PROPOSED STUDY PLAN

NUYAKUK RIVER HYDROELECTRIC PROJECT
FERC NO. 14873

Submitted by:

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ACRONYMS AND ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AHRS	Alaska Historic Resources Survey
APE	Area of Potential Effects
BBN	Bayesian Belief Networks
BLM	Bureau of Land Management
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
DLA	Draft License Application
DO	dissolved oxygen
EA	Environmental Assessment
EPA	Environmental Protection Agency
Falls	Nuyakuk Falls
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
ft	foot
GIS	Geographic Information System
GMU	Game Management Unit
HPMP	Historic Properties Management Plan
ILP	Integrated Licensing Process
IRA	Integrated Risk Assessment
IM	Intensive Management
ISR	Initial Study Report
kV	kilovolt
kW	kilowatt
LCM	Life Cycle Model
MCH	Mulchatna Caribou Herd
mg/L	milligrams per liter
MOA	Memorandum of Agreement
msl	mean sea level

MW	megawatt
MWh	megawatt hour
NAVD 88	North American Vertical Datum of 1988
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	National Park Service
NWI	National Wetlands Inventory
PA	Programmatic Agreement
PAD	Pre-Application Document
PLP	Preliminary Licensing Proposal
Project	Nuyakuk River Hydroelectric Project (P-14873)
psig	pounds per square inch, gage
PSP	Proposed Study Plan
RSP	Revised Study Plan
S&I	Survey and Inventory
SD	Scoping Document
SHPO	State Historic Preservation Office
TBD	to be determined
TCP	Traditional Cultural Properties
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USR	Updated Study Report
UTBB	United Tribes of Bristol Bay
WTSPMC	Wood-Tikchik State Park Management Council

1.0 INTRODUCTION

Nushagak Electric & Telephone Cooperative, Inc. (Cooperative) is filing with the Federal Energy Regulatory Commission (FERC or Commission) an updated Proposed Study Plan (PSP) describing the studies proposed for the Nuyakuk River Hydroelectric Project (Project), FERC No. 14873, in accordance with 18 CFR §5.11. The Cooperative is seeking an original license for the proposed Project and has elected to use FERC's Integrated Licensing Process (ILP) as described in 18 CFR Part 5.

The Cooperative filed a Preliminary Permit Application on March 22, 2018. On June 11, 2018, FERC issued a preliminary permit for the Project effective June 1, 2018, with an expiration date of June 1, 2021. The Cooperative filed a Notice of Intent (NOI) and Pre-Application Document (PAD) on October 8, 2019, with the purpose of summarizing existing information on natural resources in the proposed Project vicinity and describing preliminary and conceptual Project design and engineering. FERC issued its Scoping Document 1 (SD1) to inform stakeholders about the scope of the Environmental Assessment (EA) it intends to prepare as part of the licensing process and to seek additional information pertinent to the analysis. The Cooperative held a Project kickoff meeting in Anchorage, Alaska on November 18, 2019, to engage Project stakeholders and present preliminary information about the Project. FERC held two Scoping Meetings for the Project in Anchorage, Alaska on December 11, 2019, to discuss existing environmental conditions, potential information needs, and resource issues.

The Cooperative filed a PSP with FERC on March 20, 2020, and based on further discussion with FERC, the Cooperative filed an updated PSP on April 16, 2020. The Cooperative held a series of virtual PSP meetings to provide additional details on study-specific methodologies on April 20 and April 22, 2020. Virtual meetings were required in place of in-person meetings due to COVID-19 gathering and travel restrictions.

Due to COVID-19 restrictions that prevented requisite public meetings and site visits and after substantive discussion with FERC and stakeholders, the Cooperative requested that FERC place the Project's ILP in abeyance on June 7, 2020. On June 9, 2020, FERC placed the ILP in abeyance, thereby temporarily suspending the licensing process. During the abeyance period the Cooperative has collaborated substantially with federal, state, and local agencies and stakeholders, particularly with respect to the planning of aquatic and fishery studies. An Aquatics Resources Work Group (ARWG) was formed early in the abeyance period which includes local technical experts from agencies, Bristol Bay Science and Research Institute, the University of Washington Fisheries Research Institute, and other organizations. These experts have extensive familiarity with the Bristol Bay area and the fisheries interests therein. The ARWG has met every 1-2 months between fall 2020 and fall 2021 and intends to meet monthly beginning in March 2022. During each meeting the group has discussed the studies and methods required to assess any potential impacts of the proposed Project on aquatic and fisheries resources. Based on the substantive progress made during these discussions and the work products the ARWG has collaboratively generated, the Cooperative has revised the PSP and provided the document for two informal reviews during the abeyance: 1) to the ARWG Technical Subcommittee on July 23, 2021, and 2) to the Project contact list, which consists of over 100 community members, Tribal organizations, state and federal agency personnel, and local municipality contacts. Comments received on each iteration of the PSP and the Cooperative's responses to those comments are included in Appendix D and E to this PSP. This revised PSP incorporates text revisions to address these comments and the technical recommendations of the ARWG, discussed and agreed upon during a series of Technical Subcommittee meetings (Table 1-1). . This document contains additional details and methodologies for several of the studies described in Section 4 of this PSP. Per communication with FERC, the filing of this updated PSP is intended to restart the ILP. FERC will ultimately determine when the Project's licensing process formally resumes and the dates of successive licensing milestones.

Table 1-1. Nuyakuk Project Aquatics Resources Work Group (ARWG) meeting dates and general topics discussed.

Date	Meeting Description
10/11/2020	ARWG Kickoff Meeting: Overview of Aquatics Resources Studies & Revisions
12/04/2020	ARWG Technical Subcommittee Meeting: Aquatic Resources Studies & PSP Revisions Discussion
1/21/2021	ARWG Technical Subcommittee Meeting: Fish Studies Framework & Project Nexus Discussion
3/10/2021	ARWG Technical Subcommittee Meeting: Life Cycle Model & Risk Assessment Discussion
4/7/2021	ARWG Technical Subcommittee Meeting: Life Cycle Model & Risk Assessment Discussion
5/24/2021	ARWG Technical Subcommittee Meeting: Project Nexus Table Discussion
7/29/2021	ARWG Technical Subcommittee Meeting: PSP Comment Discussion
1/12/2022	ARWG Technical Subcommittee Meeting: Licensing Re-Initiation Discussion
3/1/2022	ARWG Technical Subcommittee Meeting: 2022 Planning and ILP Re-Initiation

1.1 Proposed Study Plan Overview

In accordance with ILP regulations, comments on the PAD, FERC's SD 1, and study requests were due by February 4, 2020. A total of 6 stakeholders filed letters with FERC providing general comments, comments pertaining to the PAD, comments regarding SD1, and/or study requests. Study requests received are presented in Section 3.0.

FERC's ILP regulations under 18 CFR §5.9(b) require that stakeholders who provide study requests include specific information to allow the Licensee and FERC staff to determine a requested study's appropriateness and relevancy to the Project and proposed action. The criteria required for inclusion in study requests are as follows:

1. Describe the goals and objectives of each study proposal and the information to be obtained;

2. If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;

3. If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study;

4. Describe existing information concerning the subject of the study proposal, and the need for additional information;

5. Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements;

6. Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge; and

7. Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The Cooperative has evaluated all study requests and comments received by stakeholder with respect to FERC's study request criteria listed above. Section 3.0 of this PSP provides a list of all requested studies and the rationale for inclusion or exclusion in the Project's study program. Studies deemed appropriate for inclusion in the PSP are described in detail in Section 4.0 of this PSP, including study goals and objectives, methodology, study schedules, proposed deliverables, and cost and level of effort. This version of the PSP is being provided to the Project contact list for their review and comment due to the significant revisions made since the April 2020 version of the PSP was filed with FERC. The comment period associated with this distribution will be approximately 3-4 weeks and will be determined by the Cooperative. This distribution and comment period are occurring outside of the formal FERC licensing process. The Cooperative intends to revise the PSP as needed based on the comments received and file the PSP with FERC following an in-person public workshop (see Section 1.3) on a date to be determined (TBD) in the future. It is notable that once the Cooperative files the PSP with FERC, an additional (formal) comment period will be initiated and the public will once again have the opportunity to comment on the PSP.

1.2 Comments on the Proposed Study Plan

Formal comments on this PSP, including any additional or revised study requests, must be filed with FERC by the comment deadline to be determined by FERC following filing of this PSP with FERC. Comments must include an explanation of any study plan concerns, and any accommodations reached with the Cooperative regarding those concerns (18 CFR §5.12). Any proposed modifications to the PSP must address FERC's criteria as presented in 18 CFR §5.9(b). As necessary, the Cooperative will prepare a Revised Study Plan (RSP) to address comments received to the extent practicable. Successive ILP milestone dates will be determined by FERC and adhered to by the Cooperative.

1.3 Proposed Study Plan Meeting

In accordance with 18 CFR §5.11(e), the Cooperative held three virtual/teleconference PSP Meetings. One meeting was held on April 20 and two were held on April 22, 2020 (afternoon and evening). In-person meetings were not permissible due to the COVID-19 pandemic and the associated travel restrictions. The purpose of the PSP Meetings was to present the Cooperative's study plan proposal, as outlined in the PSP, provide additional context and answer any questions in an effort to allow for the most comprehensive review process possible.

1.4 Public Meetings

The Cooperative realizes the importance of public involvement in the re-initiation of this process and throughout the remainder of the ILP. We are committed to a high level of transparency during every phase of this process. As such, the Cooperative hosted a series of two virtual public meetings on September 21 and 23, 2021 to present the recommendations of the ARWG associated with the revised PSP. The timeframe for the public meetings was selected in an effort to both be timely and avoid the commercial salmon season and fall subsistence hunt, to the extent possible. The meetings were held on:

September 21, 2021: 1:00pm – 4:00pm (AK time)

September 23, 2021: 5:30pm – 8:30pm (AK time)

The meeting times and dates were intended to accommodate individuals during both business and evening hours. Detailed meeting agendas and virtual meeting logistics information were provided to the Project contact list in advance of the meetings.

Initially an in-person public workshop was planned for mid-September 2021, but due to COVID-19 concerns, it was decided that in-person Project meetings could not be held safely at this time. In the future, once COVID-19 concerns abate, the Cooperative will reschedule the in-person public workshop. Further details about the workshop including the selected date, location, and remote meeting access will be provided to the Project contact list well in advance of the workshop.

1.5 FERC Process Plan and Schedule

ILP schedule dates will be determined by FERC upon re-initiation of the ILP and adhered to by the Cooperative. A tentative ILP schedule based on a March 1, 2022 ILP-re-initiation is listed in Table 1-2, however, these dates may be revised slightly by FERC when ordering the ILP re-initiation. The Cooperative will adopt the FERC process plan and schedule provided by FERC in FERC's ILP re-initiation order. The Cooperative anticipates FERC Study Plan Determination issuance in 2022 and intends to conduct robust study seasons in 2023 and 2024. At the close of each study season, the Cooperative will produce study reports and hold study report meetings in accordance with ILP regulations. The Cooperative expects to file draft and final license applications in mid- and late 2025, respectively.

Table 1-2. Tentative FERC process plan and schedule.

Pre-Filing Major Milestone	Responsible Party	Date [Required FERC ILP Timeframe]
Proposed Study Plan (PSP) filed	Cooperative	March 1, 2022
Comments due on PSP	Licensing Participants	May 30, 2022 [90 days after PSP filed]
File Revised Study Plan (RSP)	Cooperative	June 29, 2022 [30 days after PSP comments filed]
Revised Study Plan Comments Due	Licensing Participants	July 14, 2022 [15 days after Revised PSP filed]
Study Plan Determination (SPD) Issued	FERC	August 13, 2022 [30 days after revised PSP filed]
File Initial Study Report (ISR)	Cooperative	August 13, 2023
Initial Study Report Meeting	Cooperative	August 28, 2023
File Updated Study Report (USR)	Cooperative	August 13, 2024
Updated Study Report Meeting	Cooperative	August 28, 2024
File Preliminary Licensing Proposal or Draft License Application (PLP/DLA)	Cooperative	January 2025 [Not later than 150 days before filing of Final License Application]
Comments due on PLP/DLA	Licensing Participants	[90 days after PLP/DLA filed]
File License Application	Cooperative	June 2025
License Issuance	FERC	June 2026 [assume 1 year after FLA filed]

Note: Unanticipated study disputes or extension of time requests are not included in this tentative schedule. Any milestone date occurring on a Saturday, Sunday, or holiday is shifted to the next business day.

2.0 PROJECT LOCATION AND DESCRIPTION

The Project would be located in southwest Alaska on the Nuyakuk River approximately 60 miles north of Dillingham, AK (pop. 2,364) near Tikchik Lake in the watershed that drains the eastern side of the Wood River Mountains. The Project site is inside the current Wood-Tikchik State Park boundary by approximately 4 miles. From the Project site, the Nuyakuk River runs approximately 40 miles before converging with the Nushagak River, which continues to Bristol Bay.

The proposed Project is a new 10 megawatt (MW) conventional hydropower project consisting of an intake structure, power conduit, powerhouse forebay, powerhouse, and tailrace channel approximately 4 miles downstream of the Tikchik Lake outlet above a natural Falls on the Nuyakuk River. Power from the Project would be available to the customers of the Cooperative and potentially other areas in the region. The renewable power provided by the Project would represent a significant improvement in the current distribution system and minimize the reliance of local communities on fossil fuels as their primary source of electricity. Currently, the population that would be served by this Project relies wholly on diesel generation, which is barged upstream through the Nushagak River drainage to requisite locations. The reduction of water transport of fuels will reduce the potential for negative environmental impacts due to spills. The primary industry in the Project service area is related to commercial harvesting and processing of salmon. The long-term demand for more reliable, efficient, and cost-effective power along with the likely limited resource impacts makes this Project a highly viable opportunity.

2.1 Project Location

The proposed Project would be located on the Nuyakuk River approximately 60 miles north of Dillingham, AK (pop. 2,364), within the 1,571 square mile watershed that drains the eastern side of the Wood River Mountains (Figure 2-1). The Project site is inside the current Wood-Tikchik State Park boundary by approximately 4 miles. The Project's river intake would divert water from the Nuyakuk River, above Nuyakuk Falls (Falls), located about 4.6 river miles downstream from the Tikchik Lake outlet to a powerhouse located at approximately river mile 5.3 downstream to the base of Nuyakuk Falls. From the Project site, the Nuyakuk River runs approximately 40 miles before converging with the Nushagak River, which continues to Bristol Bay.

2.2 Project Lands

The proposed Project boundary consists of roughly 2,861 acres which includes a 75-ft buffer around all Project facilities and on either side of the proposed transmission line. Acreage of proposed Project lands by ownership is presented in Table 2-1. The Alaska Department of Natural Resources (ADNR) manages a total of about 1,667 acres (58.3 percent) of proposed Project lands. Of this, roughly 266 acres (9.3 percent) is land within Wood-Tikchik State Park. Native lands total about 707 acres (24.7 percent) of proposed Project lands. The remainder of proposed Project lands are owned or managed by the Bureau of Land Management (BLM) (357 acres or 12.5 percent) and private or municipal entities own an additional 130 acres (4.5 percent). See Table 2-1 for exact values.

Table 2-1. Land ownership within the proposed Project boundary.

Owner/Agency	Acreage
State of Alaska (ADNR – excluding Wood-Tikchik State Park)	1,400.72
State of Alaska (ADNR - Wood-Tikchik State Park)	265.85
Native	707.39
Federal Government (BLM)	357.08
Private or Municipal	129.56
Total proposed Project lands	**2,860.60**

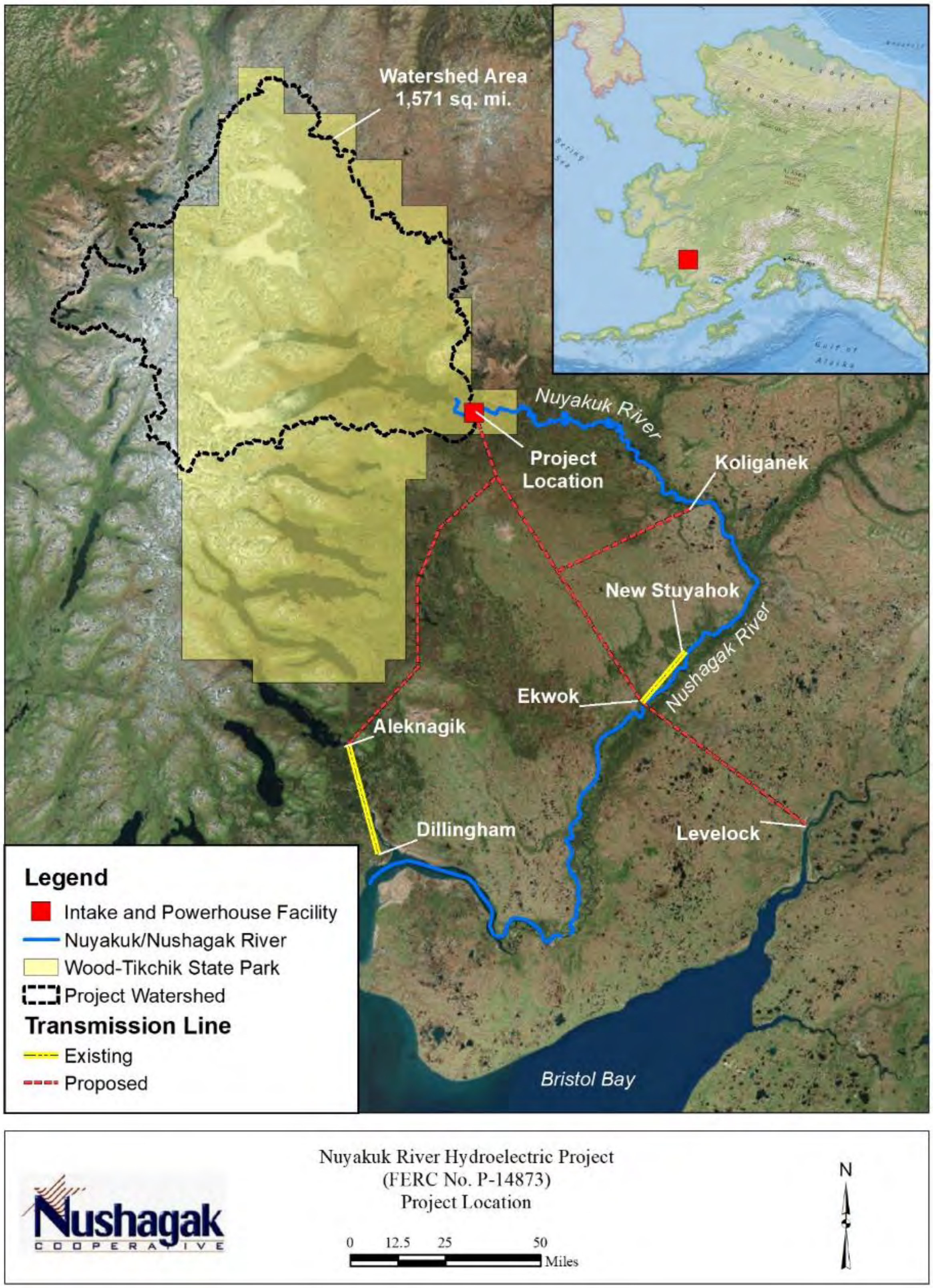

Figure 2-1. Proposed Project location.

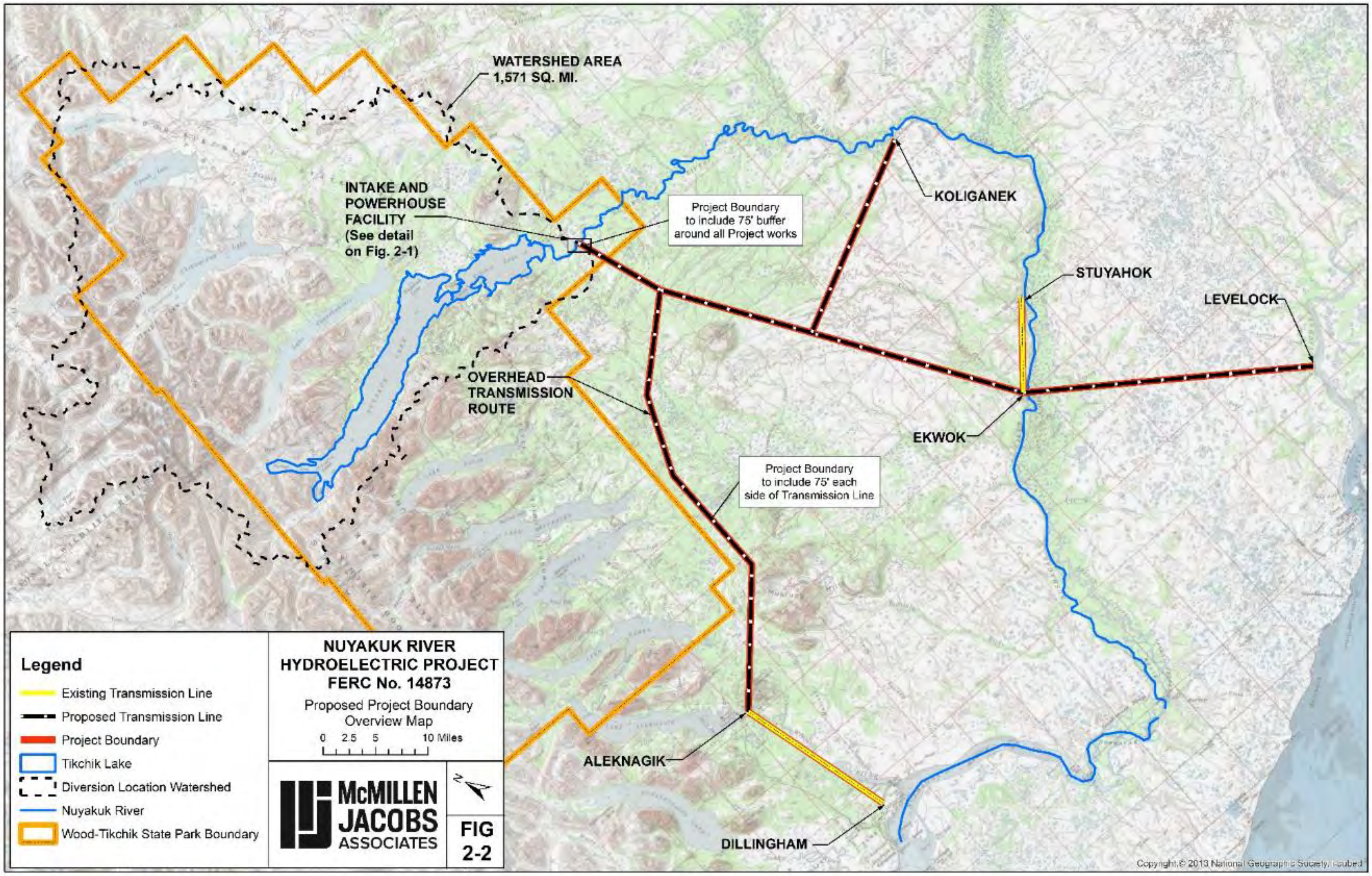

Figure 2-2. Proposed Project boundary.

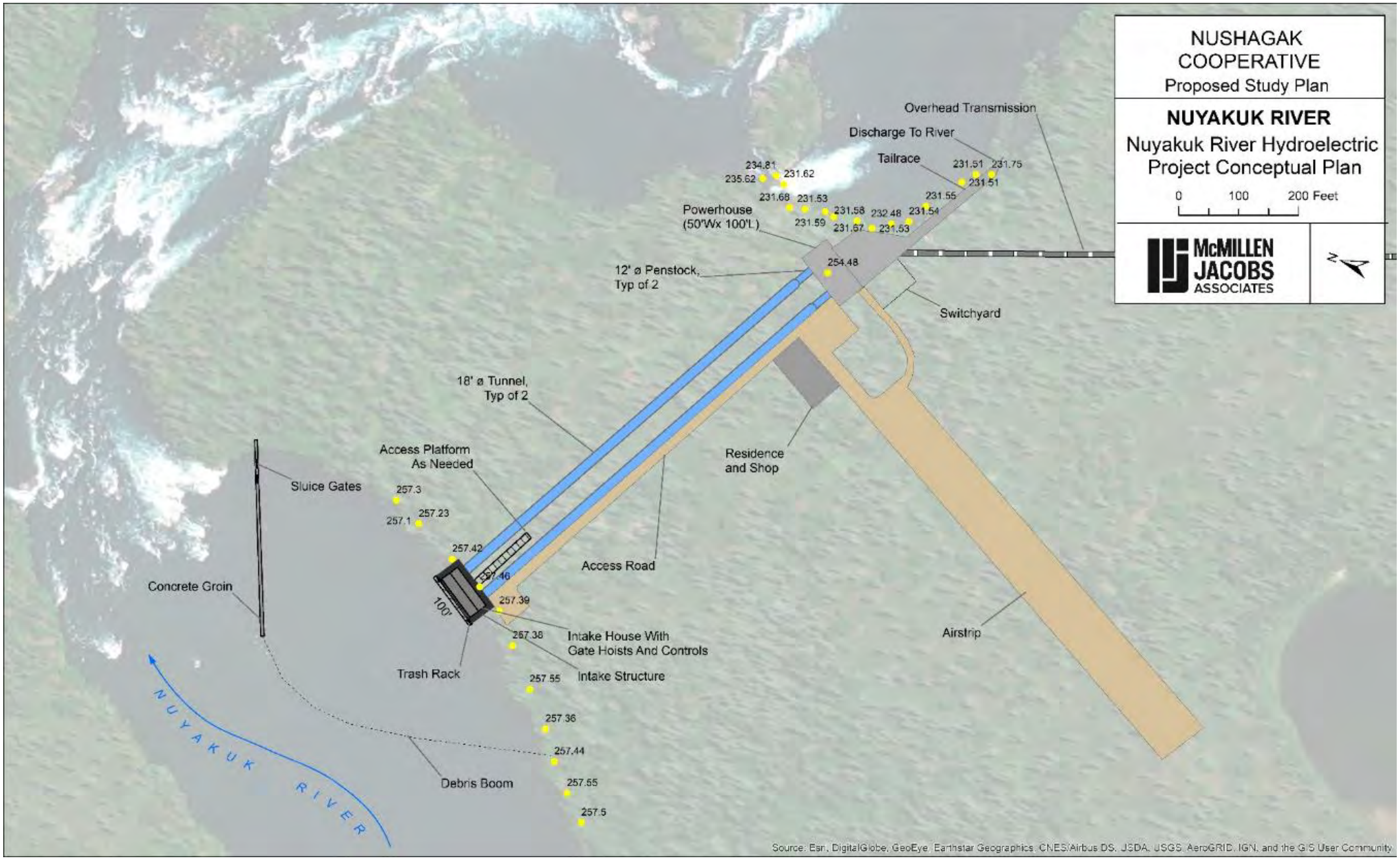

Figure 2-3. Project conceptual plan.

