating water levels associated with flexible capacity operations were minimal in 2022. While some mud and rock were exposed along the shoreline, there was no offensive odor of decaying organic matter.

2.1.6 *Wetlands*

The results of this Operations Study show that Project operations have the potential to affect some wetland habitats along the reservoir if they have a strong surface water connection to the reservoir. The environmental effects on these wetlands are generally temporary in nature, and include loss of fish habitat, reduction of shallow water habitat for amphibians, birds, and other wildlife, and the potential reduction of submergent vegetation at some sites.

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3. Summary of Total Dissolved Gas Study

Water quality standards developed by the DEQ (Circular DEQ-7) (DEQ 2019) set a standard of 110 percent of saturation for TDG. This water quality standard was developed to protect fish from high levels of TDG, which may cause gas bubble trauma (GBT). GBT can cause injury and, in severe cases, death to fish.

TDG data were collected throughout the spring runoff season to capture the variability of TDG entrainment in relation to flow rate in the Clark Fork River. During this time, operators of the Project tested various configurations of spill through the Main Dam using different combinations of the four radial gates. In 2022, Clark Fork River flows were above average, and peaked at a flow of 85,000 cubic feet per second (cfs) at the U.S. Geological Survey (USGS) Clark Fork River at Plains stream gage (12389000). The median peak streamflow at the Plains gaging station is 74,750 cfs for the period of record (1912-2021) (USGS 2022). The high flows provided an opportunity to test radial gate configurations at flows in excess of 80,000 cfs.

3.1 Conclusions

The study found that operating non-adjacent radial gates in combination with each other will generally reduce the amount of TDG entrained in the river downstream under most river conditions. However, operation in this manner may not always be possible due to the need to provide debris passage. The radial gates benefit TDG by limiting the need for emergency stanchion removal.

A general range of the percent TDG entrained at a particular river flow can be estimated based on the results of this study and previous years of data collection, but other outside environmental factors, such as incoming upstream TDG saturation and the water surface elevation below the Main Channel Dam, may affect the exact value of percent TDG entrainment from year to year at any given flow and radial gate operating combination.

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4. Summary of Hydraulic Conditions Study

The Hydraulic Conditions Study involved development of a three dimensional (3D) Model which, together with the two-dimensional (2D) Model developed and reported in the ISR, was used to assess the velocity field downstream of the fish passage facility to understand if the flow field created by discharge from the fish passage facility provides a sufficient behavioral cue (attraction flow) to Bull Trout and other species, and whether velocities are low enough as to not fatigue fish attempting to approach the fish passage facility entrance.

4.1 Conclusions

4.1.1 *Phase 1: 2D Model*

The Phase 1 study results provide an estimate of the hydraulic conditions of the Main Dam and Fish Passage Facility including flow depths, velocities, and patterns in the downstream channel for flow rates ranging from 200 cfs up to about 37,000 cfs. Over this wide range of flow rates, the hydraulic characteristics of the flow downstream of the Main Dam vary considerably but present a similar pattern.

In the area immediately downstream of the fish passage facility entrance, two different flow patterns were observed in the four scenarios evaluated. At higher flows, the outlet of the fish passage facility and high velocity jet (HVJ) are submerged, resulting in these structures having minimal influence on the surrounding flow velocities. This is also evident based on the flow path streamlines, which show most of the flow path streamlines concentrated over the Main Dam gates and through the falls area. These modeling results indicate that at higher flows the attraction flow at the fish passage facility may be insufficient to provide efficient fish passage.

During lower flows, the HVJ is not submerged and the discharges from the upstream fish passage entrance produce a significant portion of the flow in this area. Therefore, at these lower flow rates, most of the flow path streamlines are concentrated near the entrance of the fish passage facility. These results indicate improved fish attraction to the fish passage facility entrance.

Away from the fish passage entrance, the pools and channel immediately downstream of the Main Dam reduce the velocities and increase flow depths prior to the flow entering the highly turbulent falls area where velocities substantially increase. Velocities generally range from a few feet per second up to 27 fps over the falls area. Even at the lowest flow modeled, 200 cfs, the velocity through the falls is 17 fps, indicating that the falls is a potential obstacle to fish passage at all modeled flows. The falls is a natural feature of the Clark Fork River.

Downstream of the falls area, the flow enters the main river channel, where the sharp right bend in the channel at the Dollar Hole has the greatest depths in the modeled reach. In this

area, velocities are reduced as the flow turns right toward the High Bridge. Even at the highest flow modeled, 37,000 cfs, the depth averaged velocity in the area of the Dollar Hole was as low as 6 fps.

As the flow approaches the High Bridge, depths are reduced slightly, increasing the velocity just before entering the narrow and deep section under the High Bridge. Velocities and depths tend to increase again due to the narrowing of the channel before discharging downstream of the bridge. At the highest flows modeled, depth averaged velocities in the area downstream of the High Bridge were as high as 20 fps. At the lower modeled flows, the area downstream of the High Bridge has moderate velocity and is unlikely to be an obstacle to fish passage. The High Bridge area is also a natural feature of the Clark Fork River.

