Thompson Falls Hydroelectric Project
FERC Project No. 1869

NorthWestern Energy
2022 Thompson Falls Relicensing Initial Study Report Executive Summary

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List of Abbreviations and Acronyms

2D	two-dimensional
3D	three-dimensional
AIS	aquatic invasive species
APE	Area of Potential Effect
ARM	Administrative Rules of Montana
BO	Biological Opinion
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
CS&KT	Confederated Salish and Kootenai Tribes
DEM	digital elevation model
DEQ	Montana Department of Environmental Quality
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
GEI	GEI Consultants, Inc.
H-A&E	Historic Architectural and Engineering Properties
HAP	Historic Archaeological Properties
Historic District	Thompson Falls Hydroelectric Dam Historic District
ILP	FERC's Integrated Licensing Process
Licensee	NorthWestern Energy
LiDAR	Light Detecting and Ranging
Literature Review	Literature Review of Downstream Fish Passage Issues at Thompson Falls Hydroelectric Project (GEI, 2007)
mm	millimeters
MW	megawatt
National Register	National Register of Historic Places
NorthWestern	NorthWestern Energy
NPS	National Park Service
PAD	Pre-Application Document
PAP	Prehistoric and Historic Archaeological Properties

PIT	passive integrated transponder
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
RTK-GPS	Real-Time Kinematic Global Positioning System
Scientific Panel	Thompson Falls Scientific Review Panel
SHPO	Montana State Historic Preservation Office
TDG	total dissolved gas
Thompson Falls Project	Thompson Falls Hydroelectric Project
TIN	Triangular Irregular Network
U.S.	United States
USFS	U.S. Forest Service
USR	Updated Study Report
ZOP	zone of passage

1.0 Introduction

1.1 Project Background

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. The Project has been operating continuously since 1915.

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. 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 (MW).

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[1] 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] Relicensing Participants include local, state, and federal governmental agencies, Native American Tribes, local landowners, non-governmental organizations, and other interested parties.

1.2 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 is 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 study plan meeting on January 6, 2021, which was open to any interested party. 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, sometimes multiple times, with representatives of FWP, the U. S. Fish and Wildlife Service (FWS), USFS, and Montana Department of Environmental Quality (DEQ), to discuss the PSP, attempt to resolve any differences over study requests, and inform NorthWestern's development of the Revised Study Plan (RSP).

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. 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. The FERC Study Plan Determination directed NorthWestern to conduct seven of the studies proposed in the RSP. The Study Plan Determination did not require NorthWestern to conduct the Water Quality Study, Downstream Transport of Bull Trout Study, Westslope Cutthroat Genetics Study, study of Distribution and Status of Westslope Cutthroat Trout, or the study of Heavy Metals and Organic Compounds in Thompson Falls Reservoir.

1.3 Studies Conducted

The seven studies included in the FERC Study Plan Determination were:

1. Operations Study: A study of operational scenarios to provide flexible capacity and the potential impact of those operational scenarios on Project resources in the Project reservoir and below the powerhouses
2. Total Dissolved Gas (TDG): A study of TDG in the Project reservoir, below the Main Channel Dam, and at the Birdland Bay Bridge
3. Hydraulic Conditions: A hydraulics study to characterize a depth-averaged velocity field and water depths between the Main Channel Dam and the High Bridge (below the Main Channel Dam)
4. Fish Behavior: Radio telemetry study of salmonids to evaluate movement paths/rates and behavior in response to hydraulic conditions, from downstream of the powerhouses to the Main Channel Dam
5. Visitor Use Survey: A study surveying recreationists at the 10 recreation sites related to the Project on or near the reservoir and the Clark Fork River below the dams
6. Cultural Resources: A study to update the inventory of the Historic Architectural and Engineering Properties (H-A&E) and to identify areas where there is a high probability for the occurrence of prehistoric or historic archaeological properties within the proposed Area of Potential Effect[2] (APE)
7. Updated Literature Review of Downstream Fish Passage: A literature review of information in the scientific literature published since 2007, regarding downstream passage survival of various size classes of fish, with respect to current Project configuration and operations.

Study reports on each of the seven studies are presented in separate reports, being filed with FERC simultaneously with this Executive Summary.

1.4 Study Schedule

FERC's rules specify certain milestones in the implementation of a FERC Study Plan Determination, as shown in **Table EX-1**.

One requirement is that NorthWestern hold an Initial Study Report meeting within 15 days of filing the Initial Study Report. Relicensing Participants are invited to attend this meeting to discuss the study results, and any proposals to modify the FERC-approved Study Plan for the second study season. This meeting will be held Thursday, May 5, 2022 at NorthWestern's

[2] The Interim Study Report to identify areas where there is a high probability for the occurrence of prehistoric or historic archaeological properties within the proposed Area of Potential Effect was filed with FERC on January 26, 2022. The updated inventory of the H-A&E is included in this Initial Study Report.

Missoula, Montana Office, 1801 S. Russell Street, from 9:00 am to 2:00 pm (Mountain Time). A virtual option of the meeting via Zoom will be available. A detailed meeting agenda and Zoom link are available at: https://www.northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson-falls-relicensing/thompson-falls-relicensing-initial-study-report-meeting-agenda.pdf?sfvrsn=4510a52e_6

Relicensing Participants, including agency personnel, FERC staff, and parties interested in the relicensing of Thompson Falls Hydroelectric Project, were invited to attend.

Table EX-1: Thompson Falls Project Anticipated Study Plan Implementation Schedule
(NorthWestern activities in white, FERC activities in green, Relicensing Participant participation opportunities in orange).

Activity	Comment	Date	Timeline
FERC Issues Study Plan Determination	If no disputes are filed within 20 days of Study Plan Determination, the Study Plan Determination is considered final.	5/10/2021	Within 30 days from Filing Revised PSP
First Study Season	Studies required by the Study Plan Determination.	5/10/2021–5/10/2022	
Initial Study Report (this report)	This report describes progress in implementing the FERC-approved Study Plan. This includes a report on data collected, and any variance from the study plan or schedule. The report also includes any modifications to ongoing studies or new studies proposed by the applicant.	4/28/2022[3]	No later than 1 year from Study Plan Determination
Initial Study Report Meeting	Meeting with Relicensing Participants and FERC to discuss the study results and any proposals to modify the study plan.	5/5/2022	Within 15 days from Initial Study Report
Initial Study Report Meeting Summary	NorthWestern prepares and files a meeting summary, including any modifications to ongoing studies or new studies proposed by the applicant.	5/20/2022	Within 15 days from Study Meeting
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 modifications to ongoing studies or new studies proposed by the FERC staff or other participant.	6/20/2022	Within 30 days of study report summary

[3] NorthWestern intends to file this Initial Study Report earlier than required under the ILP regulations and the schedule outlined in FERC's Scoping Document 2.