2.3 Project Facilities

The Project will consist of a single primary development centered around a river intake/diversion located above Nuyakuk Falls and a single powerhouse facility located downstream below Nuyakuk Falls (Figures 2-4 and 2-5). Additional Project facilities will include two tunnels to convey water from the intake to the powerhouse, a tailrace conveyance channel to return water to the Nuyakuk River, an airstrip with local access roads, a small building to house a maintenance shop on the lower level and an operators' residence on the upper level, and an electrical transformer and switchyard area to step power up for high-voltage (34.5 kV) conveyance via overhead transmission to Dillingham, AK and the other communities served via the transmission routes. Overhead transmission is currently estimated to cover 135 miles according to the conceptualized route shown in Figure 2-1. The Project will likely also include a lower dock facility located near the powerhouse/tailrace outlet to allow for docking of small watercraft that can navigate the Nuyakuk River back to the Nushagak River.

The powerhouse is conceptualized to contain two Kaplan-style reaction turbine generating units to accommodate a combined maximum design flow of approximately 6,000 cfs divided evenly among the units. This combined maximum design flow ranges between 55% and 80% of the average flow rate for the months of June, July and August, less a design specification of 1,000 cfs for instream uses. The rated capacity on each unit would be approximately 5.0 MW. The gross head on the Project is approximately 26 feet, based on site surveying work that occurred in June of 2019.

Figure 2-4. Nuyakuk Falls, looking upriver toward Tikchik Lake. The proposed Project location is on the peninsula on the left side of the photograph.

Figure 2-5. Nuyakuk Falls, looking across the Nuyakuk River to the proposed Project location.

2.3.1 Summary of Project Features

The proposed Project features have been developed based upon existing physical and environmental information and are conceptual in nature. As part of the pre-filing consultation process, additional information will be obtained through technical and environmental studies, further site-specific topographical and bathymetric surveys to be conducted in the spring of 2020, and continuing research and consultation with equipment manufacturers and resource agencies. As new information becomes available, the design features presented below will be expected refined and/or modified as needed to accommodate any changed conditions, including maintenance of instream flow requirements. Project features as currently envisioned are summarized in Table 2-2 and described in this section.

Table 2-2. Summary of proposed Project features.

SUMMARY OF PROJECT FEATURES	
Number of Generating Units	2
Turbine Type	Kaplan (pit style)
Runner Diameter (estimated)	12-ft
Operating Speed	124.1 rpm
Generator Type	Synchronous
Rated Generator Output	
Unit 1	5.38 MW
Unit 2	5.38 MW
Maximum Rated Turbine Discharge	
Unit 1	3,000 cfs
Unit 2	3,000 cfs
Diversion Forebay Water Surface Elevation	

Minimum (Preliminary)	250.0 (ft NAVD88)
Maximum (Preliminary)	275.0 (ft NAVD88)
Turbine Centerline Elevation (Preliminary)	231.67 (ft NAVD88)
Normal Tailwater Elevation	
Minimum (Preliminary)	214.0 (ft NAVD88)
Maximum (Preliminary)	231.5 (ft NAVD88)
Average Annual Energy (assuming 23.2 feet of net head and an average monthly intake diversion flow of 4,047 cfs or 6.7 MW)	58,900 MWh
Gross Head	26.0 feet ± fluctuation
Net Head at Maximum Rated Discharge	23.2 feet
Watershed Characteristics	
Drainage Area	1,571 sq. mi.
Maximum Basin Elevation	5,250 (ft NAVD88)
Minimum Basin Elevation	248 (ft NAVD88)
Mean Annual Precipitation	59.0 inches
Area of Ponds or Lakes	12.4 %
Nuyakuk River Diversion (To be refined once geotechnical reconnaissance work is completed)	
Structure Type	Concrete Diversion / Low Head Weir (TBD)
Structure Length	100 feet
Average Monthly Water Height above Weir (Max)	5.40 feet
Crest Elevation	250.5
Water Conveyance (Gravity Tunnel from Intake to Powerhouse)	
Intake Style	Gravity (weir or orifice)
Number of Tunnels	2 (or 1 depending on the outcome of geotechnical investigations)
Tunnel Construction Type	TBD once field geotechnical drilling and data are compiled
Length of inclined tunnels to powerhouse	750 feet
Tunnel Velocity at Maximum Turbine Discharge	~ 15 ft/sec
Tunnel Flow Capacity	6,000 cfs
Unlined Tunnel Diameter	25-ft
Final Lined Diameter	23-ft
Powerhouse	
Approximate Dimensions (for three-unit powerhouse)	45 ft x 100 ft x 30 ft high
Finished Floor Elevation	250.0 (ft NAVD88)
Tailrace	
Type	Open Channel
Length	450 ft
Typical Water Depth	8-ft +/-
Typical Width	80 ft up to 300 ft
Transmission Line	
Type	Overhead
Length	Approximately 60 miles to Dillingham; 135 miles total
Voltage	34.5 kV
Access Roads (from Airstrip Runway to Powerhouse)	
Type	Single lane gravel surfacing with turnouts
Length	0.5 miles

2.3.2 Nuyakuk Falls Diversion & Intake

A concrete gravity diversion structure would be constructed above the Falls on the Nuyakuk River. The intake diversion would move water from the southern portion of the river above the Falls into a drop shaft-type structure connected with two 23-foot diameter tunnels. The intake structure could be weir flow or orifice flow, depending on the optimal configuration for both power production and fish species concerns. The intake structure would divert water that is partly impounded by a concrete groin extending out into the river. The groin acts to split the flow of the river between the Falls and the intake. In addition, it may have the added ability to check water up, in the case that an orifice-type delivery method is preferred. The concrete groin would be outfitted with a series of sluice gates or bladder weirs to allow the periodic flushing of accumulated debris or ice.

The inlet zone to the open channel canal would be protected by steel inclined bar-screens (with openings between bars on the order of 1 to 3 inches) to divert both ice and debris away from the open channel and downstream over the natural Falls. The trash rack would be oriented parallel to river flow to maximize sweeping velocity on the rack face, thereby increasing passive flushing of debris from the rack. The trash rack would be necessary to protect both the downstream telescoping vertical gates as well as the downstream turbine units. Final concept design would need to investigate whether or not an additional isolation bulkhead or sluice gates would be needed behind the trash rack for further safety or maintenance purposes. The diversion structure and intake would also be equipped with redundant level transmitters to continuously monitor water levels in these critical conveyance features.

The diversion and intake geometry will be advanced once field site investigations (bathymetry, sub-bottom profiling, and geotechnical drilling) are completed. In addition, two-dimensional river hydraulic modeling will be required for approximately 1,000 lineal feet above the Falls to aid in proper development of the intake diversion hydraulic and structural design. It is anticipated that river hydraulic modeling and geotechnical studies will be conducted as part of the overall Project licensing study program.

Each conveyance tunnel would be equipped with an isolation gate at the intake to be able to independently shut down each tunnel and corresponding turbine unit for maintenance or other emergency (e.g., turbine runaway) considerations. These gates would be co-located with an intake house with gate hoists and controls. The tunnels would extend approximately 750-feet downstream through the bluff, necking down to two 12-foot diameter steel penstocks. The penstocks would include butterfly valves for powerhouse isolation. Each penstock would connect with a 5-MW rated Kaplan turbine house below the slab of an approximately 50-foot wide by 100-foot long powerhouse.

2.3.3 Conveyance Tunnels to Powerhouse

Assuming that a two-turbine powerhouse is the most practical and reliable configuration for power generation, the Project would be developed with either one larger water conveyance tunnel feeding a bifurcation to two penstocks, or two separate smaller tunnels each of which is dedicated to one of the two penstocks and generating units. Better system reliability and Project redundancy would be provided by an arrangement that dedicates a tunnel to each unit, but the cost of providing two tunnels could be higher than that of a single tunnel unit. Advantages of a two-tunnel project would include the following:

- Ability to run one turbine unit while maintenance is performed on the other isolation gate or turbine unit.
- Design of the steel tunnel liners to fit inside the excavated rock tunnels may be significantly easier with the smaller tunnels than it would be with a single large-diameter tunnel.

If on-site geotechnical drilling and investigations show that native rock quality is poor or inconsistent, then it should be assumed that the tunnels would have to be lined with either a welded in-place steel liner (a continuous steel shell liner likely of at least 1/2-inch thickness) or perhaps with a rock-bolt and shotcrete system to protect against the inherent structural weaknesses or deficiencies in the native rock. If steel liners are used, they would be brought in longitudinal arc-sections and seem-welded both longitudinally and horizontally inside the tunnel. Once the steel liners are placed inside the tunnel, the annular void space between the liner and the native rock would be pressure grouted with structural non-shrink grout mixes designed to be pumped and flow through annular spaces.

If on-site geotechnical investigations show that native rock is of high enough quality and consistent enough through the tunnel alignment zone, then it may be possible to omit the need for an interior steel liner or rock-bolt and shotcrete liner system. This configuration would provide a large economic benefit to the Project. Detailed on-site geotechnical investigations, including field drilling and logging, will be used to clarify the design needs of the conveyance tunnels.

2.3.4 Bifurcation to Turbine Units

If a single conveyance tunnel system is pursued for the Project design, it will be necessary to provide a bifurcation design near the outlet to the tunnel and prior to the powerhouse. The bifurcation would be designed of steel pipe and would divide the flow to the two Kaplan units with their horizontal spiral cage inlet configurations. Geometric symmetry would be required to ensure an equal division of flow to the two units when all units are in operation. The low system net heads (estimated at 23 feet or 10 psig [pounds per square inch, gage]) and lack of much external groundwater or other external loading conditions suggest that the structural design and resulting plate thickness of a steel pipe bifurcation system should not be very thick. However, both handling and site-specific seismic considerations will be taken into account in the final bifurcation design.

If two separate conveyance tunnels are pursued for the Project, then the bifurcation structure can be eliminated from the Project.

2.3.5 Powerhouse

The powerhouse would be located on the south bank of the Nuyakuk River near the base of the Falls. The powerhouse is estimated to be approximately 50 feet wide by 100 feet long by 30 feet high to accommodate two Kaplan generating units. The powerhouse would have a large underground foundation that houses the entrance cage to the runners along with the impeller section of each turbine unit. The main superstructure above ground would be a pre-engineered metal building anchored to a concrete foundation.

The powerhouse concept is to contain two Kaplan-type turbine/generator units with a rated capacity of 5.0 MW for each unit at a design flow of approximately 3,000 cfs per unit, with associated switchgear and controls. The centerline of the turbine and generator units would be approximately 232 feet above mean sea level (msl). The tailwater elevation at the powerhouse would range from approximate elevation 225 feet above msl to 235 feet above msl depending upon output level. Final values for these elevations will be determined once the site topographic and bathymetric surveys are completed in 2020. The turbines would be designed to operate at high efficiencies over a range of flows from the maximum of 3,000 cfs to a minimum of around 600 cfs depending on conditions.

2.3.6 Tailrace

The tailrace would be an open rectangular concrete channel approximately 450 feet long and would range in width from about 80 feet to up to 300 feet to convey water back to the Nuyakuk River. The tailrace outlet to the river would be designed to exclude fish from entering the tailrace and to reduce velocities relative to the natural river velocities in the discharge zone. The reduced velocities may minimize the extent to which native anadromous fish are attracted to the Project discharge flow instead of the natural river channel flow pathways.

2.3.7 Switchyard / Transmission Line/Switchyard

The switchyard at the powerhouse will consist of a pad-mounted disconnect switch (i.e., breaker) and a pad-mounted step-up transformer. An overhead 34.5 kV transmission line would run from the powerhouse switchyard approximately 60 miles to a point of interconnection with the NETC electrical system. A right-of-way would be established along the proposed transmission line. This route would be used to construct the transmission line, then serve as a land-based right of way for the Project site. The route would incorporate setbacks from main waterways and alignment changes to minimize visual impacts.

The transmission line poles would be designed as tangent line structures located approximately every 400 feet on center. Transmission line design will also incorporate the latest raptor protection guidelines. Collision avoidance devices will be installed on the line at appropriate locations to protect migratory birds.

2.3.8 Proposed Construction and Development Schedule

The Project would be designed over the 12 months immediately after the license is issued and subsequently constructed over a 24-month timeframe thereafter. Construction would begin in the spring with the clearing of a right-of-way along the transmission corridor and the construction of the localized access road at the Project works on the river. A majority of the large equipment necessary to construct Project infrastructure would be barged up the river and stored at the site during construction activities. An airstrip would be constructed adjacent to the Project site to allow air transport of equipment, materials, and manpower to support construction activities. A fully equipped man camp would be erected for the Project construction staff. Portable generation facilities would provide power for the construction work and man camp facilities. Initially, temporary cofferdams would be constructed at the intake and powerhouse tailrace channel exit zone into the river. This would allow the intake structure, tunnels, and powerhouse construction to advance simultaneously to maximize the work completed during a summer construction season. The intake and tunnels would be completed first, with the powerhouse structure completed immediately following. The generation equipment would be installed, and the balance of plant construction advanced during the winter months. The diversion structure and tailrace channel would be the last components constructed followed by removal of the river cofferdams. These work activities would be completed in the last season followed by startup, commissioning, and initiation of commercial power generation.

2.4 Project Operation

2.4.1 Proposed Project Operations

The primary mode of operation for this Project will be level control, whereby outflow is balanced to inflow. The Project is conceived as a run-of-river project, with no large storage component. As such, power production will mimic some fraction of total river inflow to the Project site. The proposed proportion of river diverted to the powerhouse ranges between 43% and 87% of average river discharge over the calendar year. Currently, Senate Bill 91 of the 2019-2020 legislature establishes that a compatible use by a hydroelectric development at Nuyakuk River Falls maintains at least 70% of the daily flow in the river. One aspect of the proposed fish and aquatic studies in this PSP is to evaluate how a range of diversion rates affect fish and their habitat in the Project Area.

Mean daily discharge for the most recent 25 years in the Nuyakuk River is presented in Figure 2-6, based on United States Geological Survey (USGS) gaging data available at station 15302000 located near the outlet of Nuyakuk Lake. From the figure, it is clear that the period of high flow in the river occurs between early summer and early fall. For the remainder of the year, the river is running at near baseflow conditions. Because the Project will operate in run-of-river mode, sizing the generating units should be done to either 1) maximize power production during a specific time of year (e.g., during the winter months) or 2) produce power more or less evenly throughout the year. Under the current Project conceptualization, units have been sized to provide a stable amount of power from month to month while attempting to minimize overall capital costs associated with the hydroelectric units, tunnels, and other Project components. Average monthly power generation under this operational configuration is shown in Figure 2-7.

When powerhouse flows do not match the system loads, grid system electricity will have to be supplemented with existing diesel generation. This will most likely be in the winter months when the amount of water available to the powerhouse is less than the power demand would require. The transmission grid will therefore have five diesel generation power plants tied together to complete the electric grid system. The existing power plant in Dillingham has the ability to provide energy for all six villages serviced by the transmission system throughout the year, except for the months of June and July. This gives NETC the ability to feed the system from different sources as needed for load or maintenance.

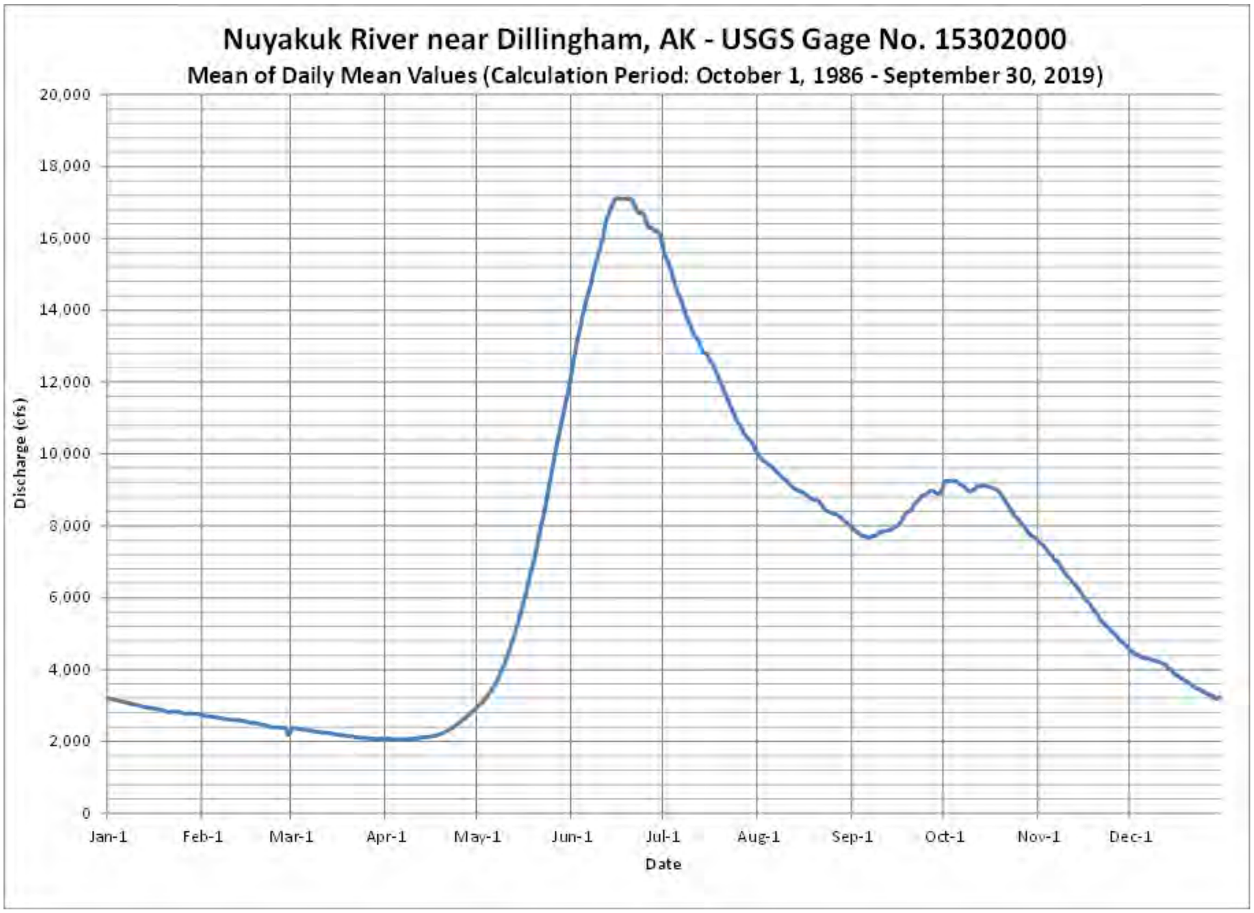

Figure 2-6. Mean daily discharge at USGS Gage No. 1530200 from October 1, 1986 – September 30, 2019.

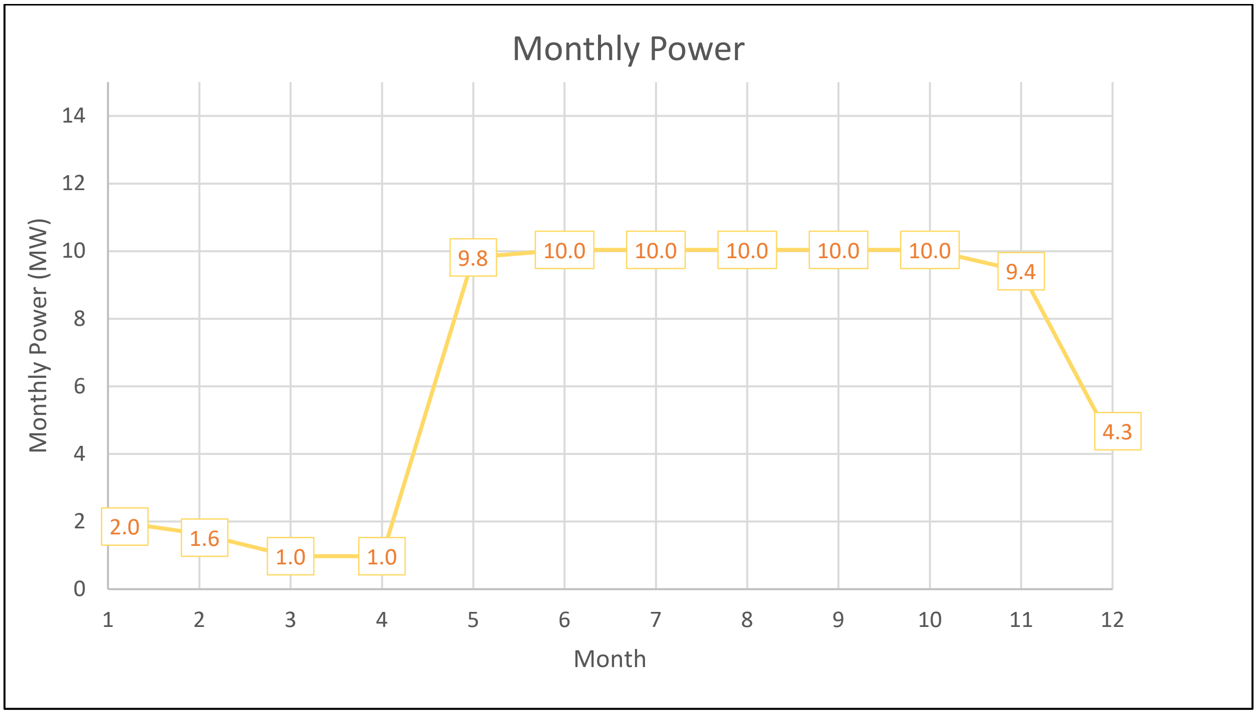

Figure 2-7. Estimated average monthly power generation for the proposed Project.

2.4.2 Project Capacity and Production

The Project will have an installed total capacity of 10.0 MW and is based on the configuration discussed above. Energy production also assumes the Project configuration described above, with two 23-foot diameter tunnels servicing two hydropower generation units over a distance of about 750 feet. For those months in which the total available inflow to the powerhouse is less than the total powerhouse flow capacity, a minimum instream flow of 1,000 cfs has been assumed to pass downstream, while the remainder is passed through the powerhouse to generate electricity. The predicted average annual energy from the Project is 58,900 MWh representing a plant factor of 66%. Estimates will be revised once instream flow studies are completed, and any flow accretions below Nuyakuk Lake are determined.

3.0 STUDY REQUESTS RECEIVED AND RESPONSES

Comments on the PAD and study requests were received from the following individuals and organizations:

- Alaska Department of Fish and Game (ADFG), Division of Sport Fish, Research & Technical Services
- Alaska Department of Natural Resources (ADNR), Division of Parks and Outdoor Recreation, Office of History & Archaeology (PAD comments only)
- Alaska Department of Natural Resources (ADNR), Division of Parks and Outdoor Recreation, Wood-Tikchik State Park Management Council (WTSPMC)
- FERC, Office of Energy Projects
- National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS)
- Royal Coachman Lodge
- United Tribes of Bristol Bay (UTBB)

Comments on the PAD that provide additional details about the Project vicinity natural resources or provide corrections to information provided in the PAD are appreciated by the Cooperative. These comments will be used to inform the PSP and future licensing documents. Any corrections to information presented in the PAD will be reflected in future filings prepared by the Cooperative. Specific responses to comments received on the PAD are presented in Appendix A.

A list of all study requests received, the Cooperative's responses, and corresponding study plans are presented in Table 3-1. Study requests filed with FERC are located in Appendix B.

Table 3-1. Study requests received and corresponding study plans.