4.1.2 *Phase 2: 3D Model*

During Phase 2 of the study, the full model domain was analyzed using 3D modeling to better evaluate the vertical velocity distributions of flow downstream of the Main Dam. Phase 2 evaluated flows of 37,000 and 2,000 cfs. These flow rates bracket the range of possible flow conditions that are likely to occur during operation of the Upstream Fish Passage Facility.

In general, the 3D cross sections show the greatest velocities in the center of the river channel, with lower velocities along margins of the river channel. These areas along the margins provide more suitable velocities for upstream fish passage.

Under both model scenarios, velocities at the fish passage entrance were below 7 fps, well within the swimming abilities of the native and salmonid fish species of interest. Fish that successfully navigate upstream of the falls can access the fish passage facility without encountering further velocity barriers.

However, as described above, there may be insufficient attraction flow for fish to locate the entrance to the fish passage facility at high flows.

The 3D model results showed a large percentage of the falls transects exceed most fish swimming abilities under both flow scenarios modeled. At the lower flow modeled (2,000 cfs), 24 percent of the cross section of the natural falls was below the maximum burst speed for fish. However, fish are collected at the fish passage facility routinely when flows are 2,000 cfs or higher (NorthWestern 2019), so at least some fish are finding the areas along the margins of the channel or other pathways with suitable velocities for fish passage. In addition, the model calculations may not capture all the details of the underlying rocky terrain surface, particularly overhangs or undercuts that do not show up in a bathymetric survey. Fish swimming along the bottom of the river channel may successfully navigate upstream by taking advantage of velocity breaks and barriers that are not apparent in the modeling.

The high flow scenario also revealed potential velocity obstacles for fish at the High Bridge, with 89 percent of the cross section having velocities in excess of the maximum burst speed.

The potential fish passage obstacle at the High Bridge does not appear to be present in the low flow scenario, when the entire cross section is below the maximum prolonged swimming speed.

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5. Summary of Fish Behavior Study

The goal of this study was to evaluate upstream fish movement *via* radio telemetry[9] through the Project's zone of influence[10] which is defined by the Zone of Passage (ZOP) concept (FWS 2017). The ZOP concept defines discrete areas for analysis of the pathway fish use to move through the influence of the Project. These areas include far field, near field, entry, internal fish passage facility, exit, and upstream. The ZOP concept provides a method to measure passage effectiveness and identify attributing causes and influences (Project and non-project related) to upstream passage effectiveness. This study focused on fish movement in the far field, near field, and fish passage facility entrance.

5.1 Conclusions

The study methodology was effective in generating information on fish movement in the Project area. All but one radio tagged trout released downstream were later detected in the ZOP.

Both Brown Trout and Rainbow Trout demonstrated an ability to travel upstream rapidly, reaching the far field from the release location in as quickly as 1 hour, and finding the fish passage facility entrance from the near field in as quickly as an hour.

The two areas where Brown and Rainbow trout congregated the most were near the mouth of Prospect Creek and along the right side of the Main Dam, near the upstream fish passage facility. Most fish move up the main section of the channel did not concentrate near the Original Powerhouse or the New Powerhouse, although some fish were detected for short periods of time in these locations before moving further upstream.

Of the 53 radio tagged trout detected entering the ZOP in 2022, 72 percent were detected in the near field. Of the 38 fish that were detected in the near field, just over half were detected entering the fish passage facility entrance. Therefore, the proportion of fish that were detected in the far field and located the fish passage entrance was approximately 40 percent.

The data collected to date indicate that during spill at the Main Dam, the detection of fish in the ZOP was limited to a few individuals. Rainbow Trout were essentially absent from the ZOP once spill started at the Main Dam, and for the remainder of the season. Brown Trout that were present in the ZOP during the spring appeared to leave the ZOP during spill, and then returned in the fall.

[9] Radio telemetry uses individually coded tags which transmit radio waves which can be detected with receivers mounted on shore.

[10] Zone of Influence means an area within which there are positive or negative effects as a result of the Project.

The data collected during this study supports that the fish passage facility was correctly sited as the telemetry shows that fish enter the near field preferentially select the right bank. The left side of the near field is generally more turbulent and violent at various spill regimes at the Main Dam. The results indicate that a fish passage facility located at the powerhouses or Dry Channel Dam would be less effective than the current passage facility location, as only small numbers of fish were detected in those areas, and only for a short duration, before making forays further upstream near the mouth of Prospect Creek, to the Main Dam, or to the fish passage facility entrance.