Activity	Comment	Date	Timeline
File Responses to Disagreements/Amendment Requests	Responses to any filings requesting modifications to ongoing studies or new studies.	7/20/2022	Within 30 days of request to amend study plan
File Responses to Disagreements/Amendment Requests[4]	Responses to any filings requesting modifications to ongoing studies or new studies.	7/20/2022	Within 30 days of request to amend study plan
FERC Determination on Disagreements/Amendment Requests	FERC Director will resolve the disagreement and amend the approved study plan as appropriate	8/20/2022	Within 30 days of response due date
Second Study Season	For those studies in the Study Plan Determination that require two study seasons.	5/10/2022–5/10/2023	2 years from Initial Study Determination
Updated Study Report Due	NorthWestern files an updated study report describing overall progress in implementing the study plan, data collected, including an explanation of any variance from the study plan and schedule. The report must also include any modifications to ongoing studies or new studies proposed by the applicant.	5/10/2023	2 years from Initial Study Determination
Updated Study Report Meeting	Same purpose as Initial Study Report Meeting	5/25/2023	Within 15 days from Updated Study Report
Updated Study Report Meeting Summary	Same purpose as Initial Study Report Meeting Summary[5]	6/9/2023	Within 15 days from Study Meeting
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 modifications to ongoing studies or new studies proposed by the FERC staff or other participant.	7/9/2023	Within 30 days of study report summary
File Responses to Disagreements/Amendment Requests	Responses to any filings requesting modifications to ongoing studies or new studies.	8/8/2023	Within 30 days of request to amend study plan

[4] Relicensing Participants may also file reply comments

[5] The review, comment, and disagreement resolution provisions for the Initial Study Report apply to the Updated Study Report.

Activity	Comment	Date	Timeline
File Responses to Disagreements/Amendment Requests[6]	Responses to any filings requesting modifications to ongoing studies or new studies.	8/8/2023	Within 30 days of request to amend study plan
FERC Determination on Disagreements/Amendment Requests	FERC Director will resolve the disagreement and amend the approved study plan as appropriate	9/7/2023	Within 30 days of response due date
File Preliminary Licensing Proposal (PLP) (or Draft License Application [DLA])	Will include draft environmental analysis by resource area	8/3/2023	
File Comments on PLP (or DLA)	Relicensing Participants may file comments on PLP (or DLA)	11/1/2023	Within 90 days of filing of PLP or DLA
File Final License Application (FLA)	NorthWestern will final a FLA in accordance with 18 CFR § 5.18	12/31/2023	No later than 24 months before the existing license expires (12/31/2025)
Issue Public Notice of FLA Filing	Applicant must publish notice of the filing of the application	1/14/2024	No later than 14 days after the FLA filing date

NorthWestern will file an Initial Study Report meeting summary by no later than May 20, 2022. 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:

(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 accordance with 18 CFR § 5.15(e), any proposal for new information gathering or studies must be accompanied by a showing of good cause why the proposal should be approved, and must include, as appropriate to the facts of the case, a statement explaining:

(1) Any material changes in the law or regulations applicable to the information request

(2) Why the goals and objectives of any approved study could not be met with the approved study methodology

(3) Why the request was not made earlier

[6] Relicensing Participants may also file reply comments

(4) Significant changes in the project proposal or that significant new information material to the study objectives has become available

(5) Why the new study request satisfies the study criteria in 18 CFR § 5.9(b)

A study specific schedule is in **Table EX-2**.

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Table EX-2: 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
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
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
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
Initial (or Final) Study Report, 1 year after FERC Study Plan Determination (This report)	Results of operations study	Results of 2021 monitoring	Phase 1 modeling results and scenarios for Phase 2 modeling	Results of radio tracking to-date	Results of data collected in 2021, and comparison to previous surveys	Results of re-inventory of H-A&E properties	Addendum to 2007 Literature Review

[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.

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
Study Report Meeting on May 5, 2022							
Study Report Meeting Summary, filed by May 20, 2022							
Second Study Season	Monitor and evaluate operations May – October 2022	TDG monitoring during high flows, May–Jun 2022	Phase 2 modeling Jun–Dec 2022	Radio telemetry, Mar–Oct 2022	None anticipated	Inventory phase of Prehistoric and Historic Archaeological Properties (PAP and HAP) identification	None anticipated
Updated Study Report (USR), 2 years after FERC Study Plan Determination	Results of operations evaluation	Results of TDG monitoring	Results of Phases 1 and 2 modeling	Final report on radio telemetry and literature review of fish swimming capabilities.	None anticipated	Results of PAP and HAP inventory	None anticipated
USR, due by May 10, 2023							
USR Meeting, due by May 25, 2023							
USR Meeting Summary, due by June 9, 2023							

2.0 Summary of Operations Study

2.1 Introduction

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

In October 2019, NorthWestern conducted an operations test (October 2019 test) to assess the potential impacts of operating the Project within the 4-foot range authorized by the License. Based on the results of the October 2019 test, NorthWestern concluded that drafting Thompson Falls Reservoir the full 4 feet as authorized by the current License on a regular and frequent basis would have an unacceptable level of impact. The first study season was designed to simulate operational scenarios using the Project's generational flexible capacity utilizing the top 2.5 feet of the Thompson Falls Reservoir. Objectives included evaluating a broad spectrum of flexible operational scenarios to determine plant generation capacities and outputs, rate, and degree of reservoir elevation changes that may result from these flexible operations. The operational scenarios were designed to simulate the entire spectrum of flexible generation capacities available at the Project.

The following resource areas were monitored during the Operations Study, with these specific objectives:

Operations: The Operations Study simulated operational scenarios of flexible capacity. Objectives were to evaluate a wide range of flexible operational scenarios to determine plant generation outputs, rate, and degree of reservoir elevation changes that may result from these flexible operations.

Shoreline Stability: Data were collected to determine effects on shoreline stability around the reservoir. The objective of the monitoring was to identify Project-induced erosion, if any, associated with flexible operation and associated reservoir elevation changes.

Riparian Habitats: Data were collected regarding the presence of riparian habitats, aquatic vegetation and aquatic invasive species (AIS). The objective was to identify the presence or absence of riparian habitats, aquatic vegetation and AIS and any Project-induced changes to riparian habitats, aquatic vegetation, and AIS associated with flexible operation and associated reservoir elevation changes.