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
ADFG	Fisheries Resources	Fish Species Seasonal Distribution and Abundance Near the Project Site	Yes	The Cooperative agrees that conducting a fish species distribution and abundance analysis in the Project area would be beneficial and looks forward to working with stakeholders to define the assessment area. See Section 4.1.1 for further details.	4.1.1: Characterization of the Fish Community and Behavior Near the Project Area
ADFG	Aquatic Resources	Two-Dimensional Bathymetric and Hydrodynamic Modeling of Nuyakuk Falls	Yes	The Cooperative agrees that modeling of the Falls is necessary to document current passage conditions at all flows and the impact to the Falls (positive and/or negative) from incorporating the Project. It is anticipated that the methodology and modeling parameters will be worked out with the agencies during the study planning process in the spring and early summer of 2020. See Section 4.1.2 for further details.	4.1.2: Nuyakuk Falls Fish Passage Study
ADFG	Fisheries Resources	Nuyakuk Falls Fish Passage Evaluation and Modeling	Yes	The Cooperative agrees that modeling of the Falls is necessary to document current passage conditions at all flows and the impact to the Falls (positive and/or negative) from incorporating the Project. It is anticipated that the methodology and modeling parameters will be worked out with the agencies during the study planning process during the spring and early summer of 2020. See Section 4.1.2 for further details.	4.1.2: Nuyakuk Falls Fish Passage Study
ADFG	Fisheries Resources	Fish Entrainment and Impingement Study	Yes	The Cooperative agrees that conducting this desktop analysis would assist in informing the potential for entrainment of fish through Project routes. See Section 4.1.3 for further details.	4.1.3: Fish Entrainment and Impingement Study

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
ADFG	Cultural Resources	Subsistence Survey	Yes	The Cooperative agrees that updating ADFG's subsistence survey data from 15 years ago would be valuable to updating their record and providing a baseline to assess relative to data in the future with the Project in place. Per the ADFG request, it appears that they are proposing to conduct the assessment for the Cooperative, presumably via some fund-sharing agreement. See Section 4.5 below for further details on the Cooperative's proposed approach for this study and we look forward to further dialogue during the study planning process.	Section 4.4.1: Subsistence Study
ADNR/WTSPMC	Geologic and Soil Resources	Research geotechnical integrity of proposed project site and transmission line corridor	No	The Cooperative will be evaluating geotechnical feasibility of proposed Project facilities and structures as part of ongoing engineering and design efforts.	n/a
ADNR/WTSPMC	Aquatic Resources	Research site specific hydro turbine gas entrainment related to ultimate design and operation	No	Given the overall impacts from Project construction and operation the Cooperative doesn't believe this study is warranted.	n/a
ADNR/WTSPMC	Fisheries Resources	Prioritize studying out-migrating juvenile salmon and resident species in water column and vulnerability to design and intake operation	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.1.1: Characterization of the Fish Community and Behavior Near the Project Area Section 4.1.3: Fish Entrainment and Impingement Study

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
ADNR/WTSPMC	Fisheries Resources	Prioritize studying pink salmon on years of abundance. Presence of adult and juveniles alternate biennially.	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.1.1: Characterization of the Fish Community and Behavior Near the Project Area
ADNR/WTSPMC	Fisheries Resources	Study life stage species-specific habitat suitability of water depth, water velocity, substrate and cover affinities	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.1.1: Characterization of the Fish Community and Behavior Near the Project Area Section 4.1.2: Nuyakuk Falls Fish Passage Study
ADNR/WTSPMC	Fisheries Resources	Study potential changes to fish habitat with alterations to water depth and substrate conditions	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.1.2: Nuyakuk Falls Fish Passage Study
ADNR/WTSPMC	Terrestrial Resources	Study and assess caribou population, calving range, migration routes, and potential impacts of noise during construction and operation	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.3.2: Caribou Population Evaluation Section 4.5.1: Noise Study
ADNR/WTSPMC	Terrestrial Resources	Study potential impacts of noise on furbearer presence, trapping, and subsistence use during construction and operation	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.5.1: Noise Study
ADNR/WTSPMC	Terrestrial Resources	Assess the effects of predation of fish by birds in the bypass reach area	No	Given the overall impacts from Project construction and operation the Cooperative doesn't believe this study is warranted.	n/a

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
ADNR/WTSPMC	Recreation, Land Use, and Aesthetic Resources	Evaluate impacts to tourism and commercial businesses impacts during studies, construction, and operation	No	Given the overall impacts from Project construction and operation the Cooperative doesn't believe this study is warranted.	n/a
ADNR/WTSPMC	Recreation, Land Use, and Aesthetic Resources	Evaluate potential impacts to overall recreational experience related to research, equipment, noise, and contractor presence	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.5.1: Noise Study Section 4.5.2: Recreation Inventory by Season
ADNR/WTSPMC	Recreation, Land Use, and Aesthetic Resources	Assess increased access to hunting and effects on hunting regulations	No	Given the overall impacts from Project construction and operation the Cooperative doesn't believe this study is warranted.	n/a
ADNR/WTSPMC	Cultural Resources	Study cultural and subsistence impacts related to potential changes in land use, terrestrial, and fisheries resources	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.4.1: Subsistence Study
ADNR/WTSPMC	Cultural Resources	Study potential changes to portage trail, cultural resources, subsistence uses, and access	No	The Cooperative believes that this study request is consistent with several others received from agencies and studies proposed in this PSP.	Section 4.4.1: Subsistence Study Section 4.4.2: Section 106 Evaluation

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
ADNR/WTSPMC	Socioeconomic Resources	Assess options for transmission route and transportation corridor from Ekwok to Dillingham	No	The Cooperative will be evaluating options for the transmission route and transportation corridor as part of ongoing engineering and design efforts.	n/a
FERC	Aesthetic Resources	Noise Study	Yes	The Cooperative agrees that conducting this study will confirm the limited (if any) impact of noise from the Project relative to the ambient noise from the Nuyakuk Falls. See Section 4.5 for further details.	Section 4.5.1: Noise Study
NMFS	Fisheries Resources	Fish Distribution, Timing of Migration, and Abundance	Yes	The Cooperative agrees that conducting a fish species distribution and abundance analysis in the Project area would be beneficial and looks forward to working with stakeholders to define the assessment area. See Section 4.1.1 for further details.	4.1.1: Characterization of the Fish Community and Behavior Near the Project Area
NMFS	Fisheries Resources	Upstream Fish Passage through Nuyakuk Falls	Yes	The Cooperative agrees that modeling of the Falls is necessary to document current passage conditions at all flows and the impact to the Falls (positive and/or negative) from incorporating the Project. It is anticipated that the methodology and modeling parameters will be worked out with the agencies during the study planning process during the spring and early summer of 2020. See Section 4.1.2 for further details.	4.1.2: Nuyakuk Falls Fish Passage Study

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
NMFS	Fisheries Resources	Downstream Passage and Intake Design	Yes	The Cooperative agrees that modeling of the Falls is necessary to document current passage conditions at all flows and the impact to the Falls (positive and/or negative) from incorporating the Project. It is anticipated that the methodology and modeling parameters will be worked out with the agencies during the study planning process during the spring and early summer of 2020. See Section 4.1.2 for further details.	4.1.2: Nuyakuk Falls Fish Passage Study
NMFS	Aquatic Resources	Flow Duration Curve Change Analysis	No	Per collaboration with NMFS and other partis during the abeyance period, this study and the "Future River Flows" study (see next comment), have been synthesized into a single agreed upon study to be conducted during the study program.	Section 4.1.7: Future Flows Study

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
NMFS	Aquatic Resources	Future River Flows and Water Temperatures	No	Per discussions with the ARWG during the abeyance period, the Cooperative has agreed to conduct the Future River Flows study in collaboration with NMFS.	Section 4.1.7: Future Flows Study
NMFS	Aquatic Resources	Ice Processes Assessment	Yes	The Cooperative understands the concerns associated with potential icing issues and has proposed a study to assess those conditions. See Section 4.2.3 below.	Section 4.2.3: Ice Processes Assessment
NMFS	Fisheries Resources	Assessment of False Attraction at the Tailrace Fish Barrier	Yes	The Cooperative agrees that conducting this study is necessary. See Section 4.1.4 for further details.	Section 4.1.4: Assessment of False Attraction at the Tailrace Fish Barrier
Royal Coachman Lodge	Fisheries Resources	Effect of hydro turbines on salmonids (sockeye, king, and coho salmon smolts; pink salmon alevin and fry)	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG's Fish Entrainment and Impingement Study. See Section 4.1.3 for further detail.	4.1.3: Fish Entrainment and Impingement Study

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
Royal Coachman Lodge	Fisheries Resources	Commercial, Subsistence, and Sport Fishing Economic Study	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG's Subsistence Survey. See Section 4.4.1 for further detail.	Section 4.4.1: Subsistence Study
Royal Coachman Lodge	Fisheries Resources	Resident Fish Passage	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG and NMFS's fish passage study requests. See Section 4.1.2 for further detail.	4.1.2: Nuyakuk Falls Fish Passage Study
Royal Coachman Lodge	Water Resources	Dissolved Oxygen Study	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG and NMFS's fish passage study requests and the Cooperative will incorporate a dissolved oxygen assessment into the methods. See Section 4.2.1 for further detail.	4.2.1: Water Quality Assessment – Dissolved Oxygen and Water Temperatures
Royal Coachman Lodge	Aquatic Resources	Effect of Reduced Water Flows through Nuyakuk Falls	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG and NMFS's fish passage study requests. See Section 4.1.2 for further detail.	4.1.2: Nuyakuk Falls Fish Passage Study
Royal Coachman Lodge	Cultural Resources	Portage Trail Archaeology Study	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, an assessment of the Portage Trail, from a Cultural perspective will be conducted in conjunction with the comprehensive Section 106 process for the Project. See Section 4.4.2 for further detail.	4.4.2: Section 106 Evaluation

Agency	Proposed Study Resource	Proposed Study	FERC Study Criteria	Cooperative's Response	Corresponding PSP Section (if applicable)
Royal Coachman Lodge	Recreation Resources	Recreation Effect and Economics Study	No	The Cooperative appreciates the request. Sufficient detail regarding goals and methodology is not present to determine the feasibility and need for the proposal.	n/a
Royal Coachman Lodge	Aesthetic Resources	Aesthetics and Noise Study	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with FERC's Noise Study. See Section 4.5.1 for further detail.	4.5.1: Noise Study
Royal Coachman Lodge	Aquatic Resources	Project Minimum Flow Requirements Study	No	The Cooperative appreciates the request. While sufficient detail regarding goals and methodology is not present to determine the feasibility and need for the proposal, we believe that the results from the studies proposed below along with the hydraulic model will define both the minimum flows required for continued fish success and the flows that the Project can function with.	n/a
UTBB	N/A	Engineering Feasibility Study	No	The Cooperative appreciates the request and while we don't feel this falls under the category of a required natural resource study, we plan on conducting both extensive bathymetric and geotechnical surveys in 2020 and 2021 to confirm the feasibility of the site for development. While not expected, based on initial analysis, if either of these assessment returns unfavorable results, the Cooperative would not construct the Project.	n/a
UTBB	Aquatic Resources	Flow and Sediment Study	No	The Cooperative appreciates the request and while sufficient detail isn't present to fully understand the intent of the study request, we believe it best aligns with ADFG and NMFS's fish passage study requests. See Section 4.1.2 for further detail.	4.1.2: Nuyakuk Falls Fish Passage Study

4.0 PROPOSED STUDIES

4.1 Aquatics/Fisheries Resources

The following draft study plans were developed to address the structural and operational features of the proposed Project that have a direct connection, i.e., nexus, with the fish and aquatic resources of the Nuyakuk River. Water diversion through the powerhouse is the fundamental action from which most of the potential impacts of the Project originate. Water diversion would reduce flow and may change habitat conditions through the approximately 0.82 mile Falls zone of hydraulic influence that comprises the Nuyakuk Falls, create an additional downstream passage route for fish via the power tunnel/penstock, and redistribute river flow below the Falls to a localized discharge point from the tailrace on the right bank (looking downstream) of the river. Also, the construction of several Project components (e.g., groin, intake, tailrace) will replace existing fish habitat in the river with flow control structures upstream and downstream of the Falls and thereby alter the habitat characteristics of areas in the vicinity of those components. These changes in flow patterns and channel structure have the potential to positively or negatively alter fish and aquatic habitat and affect fish behavior. In addition, any future changes in regional climate may influence the flow and temperature of water entering the Project Area which may influence Project operations (timing and magnitude of flow diversions) necessary to respond to changes in fish behavior and survival. The relationships between the Project and fish / habitat are formalized by nexus statements that describe the most likely impacts, appropriate evaluation metrics and criteria, as well as operational considerations, including monitoring and adaptive management (Appendix C1).

The Project and water diversion operations may affect multiple life stages and species of fish and may result in either individual or population level impacts at or away from the Project (Figure 4-1). In this regard, we have chosen a conceptual and analytical framework approach that describes the likely relationships of those impacts on fish and their habitat. Conceptually, this includes both adult and juvenile fish passing upstream and downstream through the Project Area, and the potential interactions between those components. For salmon, although a substantial portion of their life history takes place outside the Project Area, the health and vitality of the life stages when they are within the Project Area can influence the overall population viability. The framework includes the necessary analytical tools comprised of technical studies, models, mathematical equations, and metrics, and the underlying assumptions that will be applied to quantitatively and/or qualitatively define potential Project effects. One key tool in the overall assessment is the development of a two-dimensional hydraulic model that extends from approximately 1000 ft (0.19 mi) upstream of the powerhouse intake to 1400 ft (0.27 mi) downstream of the powerhouse tailrace (4310 ft or 0.82 mi total). The 2D model will be used to assess hydraulic and fish habitat changes in the Nuyakuk Falls and in proximity to the in-river Project structures. The framework horizon extends over the anticipated life of the Project and will encompass factors such as flow and water temperature that may slowly change over time requiring modification to Project operations to offset potential effects on future populations.

Our proposed approach to formalize the conceptual and analytical framework is to create a Life Cycle Model (LCM). As a numerical tool, it allows the testing of various scenarios and assumptions over space, stages, and time. These analyses support the evaluation of which relationships are most sensitive to changes in the factors that influence them. We can use this tool to quantitatively assess how the Project and its operations may affect specific fish populations.

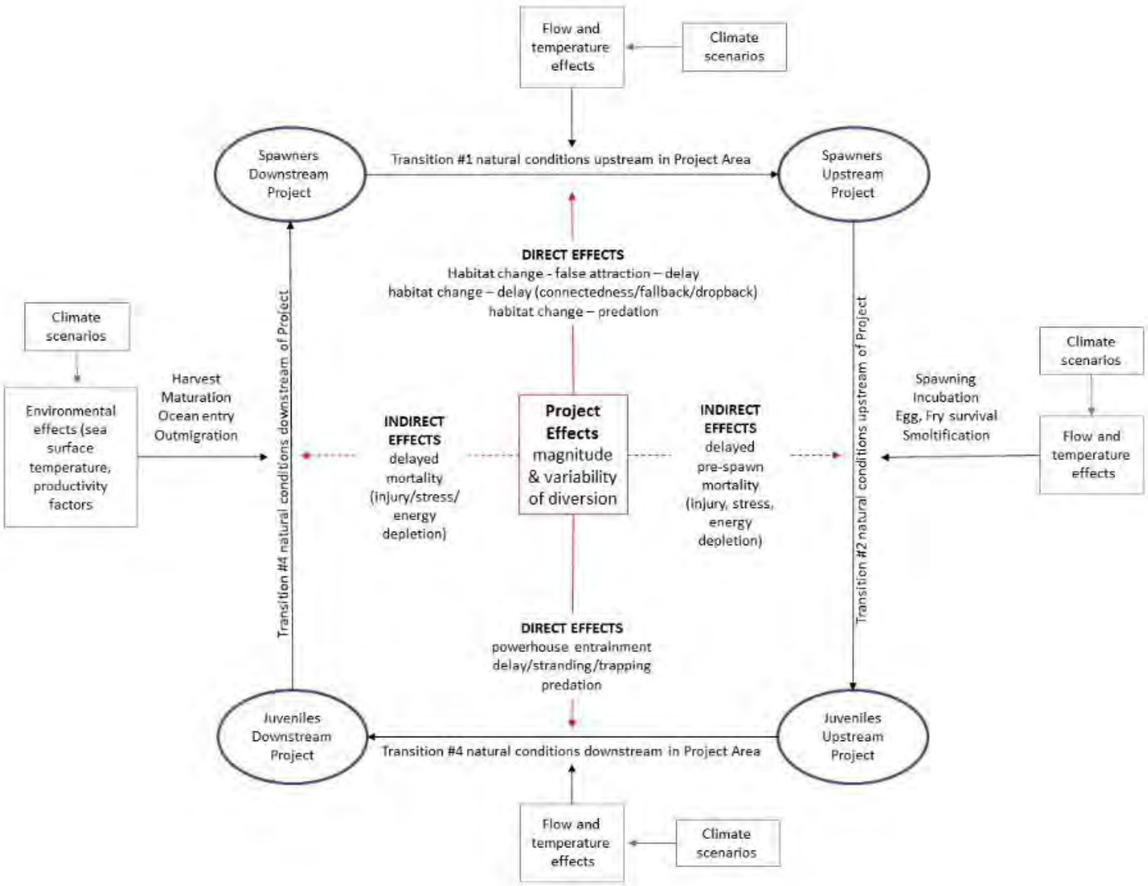

Figure 4-1. Simple salmon life cycle and potential Project impacts. A similar conceptual approach may be applicable to resident species. Time and periodicity are implicit.

As we are working towards development of a customized LCM, we will also proceed toward designing it to support an Integrated Risk Assessment (IRA). An IRA can be described as an approach to evaluate potential Project impacts to fisheries resources at the population level. The IRA will integrate population responses to a range of environmental and Project conditions or scenarios, such that we can evaluate the likelihood of certain benefits and costs associated with the Project across a range of environmental and operational conditions. This component will describe what fisheries relationships are of concern, how risk to those resources will be assessed, and the types of scenarios and sensitivity analyses that may be conducted to identify the extent to which various factors may influence the fish populations.

Nexus statements, the conceptual / analytical framework, Life Cycle Modeling, and the analysis procedures for the IRA are all components that can be used to assist in the design and refinement of specific field and desktop studies. At this time, there are four central potential impacts (positive or negative) associated with construction and operation of the Nuyakuk Project. These include whether, and the extent to which Project operations may:

1. impact the timing, distribution, and overall success of fish moving upstream and downstream through the Falls Reach (defined as the river reach from the point of proposed intake to the downstream end of the pool adjacent to the proposed tailrace);

2. result in direct and/or indirect mortality of downstream moving fish passing via the powerhouse or the Falls Reach;

3. strand or trap fish in the Falls Reach and result in the potential scour of spawning habitat below the Falls and tailrace; and

4. result in migration delay or injury which manifests as delayed mortality of fish due to false attraction at the Project tailrace or changes in habitats below the Falls.

To address the potential Project impacts listed above and described in Appendix C, we have identified fish and aquatic studies for which a proposed study approach is presented. These studies constitute a component of the feasibility assessment for the Project based predominantly on desktop studies, however, this does not preclude the potential need for empirical data collection to validate the findings or investigate a critical relationship. Information from these studies will be used in the LCM and the IRA of various fish species and life stages.

1. Characterization of the Fish Community and Behavior Near the Project Area

2. Nuyakuk Falls Fish Passage Study

3. Fish Entrainment and Impingement Study

4. Assessment of False Attraction at the Tailrace Fish Barrier

5. Sockeye and Chinook Salmon Life Cycle Model

6. Integrated Risk Assessment

4.1.1 Characterization of the Fish Community and Behavior Near the Project Area

4.1.1.1 General Description of Proposed Study

In Section 5.2.3 of the PAD, the Cooperative identifies a series of fisheries studies to be utilized in an effort to document both the existing condition and the level of impact (positive and negative) to the Project area as a result of construction and operations. One of the potential studies was identified as:

- Fish Species Seasonal Distribution and Abundance Near the Project Site
- In addition, the Cooperative conducted extensive study collaboration with the Aquatic Resources Working group through 2020 and into 2021. This collaboration identified the need to also characterize the current migratory behavior of targeted fish species, specifically Sockeye and Chinook Salmon.

Per multiple PAD comment and study request letters, including those from ADFG and NMFS, the Cooperative received general concurrence with their proposal to conduct this study and looks forward to collaborating with all interested stakeholders in further defining the specific area of assessment and associated methodologies to utilize for this study.

4.1.1.2 Geographic Scope

The Cooperative proposes to conduct seasonal species abundance and distribution surveys for resident and anadromous salmonids in potential areas of Project impact from approximately 0.5 miles upstream of the Nuyakuk Falls (the Falls) to an area approximately 0.5 miles downstream of the Falls, which includes the proposed tailrace area of the Project (Figure 4-2). Based on current design, this 1.36 mile study area would account for the entire area of potential flow alteration associated with Project operations. At this time, it is not anticipated that a significant amount of upstream natural flow alteration would occur more than 0.5 miles upstream of the intake and all flow is anticipated to be returned to the system well within 0.5 miles downstream of the Falls.

There will be three key zones of study in which, a variety of methods may be used depending on likely efficiency of data collection and safety considerations. Those three zones are as follows:

- Zone 1 – 0.5 miles upstream of the Nuyakuk Falls with the downstream end of Zone 1 located at the Falls hydraulic control (Upstream of Falls);
- Zone 2 – The Nuyakuk Falls Reach from the upstream hydraulic control to the Falls tail-out (Falls); and
- Zone 3 – From the tail-out of the Falls to 0.5 miles downstream (Downstream of Falls)

The extents of the study area may be modified according to new information on hydraulics and flow field generated from 2D modeling. In addition, activities such as fish collection for telemetry may occur outside the proposed study area.

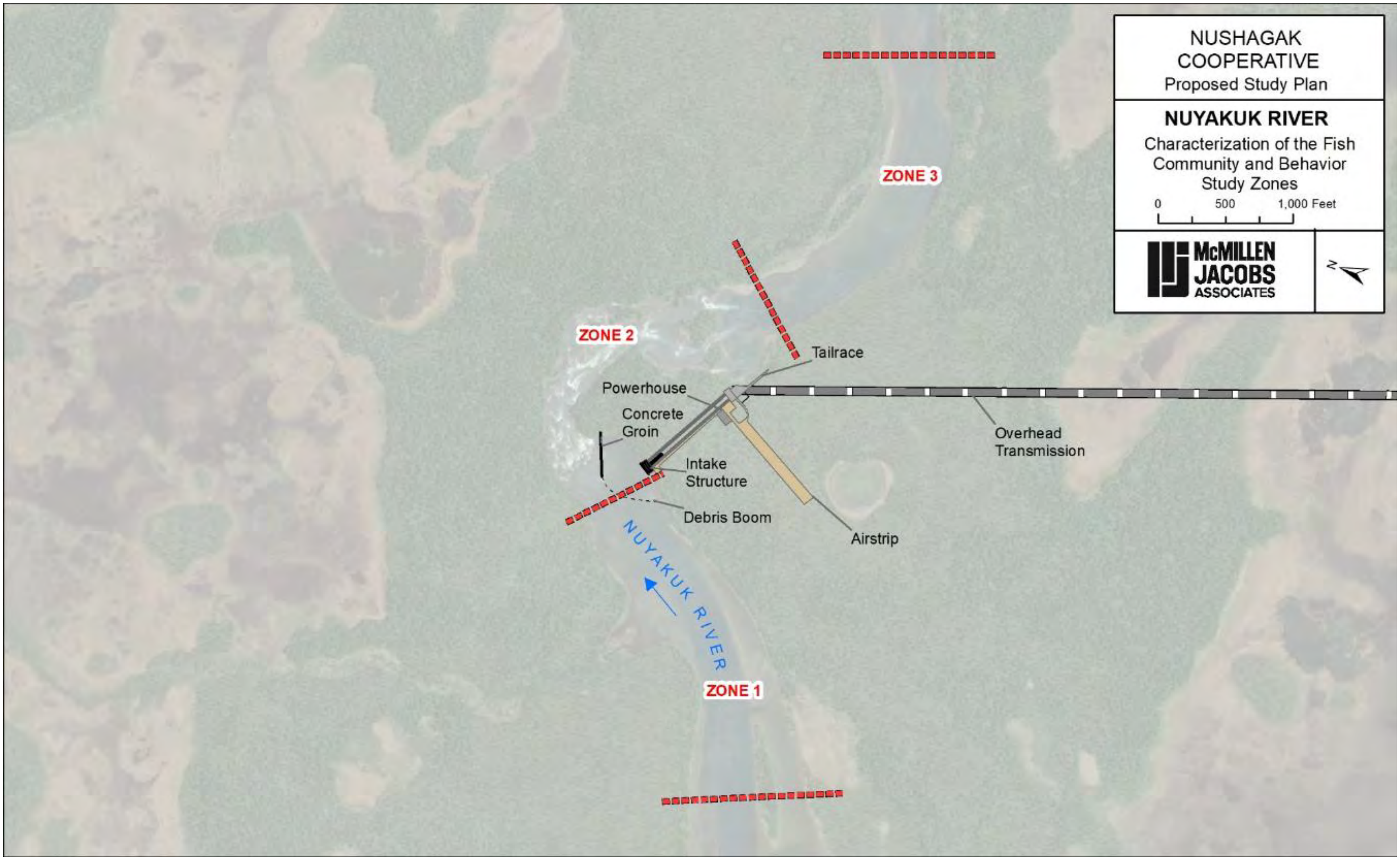

Figure 4-2. Proposed characterization of the fish community and behavior near the Project area study Zones 1-3, Nuyakuk River, Alaska (FERC No. 14873).

4.1.1.3 Study Goals and Objectives

The primary goal of this study is as follows:

Determine the seasonal species composition, relative abundance, habitat use and migratory patterns of fishes within the Project Area.

Eight specific questions will be addressed by this study.

1. What fish species use the aquatic habitats in the Project Area across seasons?
    a. Focus on piscivores at intake, groin, in the Falls, powerhouse tailrace, Falls tailout
2. What is the relative abundance of fishes in the Project Area seasonally?
3. What are the baseline migratory patterns and behaviors (such as timing, holding, number of attempts) evident for Sockeye and Chinook Salmon passing upstream through the Project Area?
4. What is the proportion of adult salmon that successfully pass through the Falls Reach under baseline conditions?
5. What is the baseline condition of injury/mortality in adult salmon observed downstream of the Falls proper?
6. What is the baseline migration pattern and distribution across the channel for Sockeye and Chinook Salmon passing downstream through the Project Area?
7. What is the proportion of juvenile salmon that successfully pass through the Falls Reach under baseline conditions?
8. What is the baseline condition of injury/mortality in juvenile salmon passing the Falls proper?
9. Is there visual evidence of avian or mammalian predation of salmon smolts in the Project Area across seasons?

4.1.1.4 Relevant Resource Management Goals

Five species of anadromous salmonids and multiple resident species are known to utilize the Nuyakuk River at some point during their life cycle. Limited data exists documenting the extent to which they utilize the proposed Project area and/or the watershed upstream.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.1.5 Existing Information and Need for Additional Information

Available fisheries data for the Nuyakuk River was summarized in the PAD; however, since PAD development, additional data have become available and may provide additional insight into fish community and habitat use in the Project Area. A brief review of the Alaska Department of Fish Game's Anadromous Waters Catalog indicated that five species of Pacific Salmon have been documented upstream of the Project Area in the Tikchik River (Johnson and Blossom 2019). In addition, Sockeye Salmon escapement data for the Nuyakuk River is available for the period from 1950 to 2006. These daily counts also provide an historic record of run timing for adult Sockeye Salmon entering the Project Area.

More site-specific information is necessary to fill data gaps needed to adequately define the existing condition at the proposed Project site and assess any potential impacts (positive and negative) associated with Project development and operations. The Cooperative looks forward to continued collaboration with stakeholders over the next few months in developing and refining the best suite of methods to effectively characterize the fish community in the Project Area.

4.1.1.6 Project Nexus

The proposed Project would divert a percentage of Nuyakuk River flow from upstream of the Falls through a powerhouse at a variable rate over time. All water would then be returned to the natural channel immediately below the Falls resulting in a short bypass reach consisting almost entirely of the Nuyakuk Falls section and herein called the Falls Reach. Riverine habitat in the Falls Reach would change in quantity and composition of habitats due to a reduced quantity and altered distribution of flow. Channel configuration, substrate composition, and the composition and configuration of habitat below the Falls proper could also be modified. Some riverine habitat will be replaced with water conveyance structures. These potential changes in fish habitat may affect the timing, distribution, relative abundance, and survival of the present fish community and respective behaviors. Appendix C contains a more comprehensive listing of primary and secondary Project nexus issues, methods and hypotheses related to potential operational effects in the Project Area.

Understanding the seasonal presence and distribution of anadromous and resident salmonids and the seasonal habitat use by fishes in the Falls Reach will be essential for evaluating the impacts (positive and negative) associated with Project development and operation. For specific study activities, such as observational/telemetry tasks, target species will be selected in cooperation with the Aquatic Species Working Group.

4.1.1.7 Methodology

The Cooperative has a vested interest in developing a collaborative study that effectively meets the needs of the stakeholders while at the same time focuses on the area of potential impact. As such and per commitment from stakeholders such as ADFG, NMFS and BBSRI, the Cooperative will continue working with stakeholders to refine study methods to be utilized to ensure both effective documentation of existing conditions and a safe study design for all biologists in the field.

There are numerous methods that can be used for sampling fish in riverine systems, but the effectiveness of each is highly dependent on prevailing sampling conditions (water velocity, depth, turbidity, water temperature, etc.), target fish species and life stages and their behavioral characteristics, and the timing of sampling. Based on available information, the Cooperative has developed a preliminary study plan for consideration, that includes a number of candidate sampling methods deemed initially suitable for the three zones of the Project study reach. The overall methodology includes an initial compilation and review of literature and available data. This review and each of the methods under consideration are described below.

Literature Review

This study will begin with a comprehensive literature review summarizing available information on fish abundance, distribution, and species periodicities in the Nuyakuk River. The review will include information presented in the PAD as well as data sources identified by NMFS in their February 4, 2020 Study Request such as ADFG tower counts, Brennan et al. 2019, Igiugig Project (P-13511), Daigneault et al. 2007 and other similar drainages in Bristol Bay. The literature review will ultimately result in a better understanding of species potentially present at the Project, the species-specific periodicities of use of the Project area, and potential interannual variability in run timing.