River temperature may be a contributing factor limiting salmonid movement during July and August when Clark Fork River temperatures tend to peak. Summer water temperature is consistent throughout the Project (upper river, in Thompson Falls Reservoir, and in the river downstream of the Project), except for areas at the mouth of cooler tributaries. During the hot summer season, few radio tagged salmonids were generally recorded at the fish passage facility. Radio-tagged fish were not present in the near field, and relatively few were detected in the far field, during the period of high-water temperatures.

Prospect Creek provides a cooler water source and creates an area more tolerable for salmonids in the summer. Although thermal stratification was observed at the three deep water locations downstream of the Main Dam (Prospect Hole, High Bridge, and Dollar Hole), thermal conditions are likely more preferrable for salmonids at the Prospect Hole compared to the other two sites. This may explain observations of fish staying near the confluence of Prospect Creek during the summer compared to other areas in the ZOP.

5.2 Proposed Third Study Season

The fish collection methods implemented in 2021 and 2022 will continue in 2023 with emphasis on Rainbow Trout. NorthWestern radio tagged 30 Rainbow Trout during the spring 2023. These fish will be monitored until the end of July 2023. Methods of fish collection and data analysis implemented in 2021 and 2022 will continue for the 2023 season.

Manual tracking will continue to occur throughout the second study season, ending July 31 with frequency dependent on fish presence (as determined from data from the fixed receivers) in the ZOP. Manual tracking will focus on spring movement prior to and during peak flows as well as determining if fish tagged in 2023 show similar movement patterns as in 2022.

6. Summary of Cultural Resources Study

The second season cultural resource inventory was implemented to determine the locations, types, and significance of precontact and historic cultural properties within the APE. Based on a Predictive Model completed in the first study season and reported in the ISR, the inventory involved pedestrian and waterborne transects in areas with a high probability for cultural resources. Fieldwork included transect spacing, GPS mapping, feature and artifact photography, required site record form preparation, and cultural resource documentation and evaluation. The information collected in the second season study combined with the first season study will be the basis for the Historic Properties Management Plan that will be prepared.

6.1 Conclusions

The study revealed that six cultural resources lay within, or partially within, the APE. Those include portions of the Thompson Falls Hydroelectric Dam Historic District (24SA0165), Northern Pacific Railroad (24SA0199), Plains-Thompson Falls pre-1924 Roadbed (24SA0352), Yellowstone Pipeline (24SA0674), Thompson Falls to Burke A & B Transmission Lines (24SA0719), and Thompson Falls-Kerr "A" Transmission Line (24SA0756).

Two of those properties, the Thompson Falls Hydroelectric Dam Historic District and Northern Pacific Railroad are eligible for, or listed in, the National Register. Research conducted as part of Task 1 of the Cultural Resources Study Plan establish a baseline against which future project impacts within the Thompson Falls Hydroelectric Dam Historic District can be evaluated and will support informed determinations of Project effect. The new information about contributing and non-contributing elements, and about the district's historic significance and resource integrity will aid in development of a Historic Properties Management Plan under the new License and in assessing future Project effects.

Operation of the Project poses no effect to the elements of integrity and significance that contribute to the National Register eligibility of the Northern Pacific Railroad. NorthWestern's activities will not result in an alteration to the existing grade or the bridge across the Thompson River.

The remaining four cultural resources (24SA0352, 24SA0674, 24SA0719, and 24SA0756) within the APE have been recommended as ineligible for National Register listing. Those properties lack historic integrity and/or significance, therefore potential impacts to the properties need not be considered during operation of the Project.

Finally, the cultural resource inventory revealed that five previously recorded cultural resources reported to be within or abutting the APE are, in fact, outside the APE boundary so

are not considered further. Those include 24SA0130 (Salish House), 24SA0131 (Historic Resources of Thompson Falls), 24SA0291 (precontact/historic artifact scatter), 24SA0593 (railroad Chinese camp), and 24SA0690 (livestock corral and storage area).

7. Summary of Environmental Justice Study

Statistics from the U.S. Census Bureau's American Community Survey include 5-year estimates for racial, ethnic, and poverty populations for each state, county, and census block group within the study area (Census 2022). Those statistics were analyzed to determine if an Environmental Justice Community (EJC) exists within the study area by applying the methods included in the guidance from the EPA (EPA 2016).

7.1 Conclusions

There are two EJCs within the study area based on the presence of low-income populations. There are significant benefits from the Project, including serving as a low-cost renewable energy source, and providing economic and recreation benefits to the communities. Outreach to the Thompson Falls community, including the EJCs, has been conducted and is ongoing. Based, in part, on public input, NorthWestern opted not to adopt the 4-foot fluctuation that is allowed under the current license, and instead proposes to use only the top 2.5 feet of the reservoir. As part of its Final License Application, moreover, NorthWestern will propose to continue to provide recreational opportunities that benefit the EJCs and all members of the public. Based on the above, there are no disproportionately adverse Project impacts on the identified EJCs.

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