Fisheries: Data collected were evaluated to determine effects on fish populations, fish access to tributary streams, and to the operation of the Project's fish passage facility.

Recreation and Aesthetics: Data collected were evaluated to determine effects to public and private boat launches and docks and the aesthetic qualities of the reservoir.

Public Safety: Data collected were evaluated to determine effects the different operational scenarios have on the Project's public safety including changing water levels in the Project reservoir and below the powerhouses.

Water Quality: Data collected were evaluated to determine effects on water quality in the reservoir, downstream of the powerhouses and downstream at Birdland Bay Bridge.

Wetlands: Data collected were evaluated to determine effects on wetlands within and adjacent to the Project boundary.

Cultural: Data collected were evaluated to determine effects on three previously recorded cultural properties located in the reservoir fluctuation zone[8] and exposed in shoreline embankments at the face of the backshore zone.[9]

2.2 Methods

2.3 The Operations Study simulated operational scenarios of flexible capacity at the Project.

These scenarios included the extreme limits of the Project's operational capability. The Operations Study was implemented in three phases, each with different levels of generation and corresponding raising and lowering of the reservoir within 2.5 feet below full pool (the maximum elevation of the reservoir during normal operations). The three phases of the Operations Study were scheduled when inflows to the Project were expected to support flexible operations at the Project as planned in the Operations Study. Variances from the FERC-approved Study Plan

Low river inflows did not support the full magnitude of the planned decreases while maintaining required FERC-license required minimum outflow of 6,000 cubic feet per second (cfs). The magnitude of generation decrease is constrained to the flow differential between Project inflows and required minimum flows. The Study Plan was adjusted in both Phase 2 and Phase 3 to include only generation increases due to the low river flows. The reservoir elevation was allowed to slowly recover relying on inflows and decreased generation to support the ongoing test and to ensure that the reservoir was operated throughout the full 2.5 feet of elevation.

The FERC-approved Study Plan (NorthWestern 2021) stated that NorthWestern would record AIS when observed during the Operations Study. Riparian vegetation, aquatic vegetation, and AIS were monitored at the nine shoreline stability monitoring sites on five occasions, and at

[8] Fluctuation Zone refers to lands exposed by any reservoir drawdown.
[9] Backshore Zone refers to the lands lying beyond the full reservoir contour.

the wetland monitoring sites as well. This additional monitoring was an enhancement to the FERC-approved Study Plan (NorthWestern 2021).

Also, although not a variance, the FERC-approved Study Plan (NorthWestern 2021) described the riparian evaluation as being part of the wetlands evaluation. Riparian habitat monitoring results are being reported with the aquatic vegetation and AIS information in this Initial Study Report.

The fisheries study had a minor variance from the FERC-approved Study Plan; cross sections of the Thompson River and Cherry Creek were not completed based on observations of flows and water levels. No impacts to fish access to these tributaries were noted. Level loggers accurately described the stage change at the mouth of tributaries.

The FERC-approved Study Plan (NorthWestern 2021) specified that docks would be monitored twice, once at the full pool elevation prior to the start of the study and once during the lowest reservoir elevation. However, they were monitored more frequently than required by the Study Plan. The docks were monitored at each half-foot elevation below full pool, rather than just the lowest elevation, to provide additional information regarding effects of water level changes on access to docks, which was an enhancement to the Study Plan (NorthWestern 2021).

Water depth at boat launches was measured at the end of the ramps when there was a clear demarcation of the end of the ramp. The boat ramps at Salish Shores and North Shore Estates were gravel and did not have a clear end point. A distance of 60 feet from shore at the full pool elevation was established to standardize monitoring of the Salish Shores and North Shore Estates subdivision gravel ramps as well as the privately-owned sea plane ramp located about 600 feet upstream of the boat barrier on the south shore. Since these gravel-surface ramps have no obvious end point, this standardized distance in lieu of the end of the ramp allows for comparison of water depths.

There were no variances from the FERC-approved Study Plan (NorthWestern 2021) for the evaluations of shoreline stability, water quality, wetlands, and cultural resources.

2.4 Conclusions

2.4.1 Operations

- The first study season successfully tested the extent of flexible capacity available at the Project. However, the study tested the more extreme operational scenarios. Therefore, NorthWestern is proposing a second season study to evaluate more typical scenarios of the proposed operation as described in Appendix A of the Operations Study Report.

- The reservoir provided an approximate 101 MW-hours of flexible capacity which is important to the reliability and stability of NorthWestern's electric system and customers.
- Reservoir elevation change rates are significant at higher extremes of MW moves, but are moderate at typical levels of flexible capacity (10-30 MW).
- Plant and unit operation indicated no mechanical or electrical issues or constraints in performing the operational activities throughout the Operations Study.
- Low inflows impact capability to decrease generation while maintaining required minimum outflows.

2.4.2 Shoreline Stability

- The amount, type and cause of erosion varies greatly on the reservoir shoreline depending on slope, soils, vegetation, land use, location within the reservoir and 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.

2.4.3 Riparian Habitats

- Fluctuating water levels did not appear to impact riparian habitats, as riparian habitats have naturally adapted to fluctuating water levels.
- Fluctuating water levels appeared to change the prevalence of some aquatic vegetation and AIS, especially in areas that were dewatered.
- Long term changes to aquatic vegetation species composition and prevalence, including AIS, may occur under proposed operations, especially in areas that are dewatered.
- Changes to aquatic vegetation species composition and prevalence may have a positive, negative or neutral impact on other resource concerns and issues.

2.4.4 Fisheries

- Fish stranding was limited to juvenile fish of only non-salmonid species. Fish stranding potential appeared to increase with the rate of elevation change, particularly in areas where topography sloped back into higher elevation areas, or within confined depressions.
- The fish passage facility remained operable down to reservoir elevation 2394.5 feet. Below approximate elevation 2394.5 feet, water through the attraction flow pipe and

the sampling workstation was reduced. As presently configured, near 2394.5 feet the sampling workstation did not consistently have sufficient water for processing fish.

- During the late summer when generation rapidly increased, vegetation plugged screens at the fish passage facility, reducing waterflow through the facility and workstation, impeding functionality of the fish passage facility as presently configured.
- Access for fish to both Cherry Creek and Thompson River remained unimpeded.

2.4.5 Recreation and Aesthetics

- Assessment of boat ramps reveal that boat launching remains available at water elevations down to 2.5 feet below full pool.
- Sandy Beach and its associated swimming hole remained accessible during all three phases of the Operations Study.
- The public access docks remained usable at elevations down to 1.5 feet below full pool. Useability below that level varied depending on dock design, length, and location.
- Impacts to private docks and associated recreation access varies with fluctuating water levels and with the type, configuration, and location of docks.
- The amount of exposed mud and emergent aquatic vegetation varies throughout the Project, which may influence odor at lower water elevations.