Understanding the species and life-stage specific periodicities of fish in the Nuyakuk River will be important for determining appropriate sampling times for certain fish species likely to be present, especially during migrations. The initial periodicities will be based in part on a general understanding of the local populations as described in the published literature and refined via collection of site-specific data. The Cooperative has identified the following potential data sources and literature that may be useful in defining species and life stage periodicities:

- Bristol Bay Science and Research Institute Reports
- Observation Tower Counts 2003-2006
- Aerial Escapement Counts 1967-1999
- Spawning Ground Surveys

- Alaska Department of Fish and Game Management and Sport Fish Reports
- Alaska Department of Fish and Game e-Library
- Radio Telemetry Data 2000-2006
- Commercial and Sports Catch Records
- Run Timing Data and Statistics 2006
- Travel Time and Migration Rate Reports
- University of Washington –Alaska Salmon Program
- U.S. Fish and Wildlife Service
- Alaska State Parks
- FERC Document e-Library
- Local Fishing and Conservation Groups

Based on this review and discussions with state and federal agencies and stakeholders, a species/life stage periodicity chart will be developed for use in the Aquatics and Fish Resources studies. A preliminary example of periodicities for the major commercial and sport-fish species of the Nuyakuk River based on an initial review of published and unpublished information is shown in Table 4-1.

Table 4-1. Preliminary life-stage periodicity for a sample of the fish species utilizing the Nuyakuk River, Alaska. Subject to revision.

Species[1]	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook Salmon	Adult Migration												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
	Juv. Outmigration												
Chum Salmon	Adult Migration												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
	Juv. Outmigration												
Coho Salmon	Adult Migration												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
	Juv. Outmigration												
Pink Salmon	Adult Migration												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
	Juv. Outmigration												
Sockeye Salmon	Adult Migration[2]												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
	Juv. Outmigration												
Arctic Grayling	Adult Rearing												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
Dolly Varden	Adult Rearing												
	Spawning												
	Fry Emergence												
	Juv. Rearing												
Rainbow Trout	Adult Rearing												
	Spawning												
	Fry Emergence												
	Juv. Rearing												

Candidate Fish Sampling Methods

The Cooperative has identified various fish sampling methods that may be applicable for the Project area. However, application of methods will differ between zones due to varying sampling conditions that in Zone 2 include areas that would be hazardous to sample. As a result, the surveys conducted in Zone 2 will be limited due to both effectiveness of the methodology and constraints in sampling imposed by hazardous conditions. Strict safety protocols will be developed and employed during all fish sampling activities.

In Zones 1 and 3, the Cooperative suggests application of a systematic seasonal sampling approach targeting juvenile Pacific salmon and resident fish species. For this, five transects would be established at 200-meter intervals in Zones 1 and 3; each transect will be surveyed at least once for each season (spring, summer, and fall) (Figure 4-3). The Nuyakuk River is approximately 100-180 meters wide at the Project area. Directed fish collection techniques will likely focus on the margins of the stream banks due to the potentially hazardous conditions across the rest of the channel. Fish collection surveys will occur over a 50-m-long reach located on both stream banks beginning at the downstream end of each transect. We will use at least 3 sampling methods within the transect area to maximize potential for capturing different species and lifestages that may occupy different habitats. Given multiple methods to deploy, it is anticipated that each sampling event will last 10 days to cover the 10, 50m transects. Three survey events would occur from April through September over a range of flow conditions. Based on the average annual hydrograph, sampling events are proposed during low flows in April to May (during lower spring discharge conditions), June to July (during high flow conditions), and again in August to September (under decreased flow conditions) (Figure 2-6). This fish collection window will allow for surveys to cover the majority of time that fish would likely be migrating through or residing in the Project area. In coordination with the entrainment study, hydroacoustics (split-beam echosounder, ARIS / DIDSON imaging sonar) may also be used to characterize the horizontal and vertical distribution of downstream migrating salmon (smolts, fry) as they approach the Falls and proposed Project. If deployed hydroacoustic sampling would be combined with fish collection methods to validate species detections.

Suggested fish collection techniques include beach seines, minnow trapping, electrofishing, and gill/trammel netting. Upon completion of the reconnaissance survey, the most effective sampling methods will be selected for each transect and stream bank based on site conditions and effectiveness/safety constraints. Beach seining with a skiff may prove feasible for sampling areas of deeper water. The use of multiple methods will allow for the collection or observation of the diversity of fishes and life stages that are anticipated to be encountered in the Project area. To facilitate comparison among sampling events, to the extent possible and given that conditions may change and preclude the use of a gear type (e.g., visibility may change from survey to survey), the same methods will be implemented with a similar level of effort at each transect and bank on return visits.

As noted above, fish sampling in Zone 2 will occur on an opportunistic basis at locations that are determined safe to sample based on depth and velocity (Figure 4-3). Instream margins will be the focus in Zone 2to identify juvenile rearing opportunities within the Falls section. The primary survey methods to be used would include backpack electrofishing and minnow trapping. Fyke netting might be an option on a limited basis if conditions allow for safe deployment and retrieval. Likewise, stationary underwater video or sonar-based monitoring may prove useful for data collection while minimizing in-water work. Using the results of the bathymetric survey (from the Fish Passage Study), fish surveys in Zone 2 would target potential stranding areas to evaluate fish use under the existing and potential future flow regimes. Fish surveys in Zone 2 would occur on the same seasonal sampling schedule as Zone 1 and 3. Assuming flow conditions allow, we will sample the same sites at each of the three sampling events to look for changes in fish occupancy over the open-water period. Sampling efforts in July and August may provide additional information on fish stranding potential as flows are typically descending during these months (Figure 2-6). Proposed survey areas and techniques for Zone 2 will initially be evaluated for safety and identified during the reconnaissance survey. Fish abundance and distribution surveys will also visually identify migratory fish behavior occurring in the study area while capture techniques occur. Specific data forms will be generated to enumerate counts of salmon that are observed to be actively staging, spawning or holding within the cascade. These data will be used to compare peak number per day and movement patterns past points above and below the proposed Project.

Figure 4-3. Candidate sampling locations within zones 1 and 3 for characterizing fish community and behavior near the Project area.

Beach Seines

Hand-held beach seines (approximately 10 m long, 1.5 m deep, comprised of 3-6 mm mesh) may be used to target juvenile salmon and small-bodied resident fish species. Hand-held seines can be deployed in shallow areas along banks and islands with one end of the net anchored to the shore and the other end extended out from shore and then looped around to encircle the fish as the ends are pulled in against the beach or gravel bar. Larger beach seines (approximately 50 m long, 3 m deep, comprised of 13-25 mm square mesh) may be used to target adult resident fish species. A 30 m lead and bridle assembly will be attached to each end of the beach seine which will be deployed from shore with a motorized skiff. Multiple seine pulls will be required to successfully sample each 50-meter study reach.

Minnow Trapping

Minnow traps are an effective method for passive capture of juvenile salmonids and other juvenile resident fish species in slow moving water habitats such as pools and sloughs (Bryant 2000). Wire and/or fabric minnow traps will be baited with commercially sterilized salmon roe and soaked overnight for 16-24 hrs. Approximately 5-10 minnow traps will be deployed at each study transect/stream bank. Each study site will be delineated into sample quadrants and the number of minnow traps will be equally distributed among quadrants. Minnow traps will be placed on the stream bottom, parallel to the current in areas of cover. To prevent the loss of traps, each trap will be anchored to the stream bank by a tether line connected to the minnow trap and individually identified with flagging.

Electrofishing

Electrofishing is a widely used method to assess fish presence, relative abundance, and distribution that has been used successfully by ADFG in the Project Area (Zone 3) to document fish presence. Electrofishing is effective for a wide range of fish species, life stages, and habitat types. Electrofishing is an effective methodology to survey juvenile life stages and small-bodied fish species but can also be utilized to survey adult fish (Temple and Pearsons 2007). Electrofishing surveys are generally limited by ADFG during the presence of adult salmon. Thus, adult migration will likely restrict the window of opportunity and or location for electrofishing surveys. However, electrofishing surveys may prove to be a valuable tool when adult salmon are not present within the Project area.

Backpack electrofishing may be used as a sampling technique in wadable reaches such as along banks or islands. A Smith-Root LR-24 backpack electrofishing unit will be operated by a trained field crew leader and assisted by two people with dipnets. In all cases, the electrofishing unit will be operated and configured with settings consistent with state and federal guidelines and those established by the manufacturer (SmithRoot 2009; ADFG [Buckwalter 2011] and NMFS [2000]. Single-pass qualitative surveys will be conducted through the study reach moving in an upstream direction. All captured fish will be held in buckets, identified and measured, and released in close proximity to their capture location.

In study site locations that are too deep or too swift to safely operate a backpack electrofishing unit, boat-based electrofishing may be used as a fish sampling technique. Boat electrofishing was used by ADFG during the 2006 inventory sampling downstream of Nuyakuk Falls (ADFG

2006). Boat-mounted electrofishing is the most effective means of capturing fish in deeper waters (i.e., 10 ft maximum depth), along steep stream banks that are inaccessible via wading (Temple and Pearsons 2007). Boat electrofishing will be conducted while moving in an upstream direction by an experienced three- or four-person field crew. One person will operate the boat, while the field crew leader operates the electrofishing unit and one or two netters capture stunned fish. The boat will be outfitted with either a Smith-Root 2.5 Gas-Powered Pulsator (GPP) electrofisher powered by a smaller generator for use in low-conductivity waters or a 5 GPP electrofisher for use in higher-conductivity waters. Boat electrofisher settings will be determined in the field based on water quality conditions, professional judgment, and the overall goal of minimizing impacts to fish health (Temple and Pearsons 2007). Should boat electrofishing be permitted as a survey technique, the sample reach shall be comprised of a single qualitative pass down the entire 800-meter length of Zones 1 and 3 (Figure 4-3). Boat electrofishing will be conducted on both banks as well as deeper water areas and unique habitat features such alcoves, backwaters. side channels, sloughs, and tributary mouths.

Gill / Trammel Netting

Gill nets and trammel nets can be an effective technique when sampling for the presence and relative abundance of fish populations for a wide range of anadromous and resident species, life stages, and habitat types (Crawford 2007). Gill nets or trammel nets provide an alternative technique for sampling deeper, non-wadeable, mid-channel waters in the event that boat electrofishing is not effective or restricted by permit stipulations. These net types are designed to collect fish by entangling them as they try to swim through the mesh and as a result are not species selective. One limiting factor of gillnets is that because they are designed to intentionally entangle fish in the net mesh, fish mortality can be high. The mesh size used typically varies depending on the species and life stage targeted, with smaller mesh being more effective for juvenile life stages and smaller-bodied species (Crawford 2007). Trammel nets differ from gill nets in that instead of a single wall of netting, trammel nets consist of three layers of netting tied together on a common floatline and leadline. Gill nets can be deployed in a range of habitat types in streams, rivers and lakes. At sites with current, gill nets will be deployed as drift nets and allowed to drift with the current through the sample area. At in slow water habitats gillnets will be deployed as set (fixed) nets for a pre-determined amount of time. When used for sampling, drift and set gillnets will be fished perpendicular to the stream channel (Crawford 2007). Ideally, nets will cover the entire depth of the stream channel where set. A range of gill net sizes may be used from 50 to 125 feet in length and 6 to 8 feet in depth. Variable monofilament mesh sizes ranging from 0.5 to 2.5 inches may be used to target a range of fish species and sizes. When drift gill nets are selected for use, they will be deployed and allowed to float through the 50-meter long sample reach at transect before being collected. Multiple passes may be necessary to adequately sample the channel width. In order to reduce the variability between sites and seasons, sampling efforts will be standardized by using similar drift distances or soak times. Soak times for set gill nets will be developed with input from resource agencies.

Adult Salmon Migratory Behavior Observation

Methods for characterizing migratory behavior of adult Sockeye and Chinook salmon may include visual survey methods or active bio-telemetry. Field testing in 2022 will inform the potential effectiveness of active telemetry, passive and or visual observation to meet study objectives. Field testing and selection of most effective methods for evaluating adult behavior will be conducted in collaboration with the Aquatic Resources Working Group.

Visual surveys alone, or in combination with biotelemetry (radio or acoustic) will be used to estimate the timing, number, and migratory patterns of adult Sockeye and Chinook salmon as they migrate and spawn within the study area and can be accomplished by use of helicopters, aerial drones, visual counts from elevated platforms, or underwater counts based on video or sonar imagery collected at specific points in Zone 1-3. The study area for visual surveys will begin at the downstream end of Zone 3 and extend to the upstream end of Zone 1 (approximately 2.5 km (1.5 mi) in length). Visual surveys will be designed to document the spatial and temporal distribution of salmon within the study area, evaluate trends such as peak count per day and density of fish passing through different routes of Zones 1-3. Based on a preliminary review of fish periodicity at Nuyakuk Falls (Table 4-1), any aerial/visual surveys should begin in mid-June prior to the arrival of Chinook, Chum, Pink and Sockeye salmon and continue through the end of October for documentation of the Coho Salmon migration. Surveys will be weather dependent and should be conducted at roughly two to five-day intervals. Species-based intervals can be developed based on the information developed from the literature review and input from regional biologists.

During surveys, adult salmon in each study zone will be enumerated by species. Environmental conditions (weather, water clarity/turbidity, discharge/depth, sun angle, glare, etc.), survey extent or flight path, areas of fish concentrations, and fish behavior (e.g., holding, migrating, staging, spawning) will also be recorded during each survey. It is anticipated that multiple passes will be necessary to cover the study area especially when multiple species are present. To collect information on passage routes and holding/resting pools areas in Zone 2, multiple passes will be made focusing on documenting the spatial distribution of fish (e.g., left bank, center, right bank, various chutes, or sides of islands) as they move upstream. Any instance of adult salmon holding, milling, searching, or jumping at passage obstacles will be noted and included during modeling efforts to identify risks or stranding/ trapping/ migration delay under the Fish Passage Study. The specific upstream and/ or fallback route selection for adult salmon could also be documented using bio-telemetry technology for a subset of adults of each species, captured and tagged during upstream migration at a point downstream of Zone 3. Documentation of fish spatially in Zone 2 will provide a general understanding of fish passage routes through the Nuyakuk Falls cascade under a variety of flow conditions and may be useful in interpreting hydraulic conditions under the fish passage study. However, it is anticipated that turbulence, air bubble entrainment, or depth may preclude observations in some areas or at certain flows. The focus of aerial surveys is adult salmon; however, if possible, information on other species will be collected opportunistically.

Visual surveys may use a helicopter or un-manned aerial vehicle (UAV, drone) technology. Drone technology is currently being developed for use by ADFG and subcontractors for Coho and Sockeye counts in some Alaska river basins (ADFG 2018; KUCB 2018, 2019). A specific study will provide the details on un-manned flights if/when UAV is selected as a suitable survey technique. Aerial surveys will also utilize photo or video documentation with high resolution/frame rate camera with a polarizer to provide imagery for data analyses. Due to high velocities within the Falls, any telemetry surveys would require use of fixed antennae arrays in the immediate Project area; but this could be combined with mobile surveys via helicopter to monitor tagged fish outside of the Project Area (radio telemetry only). In addition to providing counts and timing, aerial/telemetry surveys could be used to document whether fish hold or rest in pools located within Zone 2. During the spawning season, aerial surveys in the study area may also provide information on whether any spawning occurs within the proposed bypass reach, specifically near proposed Project elements (e.g., tailrace, intake, or groin locations), and will allow for documentation of the nearest redd locations to the Project. Photo or video documentation will provide imagery for later playback and analysis of fish position within the cascade, if necessary.

Visual surveys completed in reaches above and below the Falls Reach will identify areas where potential spawning gravel may exist including the area within and downstream of the proposed tailrace. Any gravel observed during visual surveys will be documented, sampled to determine size classes present, measured for total area, and flagged in the project database to avoid human traffic on potentially sensitive spawning areas during other sampling operations. If spawning is observed, output from 2D models will be reviewed to define areas where potential changes in operational flows could dewater or scour observed redds. The potential impact area to potential for fish incubation effects based on estimates of redds/square meter and embryo per redd (estimated from literature by species) will be related.

Downstream Migrant Trapping/Migration Pattern Observations

In addition to transect sampling, the use of downstream migrant traps, either via floating trap (rotary screw, incline plan, or fyke net) or seining, will specifically target downstream migrating juvenile salmon and movements of other fish species. Downstream migrant trapping will be conducted to develop site-specific information on the migratory timing and size of juvenile salmon and other migratory fishes that will be used by the Fish Passage and Fish Entrainment and Impingement Studies. Downstream migrant trapping may occur at several locations in the Project area to account for spatial variability; however, survey efforts will be focused in Zone 1 near the proposed Project intake (Figure 4-3). Downstream migrant trap/collection will provide a baseline for migratory timing and relative abundance along the bank of the Nuyakuk River from which the proposed Project would draw water. This will also provide an opportunity for marking with transponders of juvenile fish that may be used during telemetry-based evaluations of downstream passage route selection, survivorship through Zones 1-3, impingement/ entrainment, and other metrics.

Prior to selecting a specific trap/seining location, the area near the proposed intake will be evaluated during 2022 field testing to find a site that has suitable depth and velocity conditions, a trap attachment location, and is safe to access over a range of anticipated flows. If conditions in Zone 1 near the proposed intake are not favorable to migrant trapping or if other locations provide ancillary data for evaluating the Project, additional migrant trap study locations may be added in collaboration with stakeholders in technical working group meetings. It is anticipated that small-mesh fyke netting may also be an effective collection technique for downstream migrants and, depending on flow conditions could be utilized to supplement trapping efforts or gather additional migration data within micro-habitats that are not feasible for trap operations (e.g., Zone 2). To capture the entire range of migration timing, downstream migrant trapping will be initiated as early in spring as feasible given that traps are difficult to operate during icing conditions. Migrant traps should be for operated a minimum of 72 hours during each week of the run with operation focused on peak daily run windows (nocturnal or crepuscular periods) as can be determined based on observed behavior patterns at this location. Thus, the 72 plus hours of operation could be achieved through a combination of days operated and number of hours operated each trap day. Traps will be checked as often as necessary to avoid overcrowding and a minimum of once daily.

In lieu of traps, the vertical and horizontal distribution of downstream migrating salmonid juveniles could be evaluated and monitored empirically using hydroacoustics or telemetry in the vicinity of the intake, groin, and on right and left riverbanks. There are several technologies suited to this evaluation and the scale of the Project Area would be conducive to using the smallest available transmitters. These technologies will be evaluated during field testing prior to study implementation. The Cooperative looks forward to collaborating with stakeholders in technical work group meetings to define the appropriate methodology for each aspect of the Fish Abundance and Distribution Study for the Nuyakuk Project site.

Documenting the Presence of Piscivores

The presence of piscivorous fishes by habitat type will be documented through seasonal fish collection efforts. These data can be used in conjunction with the 2D hydraulic model to evaluate the potential for creation or elimination of piscivore habitat under with-Project conditions (see Section 4.1,2.1). In addition, during the smolt outmigration period when staff are on site for fish sampling additional observations of avian and mammalian predators in the project area will be recorded. If significant avian or mammalian predation is evident in Year 1, we will evaluate methods that could be used to quantify this mortality in Year 2.

4.1.1.8 Proposed Deliverables and Schedule

Assuming timely issuance of the Study Plan Determination, the Cooperative plans conducting the study in 2023 and 2024. Upon implementation, study results will be documented in the Initial Study Report (ISR) and Updated Study Report (USR). It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.1.1.9 Level of Effort and Cost

The Cooperative agrees with stakeholders that this study will need to be a multi-year effort (2023 and 2024) to adequately define the existing condition near the Project site for the fish species of interest in a seasonal and life stage-specific construct.

The estimated cost for this study is approximately $700,000 - $1,400,000.

4.1.2 Nuyakuk Falls[1] Fish Passage Study

4.1.2.1 General Description of Proposed Study

In Section 5.2.3 of the PAD, the Cooperative identifies a series of fisheries studies to be utilized in an effort to document both the existing condition and the level of impact (positive and negative) to the Project area as a result of construction and operations. One of the potential studies was identified as:

- Nuyakuk Falls Fish Passage Evaluation and Modeling

This study will evaluate the physical and hydraulic conditions that occur within the cascade/Falls Reach over a range of flow conditions, and then via modeling, assess conditions that could occur under proposed Project operations and likelihood of fish passage under these new conditions. The focus will be on determining whether and to what extent the upstream migration of adult salmon and other fish species, and downstream migration of fry, juveniles and smolts may be affected by Project operations. One of the central issues to be addressed is whether the currently proposed minimum bypass release flow of 1,000 cfs will be sufficient to provide unobstructed fish passage through this reach, or whether alternative flow releases are needed. Figure 4-4 illustrates this by showing potential effects of Project operations on Nuyakuk River flows on a monthly basis for the most recent 25 years of USGS gage data. As a secondary element, the study will also evaluate potential risks of stranding and trapping of fry and juvenile/smolts that may occur during certain periods of Project operations. Figure 4-5 depicts conditions within the study reach at 7,200 cfs on June 22, 2017 and illustrates potential adult migration pathways and potential stranding and trapping areas. This study will evaluate how these pathways may be affected by alterations in flow, and the potential risk of stranding and trapping.

The study is of paramount importance in the licensing process since the entirety of the Nuyakuk River salmon escapement must pass through this section of the river to reach upstream spawning and rearing habitats that adjoin the highly productive lakes within Wood Tikchik State Park. Likewise, the entirety of the smolt production from these watersheds must pass downstream through this reach. The Cooperative understands this and is committed to understanding and providing flow conditions that protect this important passage corridor.

[1] Although this reach of river has been referred to as the Nuyakuk Falls, it is better characterized as a series of steep cascades and chutes interspersed with localized bedrock Falls that create a series of whitewater rapids consisting of highly turbulent non-uniform flows. For purposes of this study plan, the reach will continue to be designated as Nuyakuk Falls.

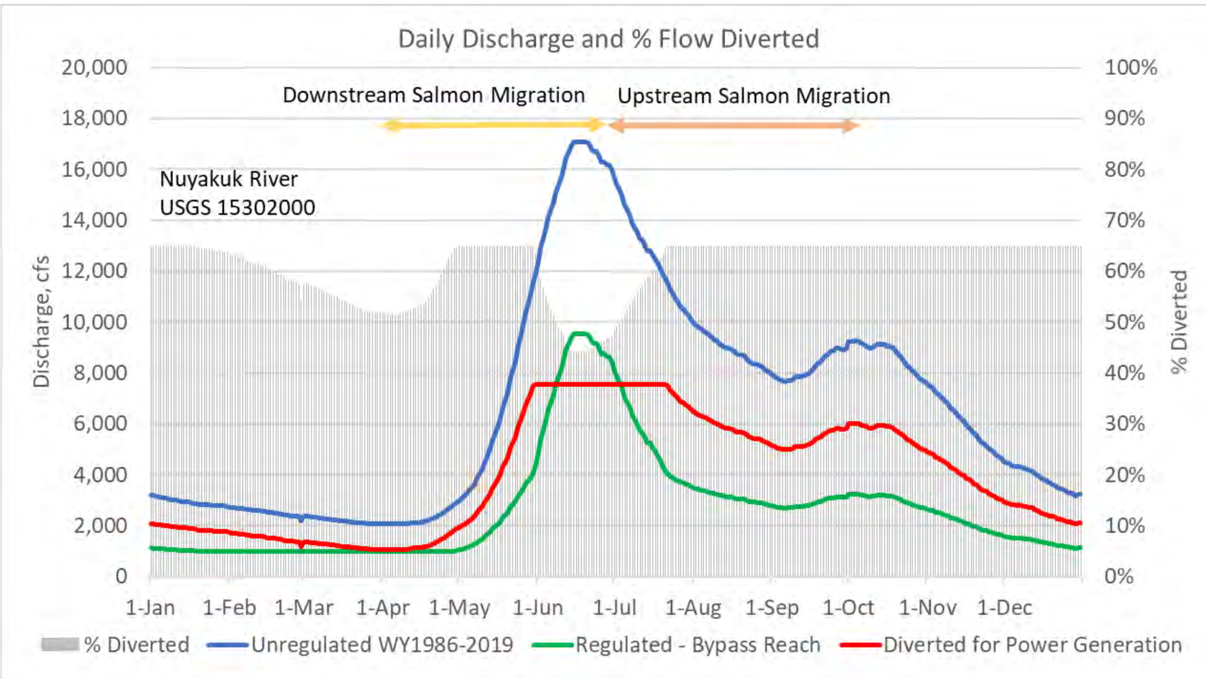

Figure 4-4. Daily hydrograph of the Nuyakuk River with (regulated) and without (unregulated) preliminary proposed Project operations, with percent flow diverted for power generation. The regulated hydrograph includes a minimum bypass flow of 1,000 cfs.

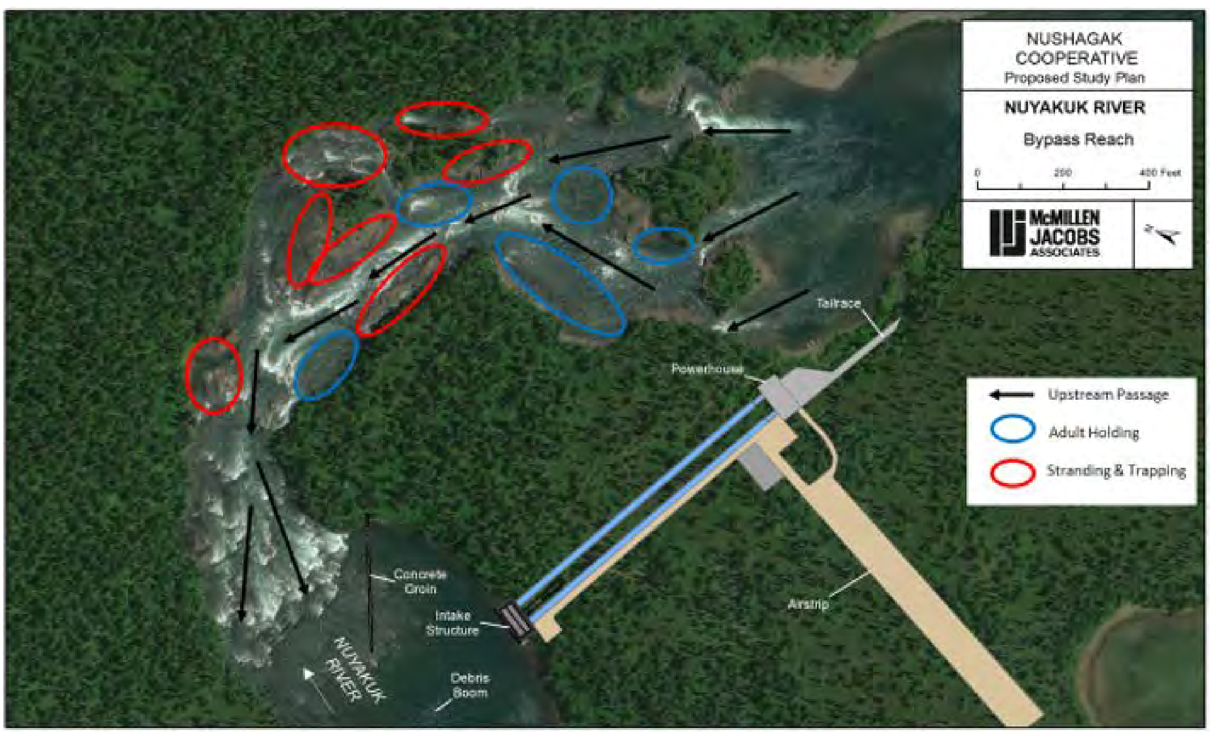

Figure 4-5. Schematic of Nuyakuk Falls Reach showing possible adult upstream migration pathways, adult holding areas, and potential stranding and trapping areas. Photo taken on June 22, 2017; flows approximately 7,200 cfs.