2.4.6 Public Safety

- Bedrock outcrops pose a risk of contact for watercraft users since they are stationary. Contact risk will increase and decrease as water elevations change and affect their depth.
- Shoals and inundated islands in the main reservoir body are visible at full pool. Contact risk is unchanged or slightly improved (i.e., lessened) by lower water elevations resulting from Project Operations.
- Sandy Beach water elevation increases are tempered by rock outcrops and gravel bars that define the outer bounds of the swimming hole.

2.4.7 Water Quality

- Proposed reservoir operations generally do not affect the water quality of the reservoir and the Clark Fork River downstream.
- Water quality appears to be independent of depth of drawdown, duration of drawdown, and drawdown frequency.

2.4.8 Wetlands

- Wetlands with a surface water connection to the reservoir (approximately 9.4 acres total) may be temporarily dewatered when the elevation of the reservoir is lowered but is restored when the reservoir is raised.
- Wetlands hydrologically connected to the reservoir *via* groundwater (approximately 200.4 acres total), do not appear to be affected by fluctuations in the water surface elevation of the reservoir.

2.4.9 Cultural Resources

- No effects to cultural resources were identified during the Operations Study.

2.5 Proposed Modifications for the Second Study Season

The FERC-approved Study Plan (NorthWestern 2021) described the Operations Study as a single year of study. During the first season of study, the scenarios implemented were at a larger magnitude and frequency than what may occur under actual flexible capacity operations at the Project. The study scenarios implemented during the first season represent the extreme bounds of operations and, as such, may not represent actual impacts on Project resources during flexible capacity operations. Therefore, NorthWestern is proposing to modify the FERC-approved Study Plan to continue the Operations Study in the second study season.

Instead of attempting to simulate flexible capacity based on the Project generation capacities, the second study season will implement baseload and flexible generation to provide grid regulation in real-time. This scenario will allow NorthWestern to monitor and evaluate potential impacts of realistic operations in the current energy market.

The focus of this modification to the Operations Study will be those resource areas where impacts were identified in the first study season and where further monitoring will refine the extent of impacts, in particular to operations, shoreline stability, riparian habitats, fisheries, recreation and aesthetics, and wetlands. The Modified Study Plan for Second Study Season is found in Appendix A of the Operations Study Report.

3.0 Summary of Total Dissolved Gas Study

3.1 Introduction

Water quality standards developed by the DEQ (Circular DEQ-7) (DEQ, 2019) sets 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.

Montana's Surface Water Quality Standards and Procedures include language specific to dams. Administrative Rules of Montana (ARM) 17.30.602 defines "naturally occurring" as "conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from the reasonable operation of dams in existence as of July 1, 1971, are natural." ARM 17.30.636 (1) states that owners and operators of water impoundments that cause conditions harmful to prescribed beneficial uses of state water shall demonstrate to the satisfaction of the department that continued operations will be done in the best practicable manner to minimize harmful effects.

The prior Licensee developed a TDG Control Plan in 2010 in consultation with the DEQ (PPL 2010). The TDG Control Plan outlines operational practices used during the spring runoff period to minimize TDG concentrations in the Clark Fork River downstream of the Thompson Falls Project. Since 2010, the TDG Control Plan has been implemented annually. NorthWestern and the prior Licensee monitored TDG in the Clark Fork River most years during the 2003 to 2020 time period. These data have helped to inform NorthWestern on the optimal operations scenario to minimize TDG concentrations.

In late 2018, construction was completed on two new radial spill gates, resulting in a total of four radial gates on the Main Channel Dam. Because these new radial gates are a change from the spill panels that were previously in use, the effect on TDG from these radial gates is not yet fully understood. Data collection occurred in 2019, 2020 and 2021, with additional data to be collected in 2022. These data will result in a better understanding of TDG concentrations at a wider range of discharge levels.

The goal of this study is to gather data on TDG concentrations upstream and downstream of the Project throughout the spring runoff season to gain a better understanding of TDG concentrations in various discharge scenarios. The main objective is to collect additional information on whether and how the Project's new radial gates affect TDG concentrations downstream of the dams and powerhouses.

3.2 Variances from the FERC-approved Study Plan

There were no variances to study methodology in 2021.

3.3 Methods

TDG concentrations are highest during the spring runoff season, so data collection is focused during the spring runoff period, which usually occurs from early May through late June of each year. The first season of the TDG study conducted in 2021 consisted of monitoring TDG concentrations during the spring runoff season (May 12 – July 1) at multiple locations around the Project's facilities under different discharge scenarios using Hach Hydrolab instruments. This study used methods that have been being used for ongoing TDG evaluation at the Project.

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 Channel Dam using different combinations of the four radial gates. Each gate spill configuration was held for approximately 4 hours to allow the downstream TDG levels to stabilize. This methodology was consistent with testing conducted in 2019 and 2020 and was used to supplement the existing dataset. In 2021, Clark Fork River flows were relatively low, and peaked at a flow of 58,700 cfs at the USGS Clark Fork River at Plains stream gage. In contrast, the median peak streamflow at this gaging station is 74,800 cfs for the period of record (1912-2020) (USGS 2021). Due to the low peak flows in 2021, there were no opportunities to test radial gate configurations at river flows above 80,000 cfs.

3.4 Conclusions

- Operating non-adjacent radial gates in combination with each other will generally reduce the amount of TDG entrained in the river downstream at river flows less than 80,000 cfs, although operation in this manner may not always be possible due to dam safety considerations.
- Radial gate testing at flows above 80,000 cfs was not conducted in 2021. NorthWestern will monitor TDG again in 2022. Data will be collected at flows above 80,000 cfs as conditions allow.

3.5 Proposed Modifications for the Second Study Season

This study will also be conducted during the 2022 study season, which will allow NorthWestern to capture data during a greater variety of discharge conditions. For the 2022 study season, the aging Hach Hydrolab DS5 instruments will be replaced with new Eureka Water Probes Manta instruments. The instrumentation change will be an upgrade to a newer technology, which allows for greater instrument reliability and precision. Results between the

Hach and Eureka probes are expected to be comparable, as the Quality Assurance/Quality Control and instrument calibration procedures will remain the same.

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4.0 Summary of Hydraulic Conditions Study

4.1 Introduction

Bull Trout (*Salvelinus confluentus*) were federally listed as a threatened species under the Endangered Species Act in 1998. The prior Licensee-prepared 2003 Biological Evaluation concluded that the Project was likely adversely affecting Bull Trout. On November 4, 2008, the FWS filed a Biological Opinion (BO) (FWS 2008) with FERC, concluding that continuing operations of the Project is likely to result in incidental 'take' of the Bull Trout in the form of harm and harassment, including mortality. The FWS further concluded that the level of anticipated incidental 'take' is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat. The BO included 'reasonable and prudent measures' which were deemed appropriate to minimize 'take', as well as terms and conditions for implementation of the reasonable and prudent measures.

The terms and conditions in the BO (FWS 2008) included a requirement for the Licensee to conduct a scientific review to determine if the Thompson Falls fish passage facility is functioning as intended, and whether operational or structural modifications are needed. The scientific review convened with the formation of the Thompson Falls Scientific Review Panel (Scientific Panel). On March 27, 2020, the Scientific Panel issued a memo (Scientific Panel 2020) summarizing its evaluation of the fish passage facility and providing recommendations on how to better evaluate the facility in the future.

The Scientific Panel suggested NorthWestern initiate two parallel studies to assist in the determination of the fish passage facility's attraction and entrance efficiency, a two-dimensional (2D) hydraulics study and a fish telemetry (radio-tag) study. The hydraulic modeling study was conducted to address the Scientific Panel recommendation. The goal of the hydraulic modeling study is 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.

4.2 Variances from the FERC-approved Study Plan

A variance from the FERC-approved Study Plan is the inclusion of three-dimensional (3D) modeling blocks for portions of the Main Channel Dam structure. This is considered to be an enhancement to the study. The 3D modeling blocks were necessary to allow the computational fluid dynamics (CFD) model to better capture the dynamic 3D flow conditions that occur at, and immediately downstream of, the Main Channel Dam structure.

In addition, the FERC-approved Study Plan described the study area as the Main Channel Dam downstream to the High Bridge. Specifically, the Study Plan stated that, "Based on available Project information and collected survey data, a 3D Computer Aided Design (commonly known as CAD) model will be created of the spillway, downstream river channel and surrounding terrain. The downstream river channel will extend to just upstream of the High Bridge, or approximately 1,500 feet downstream of the dam." The study was conducted over a longer reach of river, from the Main Channel Dam to 500 feet downstream of the High Bridge, which is an enhancement of the study.

The FERC-approved Study Plan included a delivery date of February 1, 2022 for the Interim Report to be distributed to Relicensing Participants and a date of March 1, 2022 for comments being due to NorthWestern, with a meeting with Relicensing Participants to discuss Interim Report to be held in March 2022. The Interim Report was distributed to FWP, the FWS, and the USFS on February 15, 2022, with request for comments by a March 17, 2022 to allow more time to complete the Interim Report. The meeting with FWP, the FWS, and the USFS and was held in March (March 10, 2022) as described in the FERC-approved Study Plan.

4.3 Methods

The initial task (Task 1) for developing an understanding of the hydraulic conditions downstream of the fish passage facility included developing a 3D terrain model. The 3D model development included performing a bathymetric survey of the downstream channel. The bathymetric survey data was combined with publicly available Light Detecting and Ranging data to develop a digital elevation model of the Main Channel Dam, downstream river channel, and surrounding terrain. Task 1 was accomplished by establishing ground control points and conducting the bathymetric survey with a single beam echo-sounder. As-built drawings of the Main Channel Dam and Upstream Fish Passage Facility were used to develop geometry for the discharge structures.

Task 2 entailed developing a CFD model of the existing Thompson Falls Main Channel Dam and river downstream of the dam using FLOW-3D HYDRO software (version 22.1.0.16). Four flow scenarios (37,000; 25,000; 2,000; and 200 cfs) were developed and evaluated for the first phase of the CFD modeling. The modeling scenarios were developed to determine the flow behavior and resulting downstream flow conditions.

4.4 Conclusions

The Phase 1 study results provide an estimate of the hydraulic performance of the Main Channel Dam and fish passage facility and the resulting flow depths, velocities, and flow patterns in the downstream channel for various 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 vary considerably but have a similar pattern. In the area directly downstream of the fish passage facility entrance there are generally two different flow patterns observed

between the four scenarios evaluated. At higher flows (Run 1 and Run 2), the outlet of the fish passage facility and high velocity jet are submerged and limited impacts from these structures are observed. During lower flows (Run 3 and Run 4), the high velocity jet is unsubmerged and the discharges from the upstream fish passage entrance represent a significant portion of the flow in this area. At the lower flow rates, the streamlines in this area are well concentrated from the fish passage entrance. Away from the fish passage entrance, the pools and channel immediately downstream of the Main Channel Dam reduces the velocities and increases flow depths prior to the flow entering the highly turbulent falls area where velocities increase noticeably. Downstream of the falls area, the flow enters the main river channel, depths increase considerably, and velocities are reduced as the flow turns right toward High Bridge. 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 where the velocities and depths tend to increase again before discharging downstream of the bridge. Overall, the velocities generally range from a few feet per second up to almost 30 feet per second over the falls area.

The results of the river channel hydraulic performance will be used to provide a more comprehensive understanding of how the flow conditions influence fish behavior and operation of the fish passage facility. These results will be reported in the Final Study Report, which will be filed with FERC by May 10, 2023.

4.5 Proposed Modifications for the Second Study Season

No further changes to the FERC-approved Study Plan are proposed for the second study season. During Phase 2 of the study, the full model domain will be analyzed using 3D modeling to better evaluate the vertical velocity distributions of flow downstream of the Main Channel Dam. Additional evaluations during Phase 2 of the study will evaluate flows of 37,000 cfs 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 addition to modeling the full model domain in three dimensions, it will be valuable to further refine the model mesh along the downstream channel and along the margins. This will help to better evaluate the depth specific velocities and distribution of flow within these areas that are critical for trout movement. Use of a full 3D model will also allow for a number of cross sections to be cut along the model channel flow paths to provide a detailed assessment of the vertical distribution of flow velocities at these cross sections. These cross sections will also be useful for gaining a better understanding of velocities along the margins of the downstream channel. This will help identify areas that may be a barrier to fish passage or to identify critical resting areas for the fish prior to entering the fish passage facility.

These results will be reported in the Final Study Report, which will be filed with FERC in May 2023, as part of the USR.