4.1.2.2 Geographic Scope

The geographic focus of the Fish Passage Evaluation will extend from approximately 1,000 ft (0.19) above the upper end of the Nuyakuk Falls to approximately 1,400 ft (0.27 mi) below the lower end of the Falls; total length of the study area is approximately 4,310 ft (0.82 mi.) (Figure 4-6). This study area encompasses the areas from both the Fish Entrainment and Impingement Study and the Assessment of False Attraction at the Proposed Tailrace Study and defines the principal area of the 2D hydraulic modeling. The extent of the study area may be modified based on review of the LiDAR data and preliminary results from the 2D model.

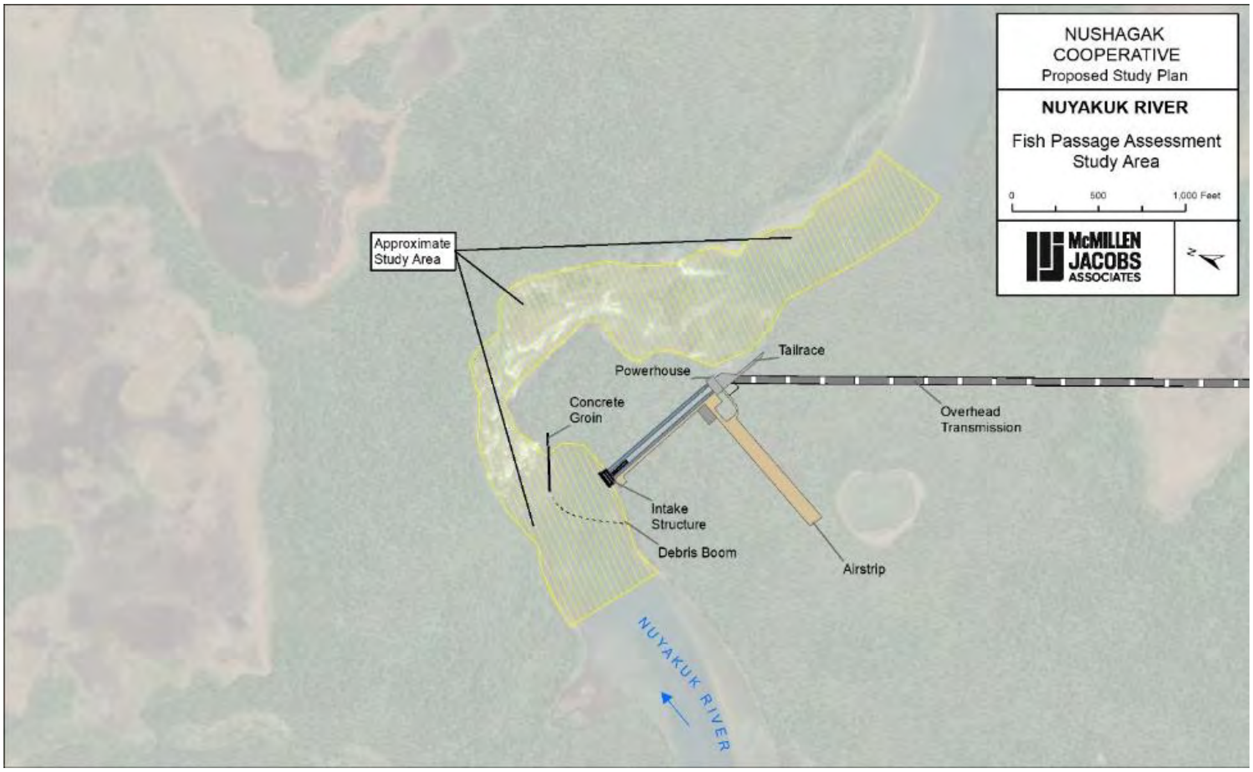

Figure 4-6. Approximate Fish Passage Assessment Study Area of the Nuyakuk River.

4.1.2.3 Study Goals and Objectives, and Questions to be Addressed

The primary goal of this study is to evaluate how potential Project-related flow changes may impact fish passage through the Falls Reach.

Five objectives are listed below that define the major focus of this study:

1. Identify major (or primary) upstream (and downstream) fish passage corridors and hydraulic conditions within the cascade/Falls Reach of the study area (i.e., proposed bypass reach) and their potential flow sensitivities currently and under proposed Project operations as relates to potential for stranding, predation risk, migration delay.

2. Estimate species-specific "flow windows" for successful upstream fish passage through the cascade/ that include upper and lower passage thresholds above and below which

passage may be impaired, migration delayed, risk or predation increased, or seasonal timing affected.

3. Identify potential areas that may be susceptible to fry and juvenile stranding and trapping within the proposed bypass reach due to Project induced flow fluctuations (ramp-up and ramp-down).

4. Evaluate effects of proposed Project operations and flow releases on adult upstream and fry/juvenile/smolt downstream fish passage and potential stranding, trapping of fish.

5. Identify potential alternative operations or refinements to operations to facilitate upstream and downstream passage and minimize/eliminate risk of stranding and trapping.

These objectives revolve around the resolution of a series of questions associated with how Project operations may affect fish passage conditions within the Falls Reach. Specific questions to be addressed include:

1. Would flow-related changes in depth and velocity and habitat composition impair or improve upstream fish passage conditions as compared to species-specific criteria?

2. Would flow-related changes in total available habitat for upstream passage result in increased densities of fish in the Falls Reach to the point that density dependent effects are likely?

3. Would flow-related changes in depth and velocity and habitat composition impair or improve downstream fish passage conditions as compared to species-specific criteria?

4. Would flow-related changes in total available habitat for downstream passage result in increased densities of fish in the Falls Reach to the point that density dependent effects are likely?

5. Would hydraulic conditions be created that could delay upstream passage of adult salmon?

6. Would hydraulic conditions be created that could delay downstream passage of juvenile salmon?

7. Would flow-related changes in the Falls Reach alter depth and velocities in fish rearing habitats or change the quantity, composition, or configuration of the rearing habitats?

8. Would rapid changes in flow dewater fringe habitat/passage corridors resulting in potential fish stranding or trapping zones?

9. Would operational flow changes have the potential to dewater or scour spawning habitats downstream of the Falls and tailrace?

The majority of these questions are conceptually captured in Figure 4-7, which provides an overview of the two major potential Project induced life history impacts related to Streamflow Regulation: *upstream passage/survival* and *downstream passage and survival.* These potential impacts would be centered around the Project footprint that encompasses Nuyakuk Falls and associated with primarily a flow reduction (due to diversion of flows for power generation) within the reach. These flow alterations will change the prevailing hydraulic parameters and will likely lead to changes in migration pathways and resting/rearing habitats that were normally available under higher flow conditions. Depending on the timing and hydraulic conditions provided under the draft proposed operations, upstream passage success and survival may be reduced due to unsuitable passage conditions, shortened passage windows, delay, increased predation, etc., or improved if more suitable conditions and longer passage windows are provided that decrease passage times and energy expenditures of fish. Similarly, downstream passage success may be reduced due to potential entrainment and turbine mortality as well as increased predation (shallower conditions) and depending on flow regulation and ramping rates, potential stranding and trapping. Alternatively, it is also possible that downstream passage success could be potentially improved if passage survival through fish friendly turbines is greater than passage survival through the Falls. The flow regulation may also change depth and velocity patterns associated with some habitats used by Resident Fish.

Figure 4-7 also incorporates the potential effects of climate change on streamflow and stream temperature. Changes in streamflow may potentially affect Project operations and correspondingly upstream and downstream passage success as noted above. However, given the relatively short length of the Nuyakuk Falls Reach, climate change effects on water temperature are not expected to be directly influenced by Project operations. This “State of Nature – Stochasticity” effect is depicted by the blue lines in Figure 4-7.

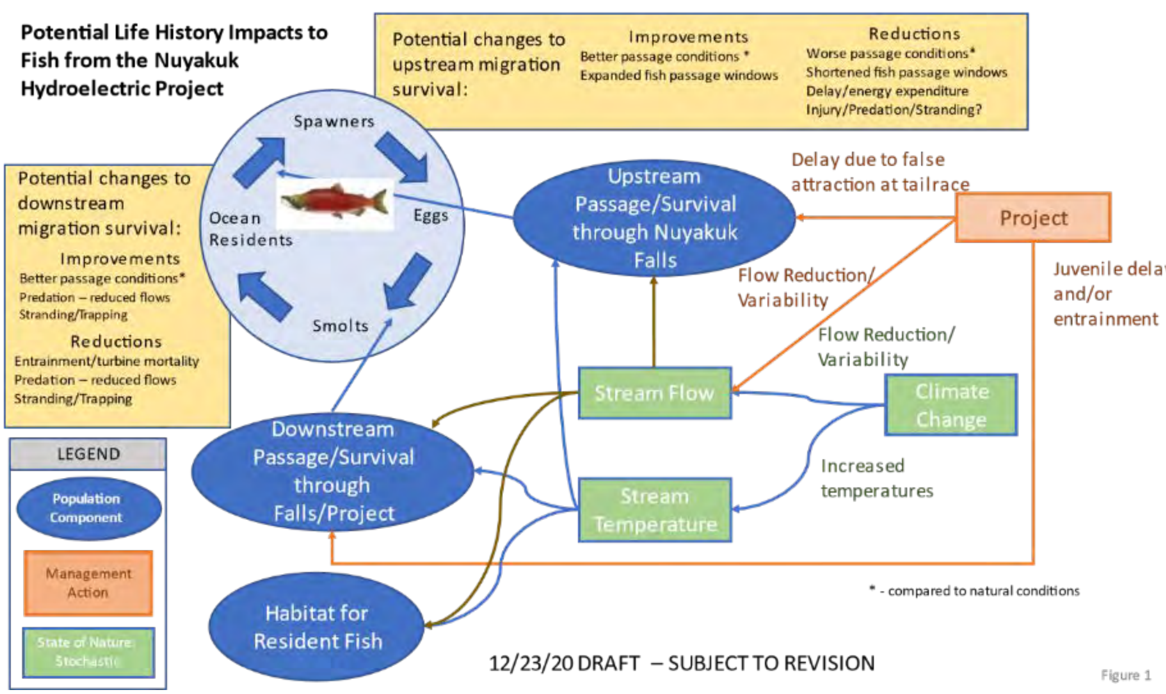

Figure 4-7. Conceptual representation of potential major effects of Nuyakuk Hydroelectric Project operations on upstream and downstream fish passage through Nuyakuk Falls, Alaska.

4.1.2.4 Relevant Resource Management Goals

Five (5) species of anadromous salmonids and multiple resident species are known to utilize the Nuyakuk River at some point during their life cycle. Limited data exists documenting the extent to which they utilize the proposed Project area and/or the watershed upstream. The Falls Reach fish passage study would be informed by the other fisheries studies described in the PSP. Fish presence and life history data will be utilized to ensure that appropriate species and range of flows occurring during specific life stages are incorporated into the passage (upstream and downstream) assessment.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

The mission of the ADFG – Division of Sport Fish is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.2.5 Existing Information and Need for Additional Information

Limited information exists that specifically relates to fish passage through the Nuyakuk Falls Reach. However, fish species information and escapement estimates do exist for areas upstream and downstream from the Falls that can be used as part of this study to draw inferences regarding migration timing of different species. This study will also rely heavily on information gathered as part of Study 4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area and data collected as part of that study. In addition, the study will rely on existing information related to fish swimming and jumping criteria (e.g., Powers and Orsborn 1985, Powers and Saunders 2002; Reiser et al. 2006; Bates 1992; Bell 1990, Katopodis and Gervais 2012; Katopodis and Gervais 2016 and others) which will be used in comparing passage conditions under different flows.

Surface photographs and aerial imagery are available depicting conditions within the Nuyakuk Falls Reach at various flows. In addition, on May 14, 2020 Quantum Spatial completed a topobathymetric LiDAR (Light Detection and Ranging) survey of the Project area, approximately centered on the Falls Reach (Quantum Spatial 2020) (Figure 4-8). The survey data included topographic LiDAR and 3 band (RGB – Red, Green, Blue) digital imagery, enabling the acquisition of a substantial amount of underwater topobathymetric features within the Falls Reach. More detail regarding this survey is provided in Section 4.1.3.6. This new LiDAR data set should prove useful in the development of a two dimensional (2D) hydrodynamic model of the Falls Reach but will require a detailed inspection and QA/QC review to ensure its utility for model development.

Figure 4-8. Area of LiDAR coverage and extent of the Fish Passage Study Area in the Nuyakuk River, Alaska.

Therefore, one of the major study components will be reviewing these data to ensure model application. This information and data will then be used in developing appropriate two dimensional (2D) hydraulic model(s) that can be applied to the passage assessment. The bathymetric data will also be used in identifying potential areas of stranding and trapping. The hydraulic models will simulate conditions within segments of the reach over a range of flows which will help identify major passage routes and their sensitivity to changes in flow. Results of these simulations will include velocities and depths as well as vertical heights at the Falls, which can then be compared with known swimming and jumping criteria to determine the probabilities of successful passage for a given flow condition and the risks associated with Project operations. Ideally, this will lead to development of a set of flow windows that define suitable passage conditions throughout the reach.

4.1.2.6 Project Nexus

The proposed Project would create a bypass reach and divert a percentage of flow away from the Falls and into a penstock for power production. Diverted water would then be discharged back into the natural channel immediately below the Falls resulting in a 0.82mile bypass section that comprises the Nuyakuk Falls Reach. This action will reduce the quantity of river flow and the distribution of flow through the Falls Reach. Depth/velocity distributions and will affect the quantity and composition of habitats suitable for passage and rearing. Understanding the potential impacts to fish passage (upstream and downstream) as a result of reduced flows through the bypass reach will assist in determining appropriate operational rule curves for power production purposes and the associated potential impacts (positive and negative) to fish movement. In addition, depending on Project operations and ramping constraints, the Project could result in the stranding and/or trapping of juveniles and fry within low gradient areas along lateral margins of the reach. This study will identify and evaluate potential stranding and/or trapping risks due to proposed Project operations. Appendix C contains a more comprehensive listing of primary and secondary Project nexus issues, methods, and hypotheses related to potential operational effects in the Project Area.

4.1.2.7 Methodology

The Cooperative has a vested interest in developing a collaborative study that effectively meets the needs of the stakeholders while at the same time focuses on the area of potential impact. As such and per commitment from stakeholders such as ADFG and NMFS, the Cooperative plans on working with stakeholders to define the appropriate methods to be utilized to ensure both effective documentation of existing conditions and a safe study design for all biologists in the field.

To assist in that effort the Cooperative has developed for consideration, the following methodological approach for conducting this study. The approach follows that of other studies that have considered flow induced effects on salmonid fish passage (e.g., Reiser et al. 2006; and consists of the following five components:

1. Define species migration periodicity;
2. Establish species swimming and leaping criteria using literature-based information;
3. Conduct bathymetric mapping of reach as defined by the May 2020 LiDAR topobathymetric data (Quantum Spatial 2020);
4. Develop 2D hydraulic model based on the terrain models developed from the LiDAR and imagery;
5. Conduct modeling and evaluate potential effects of Project operations to address questions posed in Section 4.1.2.3.

These elements are described more fully below.

Define Species Migration Periodicity

The general migratory life histories of many of the fish species in the Nuyakuk River involve the upstream migration of adults seeking suitable areas for spawning, and the downstream migration of fry, juveniles and smolts to the ocean. The timing and duration of these migrations vary by species and life stage but in general coincide with the hydrologic characteristics of a given watershed. Thus, both upstream and downstream migrations tend to occur during periods of increasing or relatively high flows and infrequently during low flow periods. Because proposed Project operations will occur throughout the year the extent to which the operations may affect upstream and/or downstream migration success will depend on the timing of those migrations and prevailing flows. An example of this is depicted in Figure 4-9 that presents in the lower panel, monthly flows (based on the historical hydrology) for both regulated (with Project) and unregulated conditions, and in the upper panel generalized migration periodicities for Nuyakuk River salmon species. The differential between regulated and unregulated flows varies by month and correspondingly the potential effects on passage success would also likely differ. Thus, it will be important to have the best information available regarding each of the species migratory periods for the Nuyakuk River, which will be established under the Characterization of the Fish Community and Behavior Near the Project Area study and may be supplemented with hydroacoustic / telemetry (radio or acoustic) evaluation of passage route selection and timing for specific migrating species.

Importantly, much/most of this information will be compiled as part of Study 4.1.1. – Characterization of the Fish Community and Behavior Near the Project Area. That study will rely on a variety of source materials from the published and unpublished literature, as well as personal contacts with agency and stakeholder personnel with direct experience with the fishery resources of the Nushagak River, and certain empirical data collected on-site. For this study, the objective will be to define for each species, the periodicities of adult upstream migration, and fry, juvenile/smolt downstream migration. This information will focus the modeling and analysis on those periods most vulnerable to Project operational effects.

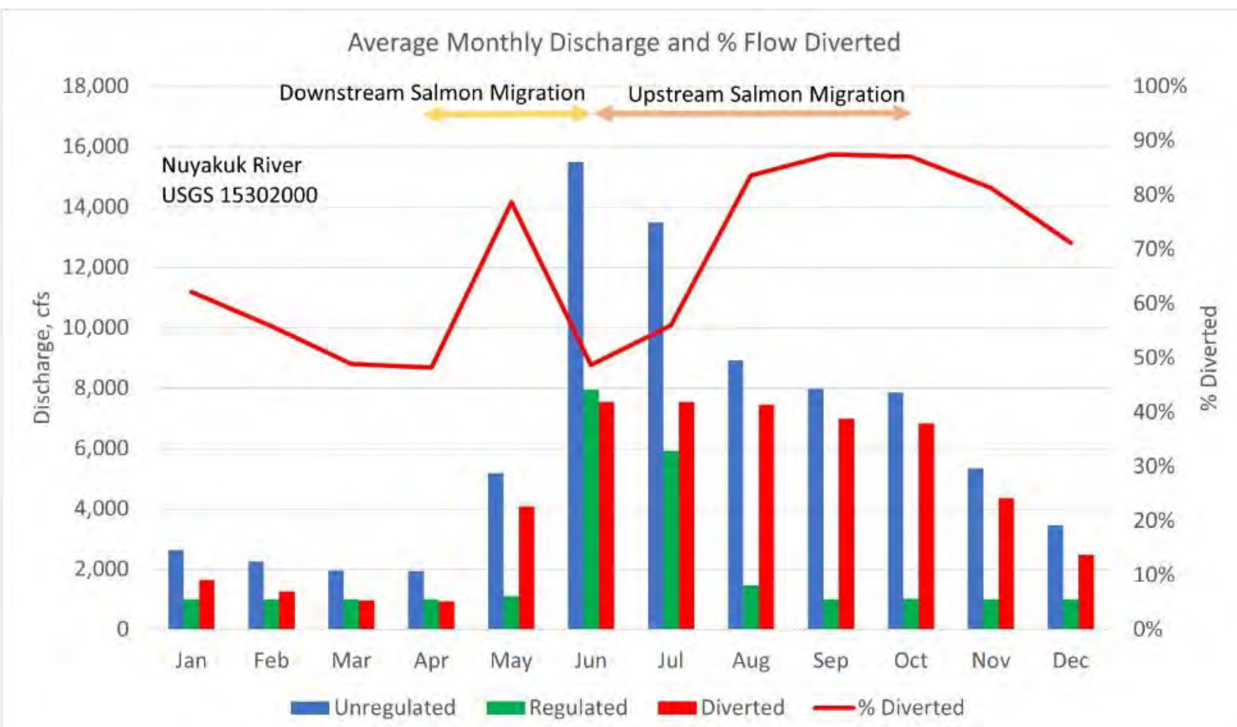

Figure 4-9. Estimated monthly periodicities of adult upstream and juvenile downstream migrations of salmon and estimated average monthly flows of the Nuyakuk River, under unregulated and regulated conditions, with percent flow diverted for generation.

Establish Species Swimming and Leaping Criteria

The swimming and leaping capabilities of salmonids largely determine the extent of their distribution in watersheds. Areas with steep (> 3%) gradients or that contain rigid/sharp breaks in channel elevations (i.e., Falls or chutes) can pose as barriers to migrating salmon. The barrier potential of these areas is often highly influenced by flow; under some flows they may be passable, and under others impassable. Such is the case for the Nuyakuk Falls Reach and therefore it will be important to identify and select a set of swimming and leaping criteria from which to evaluate existing migration pathways and assess potential effects due to Project operations.

In general, the swimming capabilities of adult salmonids fall into three categories as defined by Powers and Orsborn (1985), sustained, prolonged, and burst. At sustained velocities, fish can function normally for long periods of time without fatigue (Hoar and Randall 1978). Prolonged fish speeds can be maintained over long periods of time (15 s to 200 min). Burst speeds are used for short periods (15 s or less) to negotiate Falls and high-velocity areas. Of these, burst speeds and to a lesser extent prolonged speeds are the most relevant for the Nuyakuk Falls passage study (Table 4-2).

Table 4-2. Leaping and Jumping Capabilities of Adult Salmonids, and Preliminary Migration Periodicity for Nuyakuk River, Alaska (Table modified from Reiser et al. (2006)).

		Steelhead	Coho	Chinook	Sockeye	Pink	Chum
Sustained Velocity	(m/s)	1.40	1.04	1.04	0.97	0.79	0.79
Prolonged Velocity	(m/s)	4.17	3.23	3.29	3.11	2.34	2.34
Burst Velocity	(m/s)	8.07	6.55	6.82	6.27	4.57	4.57
Minimum Swimming Depth	(m)	0.17	0.17	0.17	0.17	0.17	0.17
Fish Body Length	(m)	0.70	0.70	0.91	0.55	0.58	0.73
Fish Body Depth	(m)		0.14				0.20
Max Jumping Height	(m)	3.35	2.19	2.38	2.10	1.21	1.21
Adult Migration Periodicity in Ward Creek (No. Days)		Mar-Apr (92)	Aug-Oct (92)	Jun-Aug (92)	Aug-Sept (48)	Jul-Aug (46)	Jul-Sept (76)

The swimming and leaping/jumping capabilities of salmonids have been evaluated, both in the field (Stuart 1964) and under laboratory conditions (Powers and Orsborn 1985) and have been summarized in in a number of publications (Bell 1991; Powers and Orsborn 1985; Bjornn and Reiser 1991, Katopodis and Gervais 2012; Katopodis and Gervais 2016). In general, successful passage at a Falls requires a fish to leap from a standing wave to the waterfall crest. Also, the flow velocity at the waterfall crest must be less than the burst speed and water depth must be greater than the fish body depth. Figure 4-8 depicts two conditions – chute and Falls, that may be encountered in the Nuyakuk Falls Reach, and lists the physical and hydraulic variables that determine passage success.

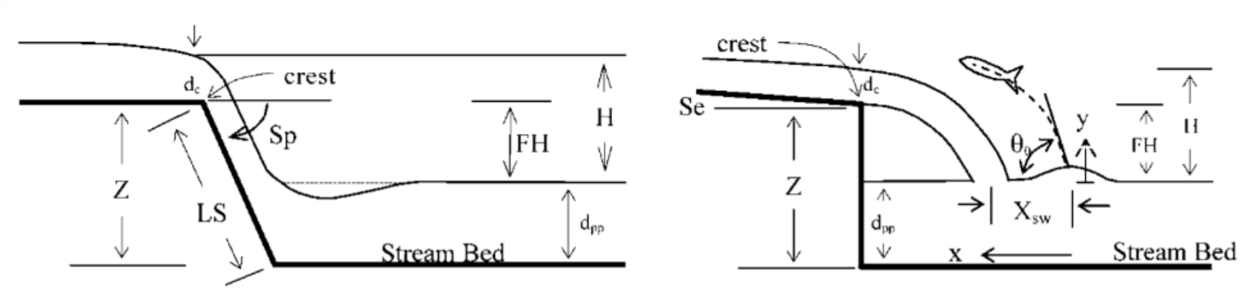

Figure 4-10. Schematics of chute-type (left) and falls-type (right) potential barriers (adapted from Powers and Orsborn 1985, as presented in Reiser et al. 2006). Variables are defined as follows: Z is the vertical distance from the bottom of the barrier to the crest of the barrier, H is the vertical distance from the downstream pool water surface to the water surface at the crest, dc is the water depth at the crest, dpp is the flow depth of the downstream pool, LS is the chute length, Sp is the angle of the chute, Se is the angle of the bed upstream of a falls, FH is the vertical distance from the downstream water surface elevation to the barrier crest, h0 is the initial leaping angle, and Xsw is the distance from the location of the impact of the falling water to the standing wave.

As part of this study, a combined literature and internet search will be completed to compile relevant information related to both swimming and leaping capabilities of salmon. From this, a set of criteria will be developed in collaboration with the stakeholders that will be used in the modeling and passage evaluation. Observational data on fish leaping behavior at the Nuyakuk Falls area during the Characterization of the Fish Community and Behavior Near the Project Area study and anecdotal information (including videography) will be included for consideration.

Conduct Bathymetric Mapping of Reach

Successful completion of this study will require survey data of the study reach (Zone 2) consisting of topo-bathymetric information to define channel elevations occurring at flow sensitive areas that pose a risk to upstream migration. Data will be linked with depth, swimming speed, and jumping criteria for passing fish (adult upstream and juvenile downstream) to determine areas of suitable/ unsuitable passage under different flow conditions. However, collection of any field data within this reach would be very challenging and dangerous given the prevailing turbulent and swift water conditions that will make data collection hazardous. The Cooperative understood these safety concerns and evaluated a number of options for obtaining the necessary information (Table 4-3). These included the collection of data using helicopter, fixed wing aircraft, or remote-controlled drone. As noted, collection of data using boat or pedestrian survey techniques was considered unsafe and was not considered further, other than to establish ground-based survey control points for measuring water surface elevations, and benchmarks. Pros and cons of the three modes of data collection were considered and described in Table 4-3).

Table 4-3. Topo-bathymetry survey methodology comparisons considered for the Nuyakuk River.