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5.0 Summary of Fish Behavior Study

5.1 Introduction

Between 2009 and 2010, the Licensee constructed a fish passage facility along the right abutment of the Main Channel Dam designed to address upstream fish passage for the federally threatened Bull Trout (*Salvelinus confluentus*). The Thompson Falls Fish Passage Facility (fish passage facility) has operated seasonally since 2011 providing upstream fish passage to over 37,000 fish representing 15 species (plus 3 hybrids), including 18 Bull Trout (NorthWestern 2022).

In compliance with the BO (FWS 2008), and the 2009 License amendment (FERC 2009), NorthWestern formulated the Thompson Falls Scientific Review Panel (Scientific Panel 2020). The Scientific Panel identified a large volume of qualitative data gathered from the fish passage facility but noted a data gap when quantitatively evaluating the proportion of "motivated" fish entering the zone of passage (ZOP) and finding the fish passage facility entrance. This study was developed to address this data gap.

Following the recommendation of the Scientific Panel, this study was developed to evaluate upstream fish movement *via* radio telemetry[10] through the Project's ZOP. The ZOP includes far field, near field, entry, internal fish passage facility, exit, and upstream areas.

This study evaluates what proportion of radio tagged fish enter the ZOP and find the fish passage facility entrance. The study also measures the duration of time and pathway(s) of these movements during various flow conditions. The Initial Study Report also includes a literature review of relative swimming capabilities of minnow, sucker, and salmonid species recorded at the fish passage facility.

5.2 Variances from the FERC-approved Study Plan

There were no variances during the first study season from the FERC-approved Study Plan (NorthWestern 2021).

5.3 Methods

This study focuses on evaluating Rainbow and Brown trout movement from the Thompson Falls Original Powerhouse upstream to the fish passage facility entrance at the Main Dam. This 0.75-mile section of the Clark Fork is further divided into the far field, near field, and fish passage facility entrance. The location of the four fixed stations and estimated detection zone

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

in the Project area represent the near field. The fish passage facility entrance is located along the right abutment of the Main Dam.

Rainbow and Brown trout were tagged with full-duplex passive integrated transponder (PIT) tags and MCFT3 series radio transmitter tags manufactured by Lotek Wireless. All MCFT3 tags were coded with the same frequency (149.7 megahertz [MHz]) and a unique code identification number.

PIT tags were detected by a remote antennae array system operating in the two fish passage facility entrances, and the lower pools and the top holding pool in the fish passage facility. Radio tags were monitored by fixed and mobile receivers. Fixed receivers (Lotek SRX1200-D2) were located at the Powerhouse, High Bridge, the Main Dam Right, and Main Dam Left, along with a 6-Element and/or a 4-Element Yagi antenna(s).

Fish were collected in the mainstem Clark Fork River upstream of the Thompson Falls Project, and the fish passage facility. Boat mounted electrofishing was used in the Clark Fork River to collect trout of suitable size for radio tagging. Radio tags were implanted in the intra-peritoneal (body cavity), and tagged fish were transported by vehicle in an aerated tank to the Flat Iron boat launch, approximately 4 miles downstream of the dam.

The fixed telemetry stations recorded data continuously throughout the study season (June – October 2021). Data from the fixed stations were downloaded weekly. Manual tracking consisted of an individual walking along the bank, within the near and far fields, with a Lotek SRX1200-MD1 receiver and an H antenna 150 MHz. Once a tagged fish was detected, its location was triangulated, and applicable information recorded using a standardized data sheet with a georeferenced grid that was uploaded into a geographic information system (GIS).

Fish movement data were analyzed to assess fish behavior through a range of flow conditions.

5.4 Conclusions

The radio telemetry study followed the movements of 16 tagged fish within the ZOP *via* fixed stations and mobile tracking with a nearly even distribution of Rainbow (n=7) and Brown (n=9) trout sampled. The study focused on movement, behavior, and travel time of fish between the far and near fields and entrance to the fish passage facility. All 16 tagged fish were detected by the fixed stations in the ZOP and 15 fish were also detected *via* manual tracking. The manual tracking data indicated most fish moved up the main section of the river channel and stayed away from the outlet areas at the Original Powerhouse and New Powerhouse.

When fish entered the Main Dam spillway area, the only pathway was up the center of the channel (through the falls) before moving to the right or left bank. Manual tracking only detected fish from the center to the right bank (side of the fish passage facility). When fish entered the near field, their presence was brief and fish spent substantially more time within the zone of the Main Dam Right station versus the Main Dam Left station before either

returning downstream to the far field, entering the fish passage facility and then returning downstream to the far field, or entering and ascending the fish passage facility. No fish that entered the near field left the ZOP immediately, but rather remained within the far field for most of the study season.

5.5 Proposed Modifications for the Second Study Season

No changes to the FERC-approved Study Plan are proposed for the second study season. This is a 2-year study with fish movement and behavior data to be collected from March through October 2022. Due to the battery life in the radio tags, each year will have a separate group of fish being monitored. The swimming abilities of these species of fish will be compared to the CFD model of the near field to evaluate the potential of any velocity barriers influencing fish movement. These results will be provided in the Final Study Report, which will be filed with FERC no later than May 10, 2023, as part of the USR.

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6.0 Summary of Visitor Use Study

6.1 Introduction

NorthWestern conducted a recreation visitor survey in the Thompson Falls Project area from Memorial Day weekend through Labor Day weekend 2021. The data provided by the visitor survey provides information about recreational use during the peak recreation season. The 2021 visitor use study replicated previous studies, which allowed trends and patterns in recreation use to be evaluated.

The goal of the visitor study was to monitor recreational use to help determine whether Project-induced recreation is being adequately accommodated. The study objectives were to collect and update information about use of recreation sites associated with Thompson Falls Reservoir and the Clark Fork River immediately upstream and downstream of the Project.

6.2 Variances from the FERC-approved Study Plan

The visitor survey was implemented in accordance with the FERC-approved Study Plan.

In addition to, and concurrent with, the visitor survey, NorthWestern collected data on visitor use volume to provide detail on visitor use patterns. This information was collected in addition to visitor survey results to present a more comprehensive description of the recreation visitor population overall.

6.3 Methods

The 2021 Thompson Falls Visitor Survey was administered to visitors at nine recreation sites associated with the Project. Six of the sites are managed, entirely or in part, by NorthWestern. This survey methodology and questionnaire largely replicated previous Thompson Falls Project surveys conducted in 1999, 2003, 2008, 2014, and 2018. This methodology was developed in cooperation with the city of Thompson Falls, Sanders County, USFS, and FWP.

Visitor sampling occurred on 60 randomly selected days between the beginning of the Memorial Day weekend through Labor Day, 2021 (May 28 – September 6), which is the peak recreation season. Each recreation site was sampled at various times of the day between 8:00 am and 9:00 pm. Systematic random sampling was used to select locations and times to provide a representative sample of times of the day and days of the week. The primary objective of the schedule was to implement a sample that is representative of typical recreation use in the Project area during the study period.

Reasonable attempts were made to sample one individual from every group of visitors present at the recreation site during the sampling event. A recreation group is defined as any group of individuals, such as family, friends, or tour group visiting the recreation site together. Groups

of visitors were approached by the survey technician, briefly informed of the survey's purpose, and asked to participate. If no one in the group agreed to participate in the survey, the survey technician noted the group refusal for survey response rate calculation. Once a person had been interviewed at a site at any time, they were eliminated from future sampling at that site, but could be included again at other sites.

The survey technician used a tablet computer to administer the survey interview. The survey questionnaire was programmed into the tablet and led the survey technician through the sequence of questions; visitor responses were entered directly into the device.

Visitor volume at recreation sites was also monitored with the use of automatic traffic and trail counters.

6.4 Conclusions

The 2021 visitor study was conducted to update 2018 visitor survey results with the intent of gauging visitor perceptions of recreation amenities during a more "normal" year than 2018. In 2018, spill panels on the Main Channel Dam were removed due to extremely high spring runoff. NorthWestern then lowered the reservoir significantly to replace the spill panels, thereby limiting access to the reservoir for much of the peak recreation season. Results from that visitor survey revealed shifts in activity participation and satisfaction levels that were very likely tied to the atypical drawdown event.

However, 2021 brought its own challenges. Being in the midst of the COVID-19 pandemic and related perceptions of risk and needs for social distancing, as well as extremely high early season temperatures and a large wildfire (and associated smoke) within a short distance of Thompson Falls Reservoir, resulted in visitation patterns that were atypical.

Despite these atypical conditions, visitors remain satisfied with recreation opportunities and amenities, overall, and continue to utilize the public recreation sites associated with the Thompson Falls Project area.

6.5 Proposed Modifications for the Second Study Season

No changes to the FERC-approved Study Plan are proposed for the second study season. The Visitor Use Study is complete, no additional studies will be conducted in 2022.

7.0 Summary of Cultural Resources Study

7.1 Introduction

There were two parts to NorthWestern's cultural resources study in 2021. NorthWestern updated inventories completed in 1982 and 1986 of H-A&E within the APE, and also developed a model to identify the high probability locations of Prehistoric and Historic Archaeological Properties (PAP and HAP) within the Study Area.

7.1.1 Re-inventory of Historic District

The original inventory of H-A&E properties at the Project was undertaken in 1982 under the sponsorship of the prior Licensee, Montana Power Company (Bowers and Hanchette 1982). Four years later, in part using data compiled in 1982, a National Register of Historic Places (National Register) nomination was prepared for the Thompson Falls Hydroelectric Dam Historic District (Historic District), which was subsequently listed (Koop 1986). The district encompasses all H-A&E within the APE; no others are known to exist.

Since 1986, there have been several alterations to the district that bear on its established boundary and its list of elements that contribute to National Register listing. Consequently, NorthWestern prepared an amendment to the 1986 district nomination and is in the process of submitting it for Montana State Historic Preservation Office (SHPO) and National Park Service (NPS) review and acceptance.

The goal of this study is to determine which buildings, structures, and sites currently contribute to the National Register-listed Historic District and might be affected by future Project operations. Because some buildings have been removed since 1986 and other structures integral to the district were not specifically identified and counted at that time, the amended nomination updates the list of contributing elements and document their historic integrity as of 2022.

7.1.2 Cultural Resources Predictive Model

The cultural resources predictive model study involved development of a model which identifies areas where there is a high probability for the occurrence of precontact or historic archaeological properties within the APE of the Thompson Falls Project. The results of the study will be used to guide future cultural resource inventory of the Project's APE.

The National Historic Preservation Act requires a "reasonable and good faith effort" to document significant resources and ensure that impacts to those resources are taken into consideration during the planning and implementation of an undertaking. One means of implementing that reasonable and good faith effort is cultural resource predictive modeling,

followed by ground truthing and verification. Predictive modeling is a technique that allows a qualified individual to predict "the location of archaeological sites or materials in a region, based either on a sample of that region or on fundamental notions concerning human behavior" (Kohler and Parker 1986). Predictive modeling has been used successfully for nearly 40 years as an important decision-making tool in cultural resources management (Kohler and Parker 1986).

7.2 Variances from the FERC-approved Study Plan

The FERC-approved Study Plan (NorthWestern 2021) schedule stated the draft Interim Report would be distributed for comment by the SHPO, Lolo National Forest cultural resource staff, Native American Tribes and Nations, and Montana Department of Natural Resources and Conservation cultural resources staff on October 1, 2021. The actual date of distribution to the above-named parties was November 2, 2021. This minor delay did not impact the schedule for implementing the remainder of the FERC- approved Study Plan.

There were no variances from the FERC-approved Study Plan regarding H-A&E properties.

7.3 Methods

7.3.1 Re-inventory of Historic District

The re-inventory and -evaluation of the Historic District was undertaken by Mitzi Rossillon, who is qualified under the U.S. Secretary of the Interior Standards for Professionals in History with experience in the inventory and evaluation of such properties. This study task critically examined the existing National Register listing and prepared the amendment using NPS's National Register Bulletins 15 and 16a (NPS 1995, 1997). The work included examination of architectural, engineering (including historic equipment systems), and archaeological elements within the Historic District.

To update the Historic District nomination, NorthWestern determined the current National Register status of each element as currently listed. It also documented the location, age, function, and historic integrity of other structures and sites within or near the 1986 Historic District boundary that are now 50 years or older and not identified in the original listing.

7.3.2 Cultural Resources Predictive Model

A recent cultural resource predictive modeling effort in the northwestern Montana region was conducted by the USFS Helena-Lewis and Clark National Forest (Bodily and McCarthy 2019). The USFS study revealed that over 95 percent of all known PAP and HAP on the Helena-Lewis and Clark National Forest are positioned on landforms characterized by less than 30 percent slope and within 250 feet of water. The USFS study revealed that low site probability areas are characterized by steeper slopes (>30%) and greater distances to water (>250 feet).

NorthWestern's study employed similar variables as those utilized by the USFS to produce a predictive model that stratifies the Thompson Falls Hydroelectric Project APE into areas of high and low cultural resource probability. That model will guide future cultural resource inventory of the Project in a manner that achieves the goals of site identification and Section 106 compliance.