Method		Safe or Unsafe	Quantitative or Qualitative Interpretation	Area-Based or Transect-Based	Single or Multiple Flow Interpretation	Limited or Not Limited by Riparian Cover	Limited or Not Limited by Air Entrainment
Pedestrian Survey (wading)		Unsafe	Quantitative	Transect-Based	Single	Not Limited	Not Limited
Boat Survey (ADCP)		Unsafe	Quantitative	Transect-Based	Single	Not Limited	Not Limited
Cable Survey (ADCP)		Unsafe (during cable installation)	Quantitative	Transect-Based	Single	Not Limited	Not Limited
Airplane Survey	3 band (RGB) digital imagery	Safe	Qualitative	Area-Based	Single	Limited	Not Limited
	Topobathymetric LiDAR	Safe	Quantitative	Area-Based	Multiple (with 2D model)	Not Limited (bare earth interpretation)	Can be Limited
Helicopter Survey	Frame-Based Video	Safe	Qualitative	Area-Based	Single	May be Limited	Not Limited
	Frame-Based Video with Floating Tracers	Safe	Quantitative	Area-Based	Single	May be Limited	Not Limited
	Topobathymetric LiDAR	Safe	Quantitative	Area-Based	Multiple (with 2D model)	Not Limited (bare earth interpretation)	Can be Limited
Drone Survey	Frame-Based Video	Safe	Qualitative	Area-Based	Single	May be Limited	Not Limited
	Frame-Based Video with Floating Tracers	Safe	Quantitative	Area-Based	Single	May be Limited	Not Limited
	Topobathymetric LiDAR	Safe	Quantitative	Area-Based	Multiple (with 2D model)	Not Limited (bare earth interpretation)	Can be Limited

Of these survey modes, the airplane survey with 3 band (RGB) digital imagery and topobathymetric LiDAR containing a green wavelength (532 nm) was selected as the most efficient and safe. The survey and LiDAR acquisition occurred on May 14, 2020 using a Riegl VQ-880-GII mounted on a Cessna Caravan (Quantum Spatial 2020). The survey consisted of consecutive overlapping flight paths of a reach of the Nuyakuk River that extended approximately 3,000 ft (0.57 mi) upstream and 2,500 ft (0.47 mi) downstream from the upper and lower ends of the Fish Passage Study Area (Figure 4-8), respectively (total of 9,810 ft or 1.86 mi). Aerial imagery was co-acquired using a PhaseOne iXU-RS1000 digital camera that collected imagery in three spectral bands (Red, Green and Blue). The LiDAR allowed for laser penetration through the water column up to a nominal depth of 20 ft (depending on water clarity, bed surface reflectivity and turbulence) and in those areas can accurately depict the bed topography of the channel below the water surface. However, the Falls Reach contains substantial areas of highly turbulent water, and mapping in those areas can be problematic and will require post-processing of data using interpolative, nearest neighbor computations.

The surveys were conducted under ice-free conditions during low flows (approximately 5,600 cfs). when water clarity was highest. This provided for high resolution of channel features, that will be useful for delineating specific passage avenues and potential stranding and trapping areas throughout the reach.

Collection of field data to support the bathymetric mapping will consist of surveys conducted during open water conditions. The first survey was conducted coincident with the LiDAR aerial survey and was used in LiDAR calibration and post-processing. The surveys included non-vegetated accuracy checkpoints as well as wetted edge, and bathymetric checkpoints for bathymetric accuracy assessment (Quantum Spatial 2020). Two other field surveys would be conducted targeting high and medium flows, tentatively scheduled for late June and mid-July. During each field survey, photographs and video footage will be taken of selected flow sensitive passage areas. The July survey will also be used to collect data useful for hydraulic model calibration. For this, floating tracers (a variety of objects can be used) will be deployed from a boat in Zone 1 and monitored via drone-based videography. These data will be post-processed to determine the magnitude and direction of surface velocities under a given flow condition. Field safety protocols will be developed and strictly enforced during each survey effort.

Develop 2D Hydraulic Model

Accurate surveys of topography/bathymetry will enable construction of a two-dimensional (2D) hydraulic model that will cover Zones 1 –3 within the Project Area. This model will provide fine scale detailed information such as depth and velocities (magnitude and direction) within each of the migration pathways and will enable the computation of other variables relevant to both fish passage (Figure 4-7) and Habitat Suitability Criteria (HSC) above and below the Falls Reach itself. The model will be calibrated using the water surface elevations surveyed near each benchmark and using the direction and surface velocity information measured using floating tracers. The calibrated model will then be used to model passage conditions under different flows.

There are a number of 2D models available that are sufficiently robust to analyze complex flow conditions like those in Zone 2. Candidate models that exist and will be evaluated for possible application include the following:

- SRH-2D (Sedimentation and River Hydraulics-Two Dimensions), developed by the United States Bureau of Reclamation (USBR). This model was recently used in licensing studies performed on the Susitna River. https://www.usbr.gov/tsc/techreferences/computer%20software/models/srh2d/index.html

- River2D – developed by the United States Geological Survey (USGS) and the University of Alberta. This model was recently used in licensing studies performed on the Susitna River. The River2D model includes a fish habitat analysis component. http://www.river2d.ualberta.ca/

- HEC-RAS 2D (Hydrologic Engineering Center-River Analysis System Two Dimensions) HEC-RAS was originally developed by the United States Army Corps of Engineers (USACE). The two-dimensional extension was developed for the USACE by RMA (Resource Management Associates, a firm based in Davis, California). https://www.hec.usace.army.mil/software/hec-ras/

- RMA2 – originally developed by RMA for the USACE. The model is currently maintained by Aquaveo (a firm originally based in Utah). https://www.aquaveo.com/software/sms-rma2

- iRIC (International River Interface Cooperative) – a suite of two-dimensional models developed as public domain software by researchers from the USGS and Japan. This collection of models includes a fish habitat analysis component. https://i-ric.org/en/about/

The Cooperative will evaluate each of these models and will select a candidate model for use that will be discussed with the stakeholders. Upon stakeholder approval, the selected model will be used for developing a 2D hydraulic model of the Nuyakuk Falls Reach.

Conduct Modeling and Evaluate Potential Effects of Project Operations.

Development of the 2D – model will enable a more detailed evaluation of Project effects. For this, the model will be initially run for flows representative of those existing during typical upstream and downstream migration periods. The model will then be used to identify areas that meet swimming, and for adult upstream passage, leaping criteria of different species, and hence represent pathways suitable for upstream and downstream migration. These areas will be longitudinally linked thereby depicting the most probable pathways of migration through the entire reach for unregulated flow conditions. Although separate analysis will occur for upstream adult passage and downstream smolt/juvenile passage, the below discussion focuses on upstream passage since it would likely be the most affected by Project operations.

The pathways identified from the 2D modeling will likely vary in length, and velocity and depth characteristics, so that successful upstream passage through each will differ in degree of difficulty. Therefore, model metrics will be analyzed to identify and categorize pathways into groups based primarily on velocity conditions and adult fish swimming speeds (sustained, prolonged and burst). These could nominally include four groupings, with Group 1 -depicting areas of low velocity (0-4 fps) where fish employ sustained speeds that could be maintained over relatively long periods of time (~30 minutes or longer); Group 2 of moderate velocity (e.g. 4 – 8 fps) where fish employ both sustained and prolonged speeds that could be maintained for ~ 3-4 minutes before resting areas needed; Group 3 - areas of moderate-fast velocity (8-13 fps) where fish use prolonged and burst speeds that could be maintained for short periods of time (~20-30 secs) before rest areas needed; and Group 4 – areas of high velocity (13-18 fps) requiring short duration (~5 secs) burst speeds before resting areas needed.

The model will then be run for a series of flows that represent a range of conditions that may occur during the migration period due to Project operations. The same swimming and leaping criteria analysis will be completed for each of the Groups/Zones to determine passage probabilities as defined by the mix of parameters including localized velocities, plunge pool depths, crest water depth, crest water velocity and others. The type of analysis envisioned for migratory pathways in Zone 2 is conceptually displayed in Figures 4-11 and 4-12 for both upstream and downstream passage leading to the determination of migration probabilities.

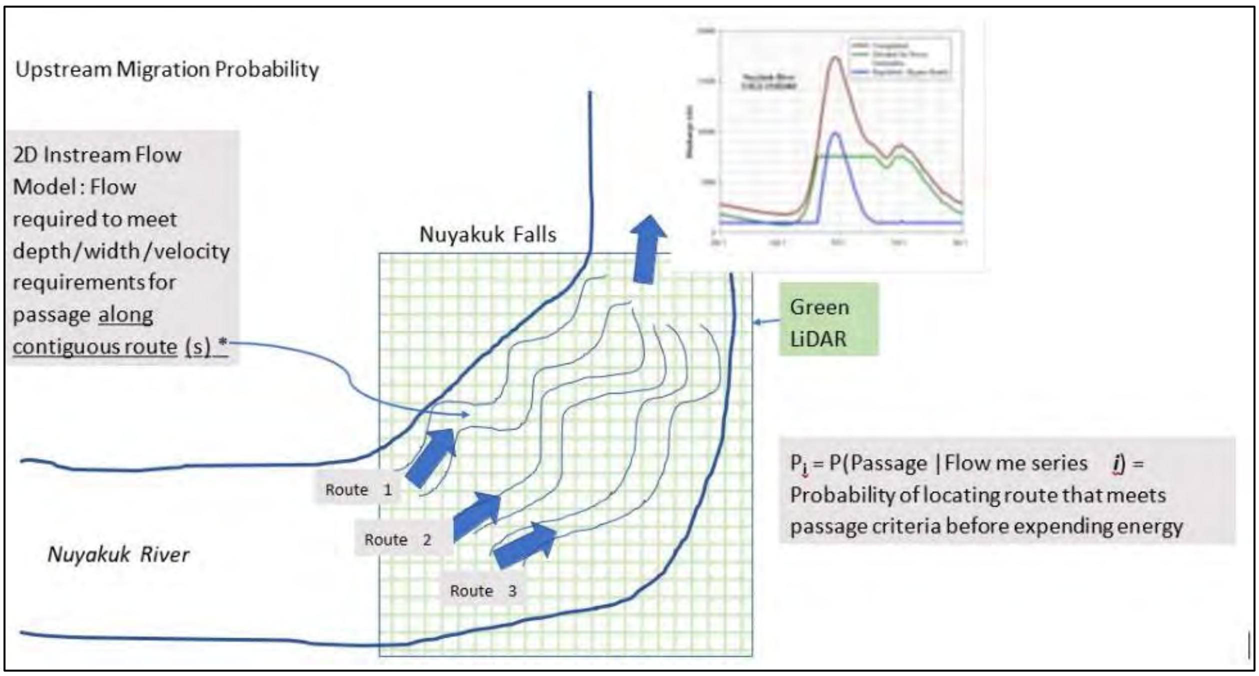

Figure 4-11. Schematic of three hypothetical upstream migration routes (Routes 1,2 and 3) each containing different combinations of Groups/Zones (as defined above) based on hydraulic parameter limits (e.g., depth, velocity, width, length) that could allow passage of adult salmonids. More than 3 routes will likely exist within the Falls Reach and these could overlap/cross, under varying flow levels; e.g., Route 1 may intersect with and become part of Route 2, Route 3 may intersect with 2 and 1, etc. Some pathways may actually lead to dead-ends forcing fish to move back downstream and attempt another route. A time series analysis covering distinct upstream migration periods will be completed using different water year types to allow a comparative assessment of Upstream Passage Probabilities under different flow conditions.

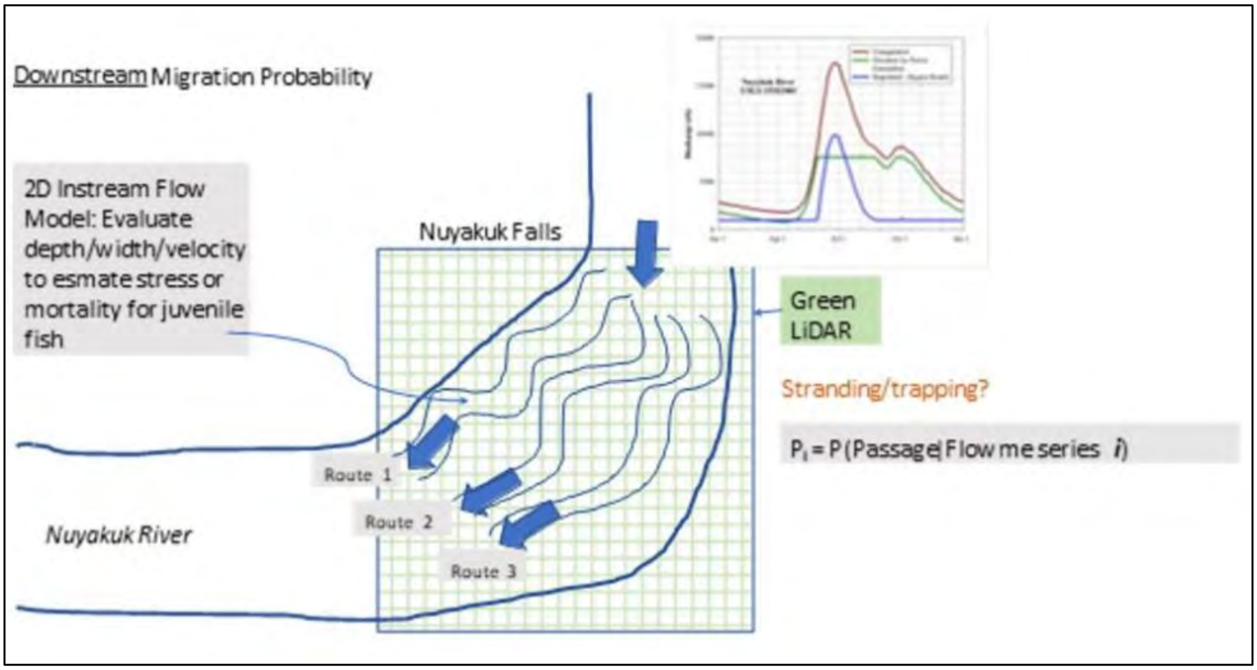

Figure 4-12. Schematic of three hypothetical downstream migration routes defined via 2D modeling. A time series analysis covering distinct downstream migration periods will be completed using different water year types will allow a comparative assessment of Downstream Passage Probabilities under different flow conditions.

The analyses are depicted more broadly in Figures 4-13 and 4-14 that illustrate the Project layout superimposed on an aerial imagery of the Nuyakuk Falls Reach. The figures contain inserts of a flow hydrograph showing potential changes in flows due to Project operations and a draft periodicity figure on top of a flow hydrograph to indicate periods of upstream and downstream migration. Analysis of habitat for resident fish due to flow changes will be made based on a Physical Habitat Simulation (PHABSIM) type analysis (Bovee et al. 1982) using representative Habitat Suitability Curves (HSC) for those species. These figures conceptually display the final endpoints of more detailed analyses that would be derived via 2D hydraulic modeling of migration pathways and specific analyses of tailrace and intake characteristics.

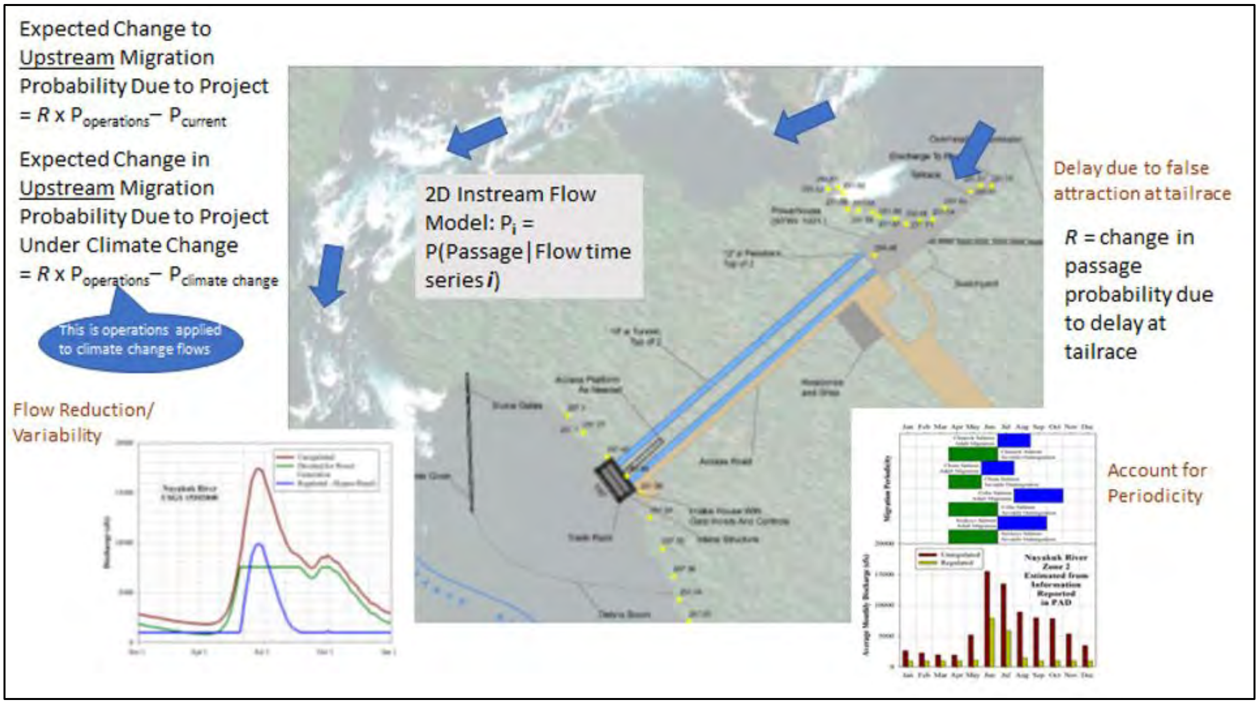

Figure 4-13. Depiction of potential changes in upstream migration Probability as a function of changes in physical and hydraulic conditions within the Falls Reach, and potential delay at the tailrace (R) and passage probabilities both with operations and without (current). Similar analysis would be applied under a Climate Change scenario as a function of flow changes, not temperature.

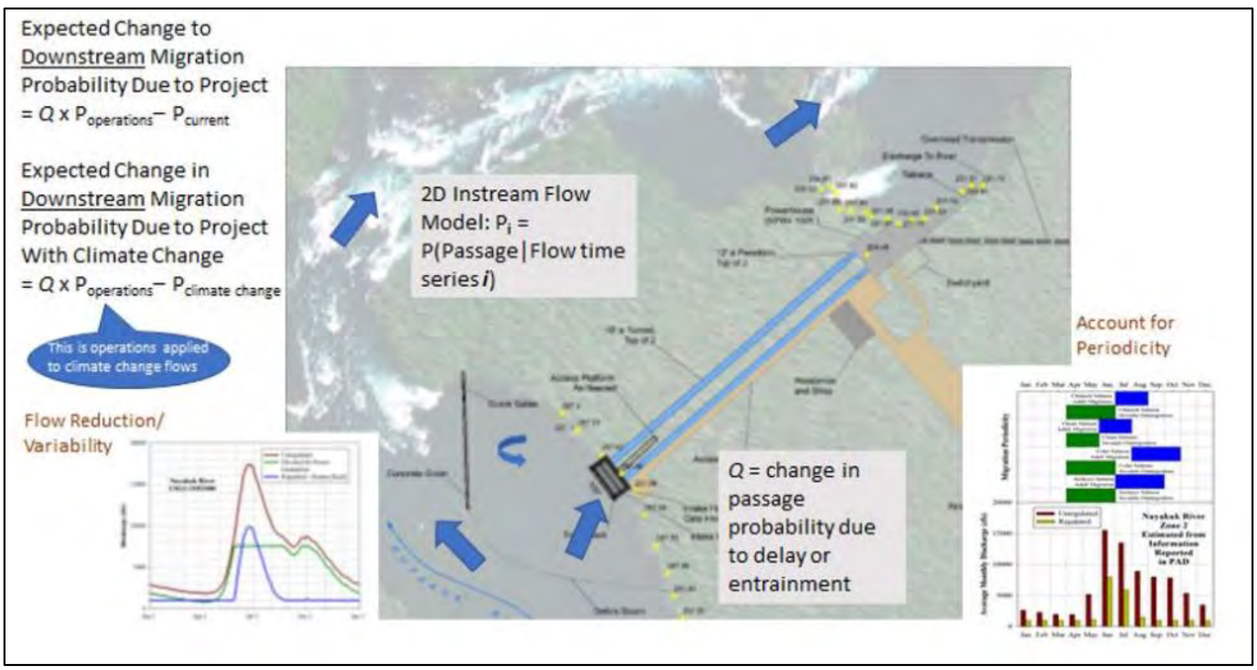

Figure 4-14. Depiction of potential changes in downstream migration Probability as a function of changes in passage probabilities due to delay, stranding/trapping or entrainment and passage probabilities both with operations and without (current). Similar analysis would

be applied under a Climate Change scenario as a function of flow changes, not temperature.

Analysis will include development of a suite of comparative matrices that lists the model-generated values of each of the parameters for each of the flows (including regulated and unregulated) and identifies probabilities of values being conducive to successful passage, and also whether they create suitable migration, rearing, holding, and spawning habitats. These types of matrix tables will be used for identifying "flow windows," which illustrates the range of flows and their associated probabilities (likelihood estimates) successful upstream migration would occur for the each of the designated areas, and then for the entire reach. A broad example of this is depicted in Figure 4-15.

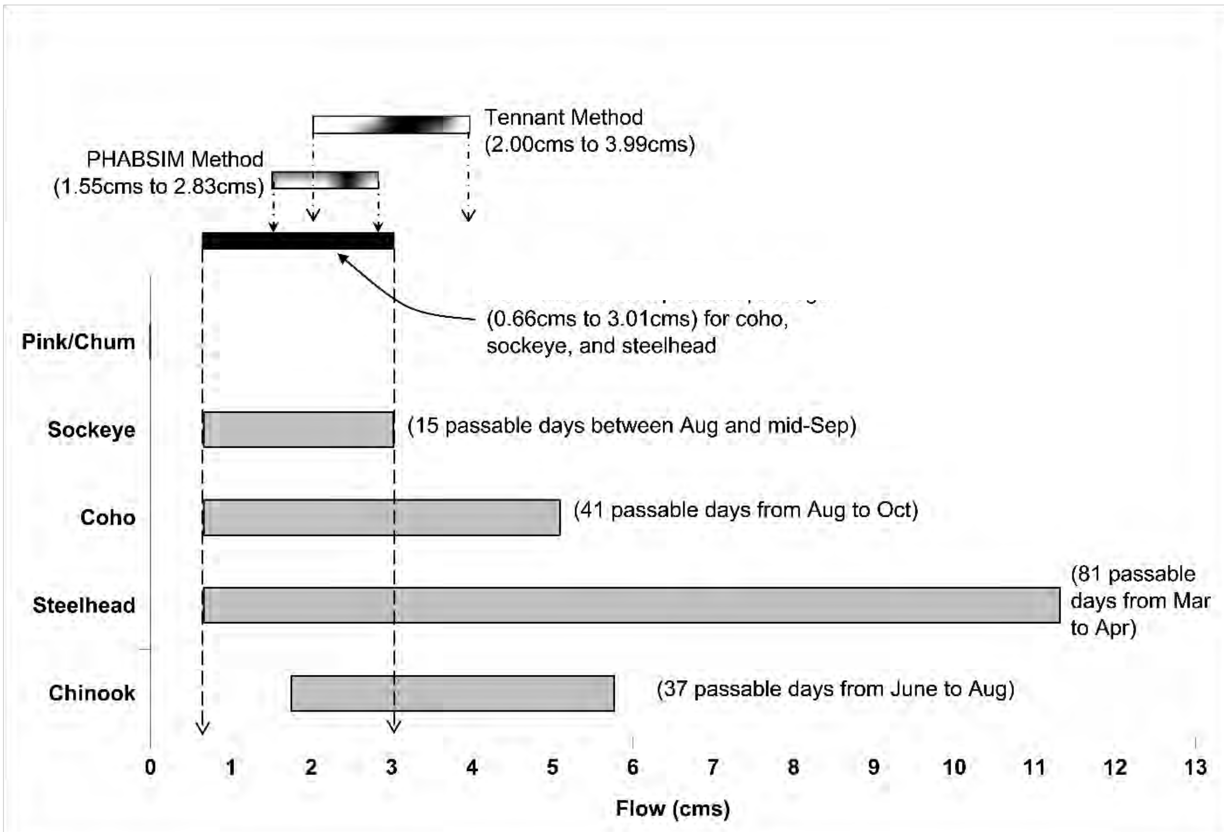

Figure 4-15. Example passage analysis denoting the ranges of flows that afford suitable passage conditions for different species. The dashed vertical lines represent the flow window that is suitable for all species. The PHABSIM and Tennant flows represent flows recommended via habitat and hydrologic analysis. (Adopted from Reiser et al. 2006). A similar type of analysis could be applied in the Nuyakuk Falls Reach.

The bathymetric mapping and modeling will also be used to identify potential areas of stranding and trapping and the flows at which these areas may develop. The risk of stranding and trapping most commonly occurs under conditions of pulse type flows such as those associated with hydroelectric peaking or load following. Under these types of operations, fish, in particular fry that may be occupying relatively shallow pool areas may suddenly become trapped within the isolated pools. Likewise, fry occupying flat shallow water areas may suddenly become stranded. Factors that influence the degree to which downramping results in stranding and trapping of small fish may include:

- Channel configuration – presence of side channels and low gradient bars; Monk (1989) noted greater stranding associated with gently sloping margin (» 1.5-2 percent slope) than on slopes of around 5 percent.
- Channel topography – presence of potholes and other topographic hollows that can trap fry as stage decreases
- Long-side channels that can alternately connect and disconnect side channel areas that can lead to trapping and eventual stranding of fish;
- Substrate type – larger substrates (e.g., cobbles) result in fry moving vertically down with receding water levels, whereas within finer substrates that are less permeable, fry tended to follow outflowing surface water;
- Ramping range – extent of stage drop experienced during downramping operation;
- Critical flow – flow below which stranding risk increases dramatically; generally associated with changes in channel form (e.g., slope);
- Time of year – smaller fish (e.g., fry) more vulnerable to stranding than larger fish; Hunter (1992) indicated that salmonid fry < 50 mm in length are the most vulnerable to stranding, with fingerlings, smolts and adults still susceptible but at higher downramping rates.
- Time of day – some species may be more vulnerable during day or nighttime periods; and
- Flow stability prior to drop in flow – fry stranding rate may be higher if downramping is infrequent and occurs after periods of sustained flows, rather than part of daily fluctuations.

The Nuyakuk Project will not be operated as a peaking or load following facility but rather as a run-of-river project, with no large storage component. As such, power production will mimic some fraction of total river inflow to the Project site. Thus, the prevailing flows within the Falls Reach would generally maintain the same seasonal pattern with or without project operations, but the flow volumes would be reduced (Figure 4-4). Even so, there is still the potential that flows could suddenly be reduced. This could occur as storm induced pulses in high flows are suddenly reduced to minimum flow levels, or from maintenance incurred operational changes that create a short duration increase in flows in the Falls Reach (to accommodate maintenance activities) followed by a sudden decrease in flows when operations resume.