Therefore, Thompson Falls Project predictive model was generated based on three primary data sets, 1) the locations, coverage, and results of previous cultural resource inventories; 2) the locations and characteristics of known cultural properties recorded within the study area; and 3) landform slope and proximity to water data as employed by the USFS in 2019 (Bodily and McCarthy 2019).

The Cultural Resources Model Interim Report was filed with FERC January 26, 2022, so is not included in this Initial Study Report. In the Cultural Resources Model Interim Report, in response to a comment on the draft Interim Report, NorthWestern noted that, "On December 21, 2021, NorthWestern sent a letter requesting the Confederated Salish and Kootenai Tribes (CS&KT) provide relevant information from the oral histories and CS&KT Site Registry database should CS&KT wish for the information to be considered in the FERC relicensing proceeding. The information CS&KT provides will be incorporated into NorthWestern's FERC filings as appropriate, and within the deadlines required by the FERC relicensing schedule. To this end, NorthWestern requests that the information be provided no later than March 1, 2022 for it to be considered in the Initial Study Report." No information was received, so no additional information is available to supplement the Interim Report.

7.4 Conclusions

7.4.1 Re-inventory of Historic District

Preparation of an amended National Register nomination for the Historic District has been completed to the point of submission to the SHPO for review and comments. NorthWestern has every expectation that the nomination will be accepted by the National Register later in 2022, and the Historic District will continue to be a listed property. The new information about contributing and non-contributing elements, and about the district's historic significance and resource integrity will aid in assessing future Project effects and development of a Historic Preservation Management Plan under the new License.

7.4.2 Cultural Resources Predictive Model

The cultural resource predictive model classifies 839 acres within the 946.7-acre Thompson Falls Project APE as high site probability areas, of which 225 acres have been previously inventoried. Fully 107.7 acres within the APE are evaluated as being low site probability areas.

7.5 Proposed Modifications for the Second Study Season

No changes to the FERC-approved Study Plan are proposed for the second study season.

7.5.1 Re-inventory of Historic District

This report completes the National Register evaluation portion of the Cultural Resource Study, as described in the FERC-approved Study Plan. The only subsequent required action is expected to be in-person presentation and discussion of the nomination to the State Historic Preservation Review Board later in 2022.

7.5.2 Cultural Resources Predictive Model

Standard archaeological procedures for work in Montana, as stipulated in the SHPO's "Guidelines and Procedures," will be employed to undertake an on-site inventory on NorthWestern-owned and public lands in the APE in the late summer and early fall of 2022 with results to be included in the USR, due on May 10, 2023.

8.0 Summary of Updated Literature Review of Downstream Fish Passage

8.1 Introduction

When water is spilling over or through the dams at the Thompson Falls Project, fish can migrate downstream *via* the spillways, outlet works, or through the turbines. During non-spill periods, the primary means of downstream passage is through the turbines. In 2007, the previous Licensee (PPL Montana) prepared a *Literature Review of Downstream Fish Passage Issues at Thompson Falls Hydroelectric Project* (GEI 2007) (2007 Literature Review)[11] which included specific consideration of federally-listed Bull Trout and Westslope Cutthroat Trout, a sensitive species and Montana Species of Special Concern (GEI 2007).

Studies done on anadromous fishes have generally indicated that passage *via* spill poses less risk than *via* turbine (Muir et al. 2001). Fish mortality is typically 0 to 2 percent for standard spill bays and 5 to 15 percent for turbine passage, with Kaplan turbines generally at the lower end of this mortality range and Francis turbines generally greater (Whitney et al. 1997). However, mortality at a specific facility can vary depending on the specific configuration of the turbines and spillways and type and timing of fish being passed.

The 2007 Literature Review (GEI 2007) calculated overall survival for downstream trout passage through the Project based on the following assumptions:

- Spillway effectiveness is 1:1 so fish will pass the Project in numbers proportional to flow. That is, if 50% of the flow is through the spillway, then 50% of the fish will pass over the spillway
- Fish will also pass the two powerhouses in proportion to flow through the powerhouses

The 2007 Literature Review estimated that survival estimates at the Project are 94 percent through the new powerhouse (Kaplan turbine), 85 percent through the original powerhouse (Francis turbines), and 98 percent through the spillway. Combined survival estimates for trout measuring greater than 100 millimeters (mm) was estimated to likely be 91 to 94 percent.

The Biological Opinion issued by the FWS October 28, 2008, concurred with the survival estimate in the 2007 Literature Review.

The Updated Literature Review focuses on information in the scientific literature published since 2007, including information on survival of different fish sizes, any turbine or generator

[11] The Literature Review is available for download at: https://northwesternenergy.com/docs/default-source/default-document-library/clean-energy/environmental-projects/thompson-falls/thompson_falls_literature_review_of_downstream_fish_passage_issues_2007.pdf?sfvrsn=5e2b0dfa_7

upgrades after 2007, spillway changes due to the new radial gates, and relevant operational changes.

8.2 Variances from the FERC-approved Study Plan

There were no variances from the FERC-approved Study Plan.

8.3 Methods

The Updated Literature Review focuses on downstream fish passage literature published since 2007. The scientific literature on downstream fish passage was screened for relevance for species and size classes of fish and turbine configurations found in the Project area. Survival studies conducted at similar hydroelectric facilities with similar turbine types and hydraulic capacities were examined and used as the basis to estimate fish survival through the turbines at the Project.

The search strategy utilized ProQuest and EBSCO databases which are standard databases within the research, academic, corporate, and government sectors for researching scholarly science-based topics across multiple publications. Search criteria included relevant terms such as "downstream passage," "Kaplan or Francis turbine," and "entrainment" and were limited to years after 2006. Results included journal articles, white papers, and biological assessments. These were then reviewed specifically looking for applicability to the Project turbine configurations, dam characteristics, species similarities, and fish lengths or juvenile and adult age classes.

The Updated Literature Review also includes an update on current Project operations and configuration and a summary of documented successful downstream fish passage at the Project.

8.4 Conclusions

The 2007 Literature Review concludes that combined survival estimates for passage through the Francis turbines, the Kaplan turbine and the spillway for trout measuring greater than 100 mm is likely 91 to 94 percent. Efforts from the current literature review are consistent with the 2007 work and little research specific to the species at Thompson Falls has been completed since 2006. Thus, no additional literature was identified that would measurably change these existing estimates of downstream survival at the Project.

8.5 Proposed Modifications for the Second Study Season

No changes to the FERC-approved Study Plan are proposed for the second study season. The Updated Downstream Fish Passage Literature Review is complete, no additional studies will be conducted in 2022.

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