The assessment of risk will first identify those areas most susceptible to potential stranding and trapping via review of the bathymetric map of the Falls Reach for notable depressions and potholes. The 2D hydraulic model would then be used to determine the critical flow below which stranding and trapping would increase dramatically. The Operations Model would subsequently be run for a number of scenarios including both regulated and unregulated flows and the frequency of exceedances of the critical flow determined and compared. The Life-Cycle Modeling will translate these frequencies in terms of a distribution of potential mortality rates that factor into the determination of population level effects. The analysis may also lead to derivation of a set of down-ramping criteria that defines the rates of flow decline to protect against stranding and trapping. This issue has been studied on a number of other Projects that have led to development of site-specific down-ramping criteria. The State of Washington for example, defaults to criteria developed by Hunter (1992) when recommending ramping restrictions (Table 4-4).

Table 4-4. Downramping rates proposed by Hunter (1992) to minimize stranding and trapping impacts on salmonids (From Reiser et al. 2007)

Season	Daylight Rates[1]	Night Rates
February 16 to June 15 (salmon fry present)	No Ramping	2 inches/hour
June 16 to October 31 (steelhead fry present)	1 inch/hour	1 inch/hour
November 1 to February 15	2 inch/hour	2 inch/hour

[1] Defined as one hour before sunrise to one hour after sunset

These analyses, as well as those for downstream migration, and operational characteristics associated with the tailrace and intake will feed into the LCM and will be further evaluated as part of the overall Project Risk Analysis (see Sections 4.1.6 and Appendix C).

Once the 2 D hydraulic model is completed and flow-habitat effects are predicted, the likelihood of Sockeye and Chinook salmon successfully passing upstream through the Falls Reach will be evaluated with agent-based and individualistic models of fish passage behavior. The results of these models will be used as inputs to the LCM being developed for these species.

4.1.2.8 Proposed Deliverables and Schedule

Assuming timely issuance of the Study Plan Determination, the Cooperative plans conducting the study in 2023 and 2024. Upon implementation, study results will be documented in the ISR and USR. It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.1.2.9 Level of Effort and Cost

The Cooperative agrees with stakeholders that this study will need to be a multi-year effort (2023 and 2024) to adequately define the existing condition near the Project site and the potential impacts (positive and negative) to fish passage related to reduced flows over the Falls as a result of Project operations.

The estimated cost for this study is approximately $500,000 - $700,000.

4.1.3 Fish Entrainment and Impingement Study

4.1.3.1 General Description of Proposed Study

The Nuyakuk River is a tributary to the Nushagak River, which supports regionally important commercial, subsistence, and recreational salmon fisheries. While existing data is limited for the Nuyakuk, there are data to indicate that five species of Pacific salmon as well as several other migratory fishes are present in the Nuyakuk, and that fish spawning does occur upstream of Nuyakuk Falls in the Tikchik River (Johnson and Blossom 2019). Therefore, the intake for the proposed hydroelectric Project along with associated infrastructure has the potential to impact fishes as they migrate, particularly juvenile fishes moving downstream past the Project. A successful Project design will incorporate intake features that minimize potential impacts associated with the entrainment, impingement, and mortality of fishes.

In Section 5.2.3 of the PAD, the Cooperative identifies a series of fisheries studies to be utilized to document both the existing condition and the level of impact (positive and negative) to the Project area as a result of construction and operations. One of the potential studies was identified as:

- Hydropower Intake Fish Entrainment and Impingement Study

Per multiple PAD comments and study request letters, including those from ADFG and NMFS, the Cooperative received general concurrence with their proposal to conduct this study and looks forward to collaborating with all interested stakeholders in further defining the appropriate methods and analytical tools to assess the potential for fish entrainment and impingement at the proposed hydropower intake and provide clear design thresholds to minimize harm to downstream migrating fish due to entrainment and/or impingement.

4.1.3.2 Geographic Scope

The geographic focus of the Fish Entrainment and Impingement Study will be the area extending upstream of Nuyakuk Falls approximately 1,000 feet (Figure 4-16). In particular, the area near the right bank of the river will be of particular interest due to its proximity to the proposed intake location. The extent of the study area may be modified according to new information on hydraulics and flow field generated from 2D modeling.

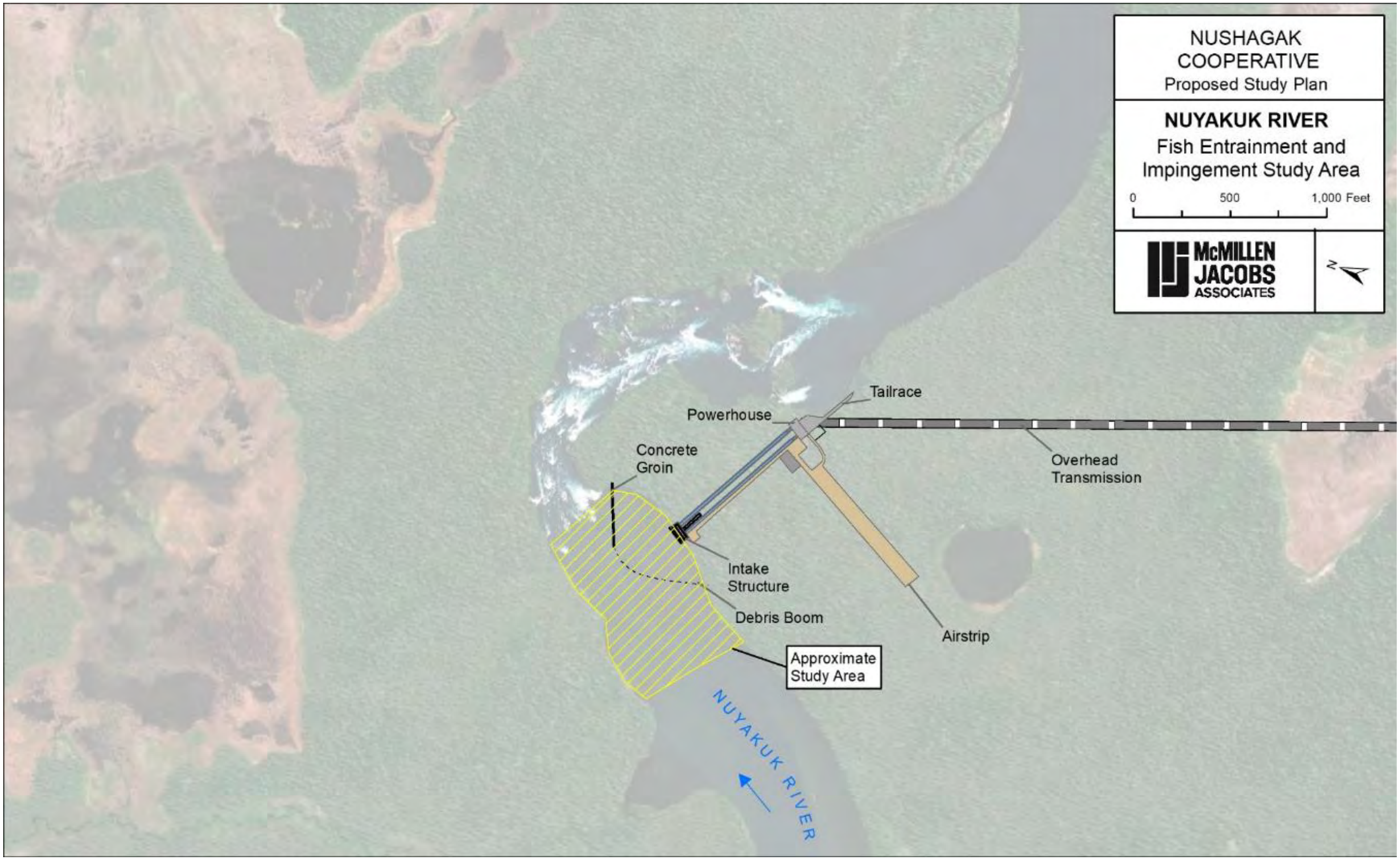

Figure 4-16. Fish Entrainment and Impingement Study Area.

4.1.3.3 Study Goals and Objectives

The primary goal of this study is to understand the potential for the Project to entrain fishes that are in the vicinity of the intake and to minimize the level of injury and mortality that might be associated with entrainment or passage through the Falls Reach. Specific objectives follow.

1. Inform the preliminary intake design (e.g., infrastructure, orientation and trash rack spacing) utilizing the hydraulic model developed under the Fish Passage Study and through a compilation and summary of information from similar projects that are subject to analogous environmental conditions as well as potential guidance/deterrent structures.

2. Estimate flow fields and magnitude of approach velocities near the hydropower intake over the range of operating flows to: evaluate threshold conditions at the proposed intake to minimize entrainment of juvenile salmonids and maximize survival within the Project area; and measure behavior (including vertical and horizontal distribution across the river) of downstream migrating juveniles in proximity to the proposed intake site.

3. Utilize information collected under the Fish Abundance and Distribution Study to identify fish species potentially impacted and their seasonal abundance and size distribution--develop a list of target fish species.

4. Determine the swimming capacities and flow avoidance/ attraction behavior of target fish species from available literature.

5. Estimate potential for entrainment and impingement rates for target fish species based on fish size, swimming ability and periodicity, local hydrology, Project technical features (including trash rack design), and operating regime using available data from entrainment studies involving the same species.

6. Estimate turbine mortality rates for target fish species and sizes by evaluating mortality at other hydroelectric facilities with similar turbine specifications and comparable physical features and operating conditions.

7. Estimate Project-related and overall mortality of target fish species on a seasonal and annual basis using flow-based entrainment and mortality models.

Questions and hypotheses that will be addressed by this study are listed below.

1. What is the estimated potential for entrainment of targeted fish species/life stages through the powerhouse?

2. What is the estimated potential for bypassing entrainment by the targeted fish species/life stages through the Falls Reach?

3. What is the estimated direct and indirect mortality of fish (by life stage or size class) that are entrained into the powerhouse?

4. What is the estimated direct and indirect mortality of fish (by life stage or size class) that bypass entrainment into the Falls Reach?

5. Is estimated passage-related mortality greater for the powerhouse or Falls Reach?

6. Is estimated future mortality in the Falls Reach greater or lesser than baseline condition through the Falls?

7. Are intake design modifications available for use at this location to reduce risk of entrainment?

4.1.3.4 Relevant Resource Management Goals

Five species of anadromous salmonids and multiple resident species are known to utilize the Nuyakuk River at some point during their life cycle. Limited documentation exists on the extent to which they utilize the proposed Project area and/or the watershed upstream. The Fish Entrainment and Impingement Study will be informed by the other fisheries studies described in the PSP.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.3.5 Existing Information and Need for Additional Information

Existing information upon which this study will rely includes:

- Historical flow data in the Nuyakuk River that will serve as a model boundary condition;
- Proposed operating regime and flow routing through the Project and Falls Reach; and
- Information about the target fish species, local distribution and periodicity, including swimming abilities across life stages.

Through literature reviews, other existing information will be obtained, including:

- Operations and maintenance constraints, intake design challenges and solutions at similar hydropower projects including those susceptible to frazil ice accumulation (e.g., Iliamna Newhalen Nondalton Electric Cooperative, Inc);
- The efficacy of non-intrusive fish passage deterrents;
- Impingement potential of target fish species by size; and
- Injury, mortality and survival rates of entrained primary fish species and sizes passing through similar projects with similar Kaplan turbines.

Additional information needed to successfully complete this study includes identification of presence or habitat use by target species as well as bathymetric data and hydraulic modeling in and around the Nuyakuk River upstream of the Falls for approximately 1,000 linear feet.

4.1.3.6 Project Nexus

The diversion of variable portions of Nuyakuk River flow into the proposed Project may affect downstream fish passage and survival through the Project area. Fish may pass downstream through the powerhouse or through the Falls Reach with reduced flow. Downstream migrating fish may be susceptible to injury or mortality via powerhouse entrainment and impingement resulting from abrasion, blade strikes, disorientation, or increased predation likelihood at Project outlets. When passing downstream via the Falls Reach, they may experience changes in habitat conditions (depth, velocity, habitat composition) that could impair or improve passage conditions as compared to baseline. Risk of indirect or longer-term impacts, such as latent mortality, also may increase associated with potential temperature changes in the Project Area as a result of Project operation interaction with climate change. Results of this desktop evaluation study are essential for a complete understanding of the Project's potential impacts on downstream migrating juvenile salmon and other migratory fish species that utilize the Project area. Appendix C contains a more comprehensive listing of primary and secondary Project nexus issues, methods and hypotheses related to potential operational effects in the Project Area.

4.1.3.7 Methodology

The Cooperative has developed the following approach for consideration, for conducting the entrainment study. These methods will be refined and revised pending comments from state and federal agencies and stakeholders.

Use Existing Information to Inform Preliminary Design

This study will begin with a literature review that summarizes intake designs at similar hydroelectric facilities as protective engineering solutions associated with salmon bearing waters. The review will include design measures implemented to reduce fish entrainment and/or impingement. Characteristics to be considered are: target fish species and sizes of concern, fish presence in the Project area, size and angle of intake, intake screen/trash rack spacing, design flow, approach velocities, sweeping velocities, debris management measures, and walls/groins or other structural modifications. Operators of similar projects will also be contacted to discuss their experience with facilities susceptible to similar icing conditions (e.g., Iliamna Newhalen

Nondalton Electric Cooperative, Inc). Finally, the review will also summarize the efficacy of non-intrusive fish entrainment deterrent and guidance systems and their potential for use at the Nuyakuk Project.

Hydrology, Flow Routing, and Hydraulic Modeling

Site-specific hydrology and flow distribution information (flow through the Project and flow through the bypass channel) will be refined and summarized as a precursor for hydraulic model development, the evaluation of intake design alternatives, and assessment of fish entrainment and impingement potential. A two-dimensional hydraulic model of Zones 1, 2, and 3 of the Nuyakuk River will be developed under the Fish Passage Study. The hydraulic model will include the reach upstream from the intake to the tunnels. The purpose of this model will be to inform this study twofold. First, it will be used to evaluate approach velocities and approach angles in relation to primary fish species swimming ability and behavior for various intake designs and orientations. Second, the model will be used to evaluate flow streamlines resulting from a variety of different groin locations and orientations and to determine those configurations that are suited to the swimming abilities of downstream migrants. Flow rates simulated in the model will reflect the entire range of flow anticipated at the Project; however, hydraulic conditions during the out-migration periods for the target species and life stages are specifically of interest.

Entrainment

The overarching goal of the literature review and hydraulic model evaluation is to refine the preliminary design for the Nuyakuk Project intake that minimizes potential fish mortality and injury due to entrainment and impingement. Once a design configuration has been developed an analysis of entrainment and impingement and turbine mortality will be carried forward. To evaluate potential impacts of operations on entrainment and impingement of fishes this study will utilize a desktop entrainment modeling approach. This modeling approach utilizes data from field studies at other hydropower projects (see EPRI 1997; FERC 1995; Winchell et al. 2000) and is a generally accepted practice for FERC licensing studies where no hydro project exists.

Examples of hydro projects where desktop entrainment studies were approved by FERC include Mason Dam Hydroelectric Project (P-12686), Uniontown Hydroelectric Project (P-12958), Overton Hydroelectric Project (P-13160), Emsworth Back Channel Hydroelectric Project (P-13761), Montgomery Locks and Dam Hydroelectric Project (P-13768), Evelyn Hydroelectric Project (P-14799), Braddock Locks and Dam hydroelectric project (P-13739), Allegheny Lock and Dam 2 Hydroelectric Project (P-13755), and the Emsworth Locks and Dam Hydroelectric Project (P-13757). A full list of relevant FERC entrainment study reports that has been compiled by the Cooperative to date is presented in Table 4-5. All of the documents listed below are publicly available on FERC's eLibrary document database system.

Table 4-5. Relevant fish entrainment study reports for FERC projects compiled by Nushagak Cooperative.

FERC Project	Study Report Citation
Mason Dam Hydroelectric Project (P-12686)	Baker County. 2011. Report on Fish Entrainment and Mortality at Mason Dam, OR. Mason Dam Hydroelectric Project (FERC No. 12686). February 2011.
Uniontown Hydroelectric Project	Uniontown Hydro LLC and Newburgh Hydro LLC. 2010. Draft

(P-12958)	Initial Study Report. Uniontown and Newburgh Hydroelectric Projects (FERC No. 12958 and FERC No. 12962). August 2010.
Overton Hydroelectric Project (P-13160)	Red River Hydro LLC. 2010. Draft Initial Study Report. Overton Lock and Dam Hydroelectric Project (FERC No. 13160). November 2010.
Kentucky Lock and Dam 12 & 14 (P-13213; P-13214)	Lock 7 Hydro Partners LLC. 2011. Fish Entrainment and Mortality Analysis. Kentucky Lock and Dam 12 & 14 Hydroelectric Projects (FERC No. 13213 and FERC No. 13214). November 2011.
Braddock Locks and Dam Hydroelectric Project (P-13739)	Lock+ Hydro Friends Fund XLII, LLC. 2012. Fish Entrainment and Survival Assessment. Braddock Locks and Dam Hydroelectric Project (FERC No. 13739). August 2012.
Allegheny Lock and Dam 2 Hydroelectric Project (P-13755)	Free Flow Power Corporation. 2013. Fish Entrainment and Passage Study. Allegheny Lock & Dam Hydroelectric Project (FERC No. P-13755). October 2013.
Emsworth Locks and Dam Hydroelectric Project (P-13757)	Free Flow Power Corporation. 2013. Ohio River Projects Fish Entrainment and Passage Study. Emsworth Locks & Dam Project (FERC No. P-13757), Emsworth Back Channel Project (FERC No. 13761), Montgomery Locks & Dam Project (FERC No. P-13768). October 2013.
Emsworth Back Channel Hydroelectric Project (P-13761)	Free Flow Power Corporation. 2013. Ohio River Projects Fish Entrainment and Passage Study. Emsworth Locks & Dam Project (FERC No. P-13757), Emsworth Back Channel Project (FERC No. 13761), Montgomery Locks & Dam Project (FERC No. P-13768). October 2013.
Montgomery Locks and Dam Hydroelectric Project (P-13768)	Free Flow Power Corporation. 2013. Ohio River Projects Fish Entrainment and Passage Study. Emsworth Locks & Dam Project (FERC No. P-13757), Emsworth Back Channel Project (FERC No. 13761), Montgomery Locks & Dam Project (FERC No. P-13768). October 2013.

The potential for fish to become entrained at a hydroelectric facility is dependent on a variety of biotic factors such as fish composition, size, swimming ability, behavior and life history; and abiotic factors including intake configuration, intake screen/trash rack spacing, operating regime, flow, and intake velocities. Particular species and life history events (migration, dispersal, freshets) as well as the physical layout of a Project can greatly influence the susceptibility or potential for entrainment (Coutant and Whitney 2000). Target species for evaluation will be selected to provide entrainment estimates for those species potentially present in the Project intake flow field that are the most abundant and important for fisheries values, as well as species that are representative of the diversity of fish families potentially present. The criteria used to evaluate potential approach and sweeping velocity will need to be species- and lifestage-specific, with NMFS criteria serving as guidelines for protection. The velocities and approach angles that result in sweeping velocity will likely vary with different intake design configurations. These values will need to be determined during the study once flow patterns, species and design options are known.

Additional supporting information may come from the fish community study. If juvenile fish are marked during fish behavior telemetry studies, they would also be candidates for potential entrainment behavior monitoring if found in the Project intake flow field. Any data from potential hydroacoustic (split-beam echosounder, ARIS / DIDSON imaging sonar) surveys may also be used to characterize the horizontal and vertical distribution of downstream migrating juvenile salmon as they approach the Falls and proposed Project.

The basic approach will be to combine site-specific information on fish species composition, fish size (both from the Fish Species and Abundance Study), fish behavior and periodicity as well as modeled flow fields (from the Fish Passage Study) with the results of both field and desktop studies at other Projects (with similar characteristics) to model and estimate entrainment rates. Hypothetical, species-specific and seasonal entrainment density estimates (fish-per-unit-flow) will be determined for various size categories of target species as based on realistic densities at existing Projects. Species-specific entrainment densities will then be filtered for those size categories that could physically pass through the trash rack (see Impingement). The seasonal entrainment densities for each species and size class will then be extrapolated to seasonal estimates of turbine flow at the Nuyakuk Project using estimated average monthly (or seasonal) flow through the turbines. Estimated monthly (or seasonal) entrainment numbers will then be generated using the product of entrainment density and flow for each species and size group. Monthly (or seasonal) estimates can then be summed to produce annual estimates for an average hydrologic year. Site-specific hydrology for wet and dry years may also be used to produce a range of entrainment estimates. Sensitivity analysis will be conducted for a reasonable range in the input parameters for calculating entrainment/impingement to context the estimate and identify potentially good and poor designs.

Impingement

Impingement occurs when fish do not become entrained through a hydroelectric Project but are instead held or impinged on the intake screen/trash rack and are unable to overcome the inflow force with swimming ability. The potential for fish to become impinged at a hydroelectric facility is dependent on a number of factors-- primarily fish size, clear or open spacing of the intake screen or trash rack, and operations or flow through the Project and associated approach velocities. Intake features are often developed considering a balance of cost, debris management, and that tradeoffs exist between entrainment and impingement risks for fishes. Specifically, for fish that do not have the swimming ability to maintain upstream position, a narrower trash rack spacing increases the risk of impingement mortality when it is exceeded by the body width of target species. In contrast, a wider trash rack spacing increases the probability of turbine entrainment if fish are unable to maintain upstream position or are actively migrating downstream.

Impingement vulnerability is largely determined by habitat use, migratory habitats, and swimming ability. Impingement is a phenomenon that has been studied extensively and summarized by the Electric Power Research Institute (EPRI 2005). Studies at other facilities can offer insights into potential levels and rates of impingement for fish species found in the Project intake flow field. Swimming capacity of individual species large enough to be impinged is also a useful tool in assessing vulnerability. A review of swimming ability (sustained, prolonged, and burst) will be developed for a number of the key species that occur in the Project intake flow field. In the absence of species-specific information, swimming performance of a comparable species may be used, or species will be categorized by swimming ability (e.g., strong, moderate, or weak) to assess size-based impingement vulnerability. Further consideration will be made for any available information on species-specific delayed or latent injury or mortality associated with impingement or entrainment at similar hydropower facilities that might be relevant to the Project area.

Some individuals of larger fish species may be vulnerable to impingement at higher operating flows. A scaling factor relating fish body width to total length will be used for the impingement assessment to determine minimum sizes of the target fish species that would physically be excluded and not able to pass through the open spaces in the trash rack. The swimming ability of large-bodied fishes that cannot physically pass through the trash rack spaces will be compared to the maximum approach velocity for the Project. If swimming ability exceeds approach velocity, fish of these sizes are generally considered to not be suspectable to impingement or entrainment and are omitted from further analysis.

Mortality

Entrainment mortality includes both direct turbine mortality as well as shear and cavitation stress and pressures effects. Turbine mortality at each hydroelectric facility is variable and is dependent on the size and species of fish and turbine characteristics. These characteristics include turbine runner type (i.e., Francis or Kaplan), size, speed, number of blades, blade spacing and thickness (EPRI 1997; Gibson and Myers 2002; Pracheil et al. 2016). Estimated rates of entrainment and impingement can then be applied to estimated rates of mortality based on previous field studies with similar turbine types and intake spacing. Numerous studies of fish injury and survival associated with Kaplan turbines have been conducted and summarized (Algera et al. 2020; Čada and Rinehart 2000; EPRI 1997; EPRI 2005) and will be used to estimate mortality rates by species and size. Size-specific direct mortality rates for Kaplan turbines can also be estimated using predictive models such as the Franke blade strike model (Franke et al. 1997) and used to compare to those observed in field studies.

A portion of the flow at Nuyakuk Falls would be diverted for power production, so the overall impact of the Project in terms of fish entrainment and mortality may be relative to that proportional flow, particularly during the outmigration period. Fish and water flowing through the Nuyakuk Falls bypass reach will continue to pass downstream and survive at or near the current rate or baseline which will be assumed to be high in this study. Under the Fish Passage Study, a bathymetric survey and hydraulic model will be used to evaluate the maintenance of appropriate downstream fish passage conditions in the bypass channel over a range of anticipated flow conditions. To put entrainment and impingement impacts into context an estimate of fish passage survival will be developed considering flows through both passage routes, turbines and bypass, using the proposed operating regime.

4.1.3.8 Proposed Deliverables and Schedule

Assuming timely issuance of the Study Plan Determination, the Cooperative plans conducting the study in 2023 and 2024. Upon implementation, study results will be documented in the ISR and USR. It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.1.3.9 Level of Effort and Cost

Overall, the level of effort and cost is commensurate with a Project the size of the Nuyakuk Project and the likely 50-year license term. The Fish Entrainment and Impingement Study will rely on data and information obtained, created and used in the Nuyakuk Falls Fish Passage Study (see Section 4.1.2) so that efforts are not unnecessarily duplicated. Specifically, the present study will rely on bathymetric data to build a hydraulic model of the river upstream of the Falls. The overall level of effort will depend, in part, on the degree to which the model geometry needs to be adjusted and model runs iterated to arrive at a suitable groin configuration for downstream migrants. The range of cost for this study is projected to be $150,000 - $250,000.

4.1.4 Assessment of False Attraction at the Tailrace Fish Barrier

4.1.4.1 General Description of Proposed Study

Hydropower Project operations can result in false attraction to Project works, resulting in migration delay and loss of productivity. The Nuyakuk Falls are located at the approximate half-way point in a migration of nearly 100 miles for some salmon species. Understanding the various solutions for minimizing false attraction to tailrace discharge will inform the Project design and licensing process, and lead to more effective and cost-efficient mitigation measures for protecting aquatic resources.

In Section 5.2.3 of the PAD, the Cooperative identifies a series of fisheries studies to be implemented to document both existing conditions and the estimated level of impact (positive and negative) to the Project area as a result of construction and operations. One of the potential studies was identified as:

- Assessment of False Attraction at the Tailrace Fish Barrier

Per multiple PAD comments and study request letters, including those from ADFG and NMFS, the Cooperative received general concurrence with their proposal to conduct this study and looks forward to collaborating with all interested stakeholders in further defining the appropriate methods and analytical tools to utilize in assessing and minimizing conditions of false attraction to fish at the proposed tailrace location.

4.1.4.2 Geographic Scope

The geographic scope of the False Attraction Assessment will focus on the area surrounding the proposed tailrace outfall below Nuyakuk Falls. The area of focus will extend from the three distinct chutes or route options at the downstream end of the Nuyakuk Falls cascade that includes the proposed tailrace outfall area, downstream approximately 1,500 ft along the right bank of the river (looking downstream) (Figure 4-17). The extents of the study area may be modified according to new information on hydraulics and flow field generated from 2D modeling.

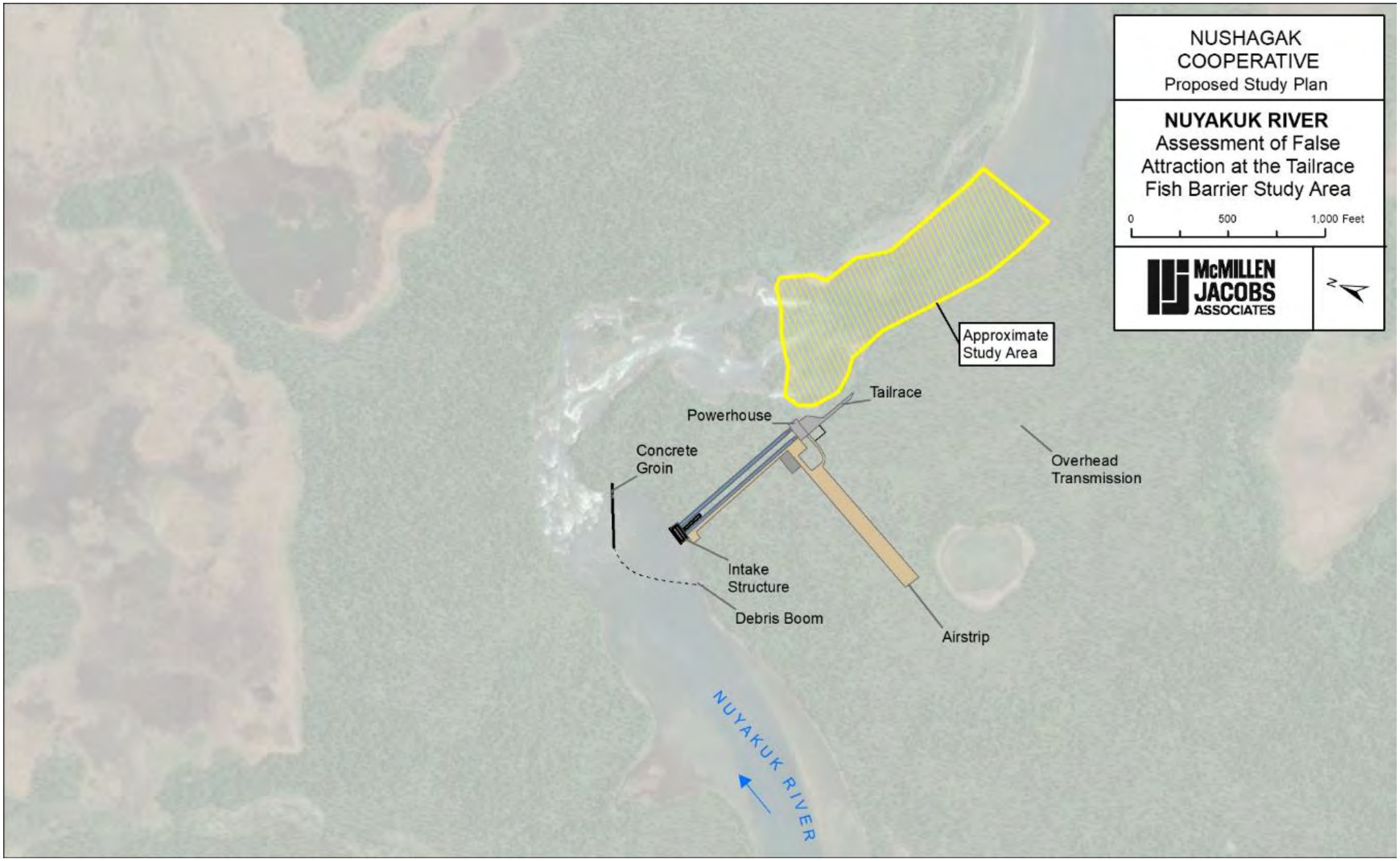

Figure 4-17. Assessment of False Attraction at the Tailrace Fish Barrier Study Area.

4.1.4.3 Study Goals and Objectives

The overall goal of this study is to inform tailrace design and outflow options to minimize potential impacts to upstream migrating fishes.

The primary objectives of this study are as follows:

1. Complete a review of tailrace designs that minimize false attraction by salmon to determine any conceptual alternatives that would be suited to the Project and would likely minimize false attraction;

2. Conduct a feasibility evaluation of the performance of tailrace location and design concepts that might minimize false attraction under a variety of operating regimes;

3. Determine and provide preliminary level designs of any tailrace refinements to minimize adult salmon injury and mortality associated with tailrace conditions, e.g., jumping at turbine draft tubes and the potential for blade strike;

4. In coordination with the fish community study, assess pre-Project across channel distribution of upstream migrating salmon with respect to the proposed tailrace and Falls tailouts;

5. In coordination with the fish passage study, evaluate potential changes post-Project in staging and ascension habitat below the Falls proper for suitability and connectiveness with respect to upstream migration and the potential for delay;

6. In coordination with the Life Cycle Model study, assess potential risk that results from incidental or latent mortality for fish that are falsely attracted to the tailrace.

Specific questions that will be addressed by this study follow.

1. Can the powerhouse discharge and tailrace design features minimize potential to attract fish to the tailrace at this location?

4.1.4.4 Relevant Resource Management Goals

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for

Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.4.5 Existing Information and Need for Additional Information

Existing information upon which this study will rely includes:

- Historical flow data in the Nuyakuk River that will serve as a model boundary condition;
- Information about the target species, including swimming abilities across life stages.

Through literature reviews, other existing information will be obtained, including:

- Existing guidelines for tailrace infrastructure designs that do not allow fish to pass and where fish do not physically injure themselves while trying to pass (NMFS 2011)
- Project studies and literature supporting an understanding of the functionally of physical barriers.

Additional information needed to successfully complete this study includes bathymetric and topographic data in and around the Nuyakuk River downstream of the Falls for approximately ¼ mile.

4.1.4.6 Project Nexus

The Nuyakuk Falls are approximately half-way through a migration of close to 100 miles for some salmon species. The diversion of variable portions of Nuyakuk River flow into the proposed Project may affect upstream fish passage and survival through the Project area. Project operations will result in a higher proportion of flow in the tailrace compared to the Falls Reach and may change the flow field, channel configuration, and water depths/velocity below the Falls proper. The composition, configuration, connectivity, and suitability of holding/staging/migration/ascension habitats downstream of the Falls proper and tailrace may change. Upstream migrating fish may be attracted to the predominant flow of the impassible route of the tailrace and thereby be delayed in finding the migration pathway into the Falls proper or subject to higher rates of injury. Understanding how the various solutions for minimizing false attraction to tailrace discharge will inform the Project design and licensing process, and lead to more effective and cost-efficient mitigation measures for protecting aquatic resources. Appendix C contains a more comprehensive listing of primary and secondary Project nexus issues, methods and hypotheses related to potential operational effects in the Project Area.

4.1.4.7 Methodology

The Cooperative has developed the following approach for consideration, for conducting the Tailrace False Attraction study. These methods will be refined and revised pending comments from state and federal agencies and stakeholders.

Review Existing Information to Inform Preliminary Design

This study will begin with a review of available information regarding tailrace designs at similar hydroelectric facilities as well as protective engineering design criterion associated with minimizing salmon false attraction and the potential for migration delay. The study will involve compilation and review of various engineering design measures implemented at similar facilities. Characteristics may include salmon species of concern, tailrace dimensions and orientation relative to the natural channel, design flows, flow routing information (e.g., proportion of overall flow), a summary of tailrace flow vectors (velocity and direction), tailrace exclusion barriers, and walls/groins or other structural modifications that should be considered to minimize false attraction to turbine outflows.

Feasibility evaluation

Once the existing information on tailrace refinements has been compiled and summarized, the Cooperative proposes to conduct a brainstorming session focused on selecting two to three preferred conceptual alternatives. These concepts will then be developed further with respect to Project-specific physical, ecological, and operational criteria. This step will include completion of 2D model runs focused on the tailrace area.

To support this feasibility evaluation, the two-dimensional hydraulic model of the Nuyakuk Falls Reach developed under the Fish Passage Study will be used to assess the three chutes or passage route options located at the base of the cascade, the proposed Project tailrace area, and the Nuyakuk River channel immediately downstream. The model will be used first to evaluate flow volumes, depths, velocities, and angles in relation to existing tailrace and Falls chute conditions and, if necessary, to evaluate flow streamlines resulting from potential engineered solutions. The flow output from the model will allow a comparative assessment of the potential effectiveness of options for enhancing fish attraction to one of the passage routes at the base of Nuyakuk Falls.

Kleinschmidt/R2 staff have developed and utilized similar models in assessing downstream passage alternatives at multiple dams throughout the West. This approach provides a transparent tool for the cooperative and other interested parties to use is assessing future potential effects of different flow conditions, passage routes and/or facility options. The alternative considered and criteria used to evaluate those alternatives will be developed in collaboration with the ARWG or a subcommittee thereof. Kleinschmidt/R2's downstream passage biological performance tool (BPT) has been approved by state and federal agencies for application in passage feasibility study and has been promoted by NMFS as the model required for fish passage evaluations in California. While the model developed for this study is a novel application for upstream passage, the basic modeling principles and comparative analysis are similar. Specific conditions of this model application are presented below.

Flow rates simulated in the model will reflect the entire range of flow anticipated at the Project; however, hydraulic conditions during the upstream migration periods for the five species of Pacific salmon will be the focus for this study. Specially, for each month during which more than 10% of the run of a species of concern has traditionally returned, the model will be run at the 20% exceedance flow and the 80% exceedance flow. These runs will be performed in combination with various operating scenarios for the hydropower facility including:

1) operating at 100% capacity (up to 6,000 cfs) and leaving the remaining flow or 1000 cfs, whichever is greater in the river; 2) removing 30% of the flow (up to 6,000 cfs Project capacity) and leaving a minimum of 70% in the river (current state law); 3) removing 50% of the flow (up to 6,000 cfs Project capacity) and leaving a minimum of 50% in the river; and 4) removing 70% of the flow (up to 6,000 cfs Project capacity) and leaving a minimum of 30% in the river.

Results of the model runs will be used in combination with other biological ecological, physical and operational characteristics to select the best engineering alternative for minimizing potential impacts to adult salmon in the Project tailrace. This would include empirical data collected on baseline conditions during other studies such as upstream Falls passage timing and delay, flow proportions and patterns, depths and velocities in the tailrace and below the Falls. This also would include potential data from: hydroacoustics (split-beam echosounder, ARIS / DIDSON imaging sonar) or telemetry (radio or acoustic) data inputs may also be used to characterize the distribution of upstream migrating salmon as they approach the Falls under baseline condition. This activity would inform model development and consideration of post-Project fish behavior with respect to the tailrace, the Falls and modified flows design. The selection process will be completed collaboratively and will use a matrix-based analysis to facilitate transparency.

Preliminary design of tailrace exclusion refinements

Depending on tailrace design, an exclusion barrier may be needed to prevent fish from entering the turbine draft tubes and minimizing the potential for turbine blade strikes. This tailrace option will be incorporated into the feasibility evaluation. If a tailrace barrier is advanced, the study will include an assessment of physical criteria such as picket opening spacing, porosity, velocity, orientation, height or freeboard, and swimming and leaping ability of target fish species. The Cooperative looks forward to collaborating with stakeholders, during continued development of the study plan, and during study implementation to evaluate and select feasible tailrace design and operational alternatives for the Project, that serve to minimize false attraction and delay.

4.1.4.8 Proposed Deliverables and Schedule

Assuming timely issuance of the Study Plan Determination, the Cooperative plans conducting the study in 2023 and 2024. Upon implementation, study results will be documented in the ISR and USR. It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.1.4.9 Level of Effort and Cost

Overall, the level of effort and cost is commensurate with a Project the size of the Nuyakuk Project and the likely 50-year license term. The Assessment of False Attraction at the Tailrace Fish Barrier Study will rely on data and information obtained, created and used in the Nuyakuk Falls Fish Passage Study (see Section 4.1.2) so that efforts are not unnecessarily duplicated. Specifically, the present study will rely on bathymetric data to build a hydraulic model of the river downstream of the Falls. The range of cost for this study is projected to be $150,000 - $250,000.

4.1.5 Chinook and Sockeye Salmon Life Cycle Modeling

4.1.5.1 General Description of Proposed Study

In Section 5.2.3 of the PAD, the Cooperative identified a series of fisheries studies to be utilized to document both the existing condition and the level of impact (positive and negative) to the Project Area because of construction, the physical structure and operations. Evaluating the impact of Project conditions to two important salmonid species in the Nuyakuk River – Chinook and Sockeye salmon – will be aided by the construction of life cycle models (LCM) wherein impacts can be put into the context of population dynamics.

The LCMs were proposed by the Aquatic Resources Working Group to address potential Project impacts to fisheries resources at the population level. Each LCM will integrate population responses to a range of environmental and Project conditions or scenarios, such that we can evaluate the magnitude and likelihood of certain responses associated with the Project across a range of environmental and operational conditions. This study will construct stage-structured population dynamics models that will relate Project and environment information to stage transitions (describing movement, survival, and reproduction) that drive population dynamics (Hendrix et al. 2014, Cunningham et. al 2015, Figure 4-1. These models will be used to integrate changes to habitat over time and space to predict the potential impact to the long-term status of the populations. This study will support the Cooperative, agencies, and stakeholders in conducting an Integrated Risk Assessment (IRA) to decide what impacts to the populations are acceptable or not acceptable (see study plan to conduct an IRA in Section 4.1.6).

4.1.5.2 Geographic Scope

Direct effects of the Project on fish populations may occur within its hydraulic zone of influence which is approximately 0.5 miles upstream and downstream of the Nuyakuk Falls (Figure 4-2). In some cases, effects in that zone have the potential to influence the abundance and productivity of fish populations that migrate through or temporarily reside there. Potential impacts can therefore indirectly influence those populations in time and space outside the Project Area through density dependent processes that may buffer or amplify direct Project effects on fish. The geographic area is thereby described as the migration route over the life history of the population (Nuyakuk, to and through the ocean, and return to the Nuyakuk).

4.1.5.3 Study Goals and Objectives

The primary goals of this study are to:

- Quantify the risk (magnitude and probability of surpassing management defined thresholds) of impact by the proposed Nuyakuk Project and operations on Chinook and Sockeye population dynamics under baseline and future climate conditions.

The primary objectives of this study are to:

- Develop a set of management relevant metrics that reflect: 1) the Nuyakuk population level impacts on the Nushugak fishery, 2) population variability in the Nuyakuk.

- Identify a set of management relevant thresholds for the metrics that constitute "risk", such that exceeding those thresholds could have a significant negative impact on the population.
- Construct a life cycle model that includes the Nuyakuk Hydro Project reach and the life cycle of these populations.
- Develop a life cycle model that can calculate the management relevant metrics and the magnitude and probability of exceeding management relevant thresholds.
- Run the life cycle model for strategic scenarios including current conditions (without-Project) and current conditions with-Project. Calculate the risk to the population and fishery (magnitude and probability of exceeding the management thresholds) under these two scenarios.
- Run the life cycle model for strategic scenarios including a baseline future climate condition (without-Project) and the future climate condition with-Project. Calculate the risk to the population and fishery (magnitude and probability of exceeding the management thresholds) under these two scenarios.

Specific questions that will be addressed by this study include:

1. What are the thresholds that stakeholders and managers define as acceptable and unacceptable levels of change to population dynamics (abundance and/or productivity) for Chinook and Sockeye salmon of the Nuyakuk River?

2. What levels of population change and the magnitude and probability of surpassing management thresholds are expected to occur naturally under a baseline condition?

   a. What is the probability that Chinook and Sockeye salmon escapement will drop below their escapement goals?

3. How will Project operations, which affect different stages of the life cycle, be evaluated for their overall effect on the populations? Project effect questions could include:

   a. How will estimated changes to upstream passage, behavior and survival of salmon through the Falls Reach impact population projections?

   b. How will estimated changes to downstream passage and behavior of salmon through the Falls Reach impact population projections?

   c. How will estimated rearing habitat changes in the Falls Reach impact the populations?

   d. How will estimated changes to downstream survival impact the populations?

   e. How will estimated stranding/trapping rates impact the populations?

   f. How will estimated reductions in fringe spawning habitats impact the populations?

  g. How will estimated migration delays and injuries due to false attraction to the tailrace impact the populations?

4. How do the effects of the Project compare to the baseline with respect to population dynamics and the magnitude and probability of surpassing management thresholds?

5. What is the expected natural level of variability (without-Project) in population dynamics and the magnitude and probability of surpassing management thresholds under future climate conditions?

6. How will Project operations affect population dynamics and the magnitude and probability of surpassing management thresholds under future climate conditions, and how do these compare to the baseline condition under future climate conditions?

4.1.5.4 Relevant Resource Management Goals

Chinook and Sockeye salmon are known to utilize the Nuyakuk River during their life cycle as they pass through the Project Area during upstream and downstream migrations. Limited data exists documenting the extent to which they utilize the proposed Project Area and/or the watershed upstream.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

The mission of the ADFG – Division of Sport Fish is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.5.5 Existing Information and Need for Additional Information

The LCM assessment will rely on limited existing information from the Nushagak, other Bristol Bay watersheds, the evaluation of direct effects and those derived from future flows and temperature regimes (Wobus et. al 2015), and from the literature. Fish survival information and escapement estimates do exist for areas upstream and downstream from the Falls that can be used as part of this study. New or existing information will be collected by or generated from the other proposed fisheries studies and/or the broader Proposed Study Plan for the Project. For example, the results produced from the 2-D flow model combined with the individual-based passage model will provide information for several species in terms of upstream and downstream passage success. For Chinook and Sockeye salmon, the LCM will provide quantitative information to support an Integrated Risk Assessment.

4.1.5.6 Project Nexus

The physical Project and its operation have the potential to have positive or negative effects on fish populations that reside in or pass through the Project Area. Water diversion from the river and through the powerhouse is the fundamental action from which potential impacts of the Project originate. Water diversion has the effects of reducing flow through the Falls Reach, creating an additional downstream passage route for fish via the powerhouse, and relocating bulk flow of the river below the Falls to a localized discharge point from the tailrace on the right bank of the river. This action results in a 0.34-mile section of river that comprises the Nuyakuk Falls Reach. These hydraulic changes may affect the timing, distribution, passage and survival of resident and migratory fish populations (adults and juveniles) and their long-term sustainability. Therefore, it is important to understand the impacts to these populations because of reduced flows through the Falls Reach, entrainment, stranding/trapping, and migration delays due to false attraction at the tailrace.

For Chinook and Sockeye, the fundamental questions related to this nexus are a) what effect does the Project have on the number of successful spawners and the number of juvenile outmigrants, and b) what magnitude and likelihood of this effect is necessary to jeopardize the sustainability of the populations. These questions are assessed within the context of environmental and harvest effects. This study will support an Integrated Risk Assessment for Chinook and Sockeye salmon populations as related to the proposed Project and its operations.

4.1.5.7 Methodology

Justification for an LCM

Resource managers and stakeholders decide what and type of change in fish population dynamics is acceptable when introducing a hydroelectric Project to the system. One tool that can be useful in that decision making process is a Life Cycle Model (LCM) that provides estimates of what change in population dynamics are likely under different operational and environmental conditions. To understand how the Project and its operations are going to affect the population, it is prudent to use a model that integrates the various processes that affect how that the Project is going to affect different life stages at geographic locations of the population.

One type of model that can do this integration is a LCM. The LCM specifies life stages and tracks the relative abundance in each one of the stages (Hendrix et. al 2014). For example, a simple life cycle might be composed of an adult and a juvenile stage. The LCM also defines how the abundance changes between stages (so called "transitions"). So, for the simple model, there would be a transition equation that defines how juveniles survived to the adult stage, and a second transition equation that defines how adults produced the juveniles. When the stages are linked into a cycle, then the LCM is capable of modeling multiple cohorts of animals by repeatedly calculating the abundances of a stage at a given time via the transition equations.

Transition equations can also be defined as a function of the abundance in the previous stage. For example, in the simple model, the transition that defines the abundance in the juvenile stage can be affected by the abundance of adults. These density-dependent processes are important in population dynamics because they can result in one stage affecting the following stage in a non-linear fashion. Density dependence is common in salmonid population dynamics, and thus a LCM of salmonids should be capable of incorporating density-dependence in the transition equations.

If the transition equations are static, then the LCM will arrive at an equilibrium abundance for each stage. On the other hand, if the transition equations are allowed to vary due to the influence of environmental factors, then the stage abundances will vary through time reflecting the influence of the environment on the population.

The transition equations can also be allowed to vary using the outputs of other models. These process-based models may operate on a finer temporal or spatial scale than the LCM and focus on reflecting the dynamics of a specific process, such as survival or movement. Often these process-based models incorporate physical driver variables that affect the mechanisms by which animals survive or move. For example, a model that calculates the time duration it takes an adult salmon pass through a set of Falls under different flow conditions would be an example of a process-based model that defines a movement rate. In this manner, the effect of the process-based drivers can be integrated to understand the population level effects. Returning to the adult movement process-level model and the simple adult and juvenile life stages, the transition from adult to juvenile could be made a function of the movement model. Thus, the production of juveniles would be affected by the movement of adults past the Falls, which in turn would be affected by the flow conditions during passage. As a result, the population abundance could be affected by the flow conditions during adult passage of the Falls.

Managers and stakeholders define the thresholds for abundance or process rates that are being calculated in the LCM (e.g., survival threshold, productivity threshold, etc.) and the LCM calculates whether the population exceeds those thresholds. Further, if the LCM includes stochasticity, then it can be run multiple times under the same environmental and operational conditions to calculate the magnitude and probability of exceeding those thresholds. In this way, the LCM can be used to perform a quantitative IRA when the threshold values are associated with different levels of risk to the population.

Allowing the transition functions to be affected by environmental conditions means that the LCM can be run under different environmental scenarios. One scenario might be the environmental conditions experienced in the recent past. In another case, a scenario might be the environmental conditions consistent with a different climate, such as predicted environmental conditions in 2050 from a climate model (see NMFS future flows study), and yet a third scenario might be predicted environmental conditions in 2100.

In summary, an LCM:

- forces to explicitly state the overarching questions, assumptions, and knowns / unknowns about a system;
- formalizes and quantifies the relationships connecting the Project to the environment and fish populations, and supports refinements in study design;

- develops a mechanism to integrate across environmental processes and the proposed studies into metrics of potential impact;
- identifies the influential and useful variables, types of data, the level of resolution necessary to parameterize the model, and an opportunity for validating model components;
- partly compensates for a limited number of years of data for the Project site;
- establishes a basis for running scenario-based conditions to quantify potential outcomes and conduct sensitivity analysis of driving factors;
- provides the opportunity for risk assessment to focus on the magnitude of potential impacts necessary to materially affect fish population production and sustainability;
- allows a forward-looking perspective to guide the identification of potential monitoring and analyses of Project construction / operation that support before / after evaluations with comparable datasets.

Components of the LCM

- Integrate Project effects (e.g., effects to upstream passage rates) over the life cycle to calculate population-level metrics such as abundance and productivity.
- Provide outputs that can then be evaluated in a decision-making framework at the level that relevant to resource managers. For example, providing an estimate of delayed migration of adult passage does not determine how the Project is going to affect the Nuyakuk population or whether there will need to be a change in fishery management to deal with the Nushagak as a weak stock of the fishery (i.e., resource level effects). However, an LCM can integrate the effect of delayed migration and other factors to determine potential Project impact.
- Incorporate process-based models. Examples of a process-based models are those that calculate the duration of migration delay, or the proportion of fish delayed in adult passage as a function of flow, or the quantity and quality of rearing and migratory habitat. Similarly, a process-based model that calculates the proportion of juvenile fish that are diverted through the powerhouse as a function of flow.
- Incorporate climate change scenarios (see NMFS future flows study).
- Incorporate density dependent population processes such as during production of juveniles or during rearing of juveniles.
- Incorporate direct or indirect Project effects that are occurring in the Project Area (e.g., delay in passage, or mortality) and that such as latent mortality outside of the Project due to injury incurred during Project passage.

- Develop a "sensitivity analysis" to understand which components of the model are most responsible for affecting management metrics and the populations.

Tasks

Task 1: Management metrics

- Define management questions, important endpoints, and metrics that are aligned with those endpoints.
    - Project level impacts
    - Population level impacts
    - Fishery resource level impacts

  This task should include input from stakeholders and decision makers.

Task 2: Model Development

- Develop an initial life cycle model.
- Revise the initial model to ensure that the model can address important questions and can calculate management metrics from Task 1.

Task 3: Data Acquisition

- Acquire data for the model.
    - Identify information where available on population vital rates (e.g., survival, movement, and production, smolt to adult return ratios, etc.) and information on density dependence from the Nuyakuk, Nushagak, other Bristol Bay systems, or appropriate Alaskan Sockeye or Chinook populations.
    - Identify abundance data, brood tables, run reconstructions, etc. (e.g., ADFG data series, Cunningham et al. 2015) that can provide indices of abundance that will be useful for the model.
    - Identify passage success and changes in habitat conditions as related to changes in flows and habitat. These inputs will be developed using 2D hydrologic and individual based fish migration models as part of the Fish Passage Study (see Section 4.1.2).

Task 4: Calibrate Baseline Model

- Calibrate a baseline model without-Project using a statistical fitting approach, such as Bayesian estimation.
- Use the information identified on population vital rates in Task 3 to help define model parameters for the life cycle model.

- Use the abundance data identified in Task 3 to further refine the population vital rate parameters and their dependence on environmental factors such as flow and temperature.

Task 5: Develop Baseline Model and Calculate Model Sensitivity

- Define the baseline model using the parameters obtained from the LCM calibration in Task 4.
- Link the baseline model outputs to the management metrics defined in Task 1 via explicit mathematical relationships and model code.
- Perform a sensitivity analysis to identify what life stages and transitions are most influential in affecting the management relevant metrics identified in Task 1.

Task 6: Develop Expected Project Effects

- Define both direct and indirect Project effects that occur in and outside of the Project reach.
- Define the expected effects of the Project on specific life stage rates. For example, the Project may affect movement rate of adult salmon migration by increasing passage times through the Project reach. The expected effects should also have an explicit mechanism. For example, passage times increase due to a higher fall-back rate. Note that the hypothesis tables are meant to provide a good set of mechanistic hypotheses about Project effects.
- Translate written Project effects into mathematical descriptions of Project effects.
- Develop expected range of Project effects using data from existing hydro Projects (e.g., juvenile survival rates through turbines) or using professional judgement estimates of what the range of Project effects are expected to be.
- Convert mathematical descriptions into model code.
- Incorporate process-based models that affect vital rates such as survival, movement, and production into model code, making explicit mathematical linkages between the LCM and the process-based models. Process-based models could include (but not be limited to):
- Passage study 2D model
- False attraction model
- Entrainment model

Task 7: Incorporate Future Climate and Water Flow Scenarios

- Use strategic climatic periods given the expected period of operation of the Project.

- Use climate scenarios of environmental conditions (e.g., flow, temperature, etc.) that correspond to the climatic periods of interest.
- Incorporate information of climate effect on flow and temperature from a NMFS Future Flows study being implemented with the Cooperative. That model will predict flows and water temperatures for strategic periods from a hydrologic model for the Nuyakuk River and a climate projection database.

Task 8: Evaluate Project Effects

- Run the LCM under baseline conditions and historical climate.
- Run the LCM under with-Project conditions from Task 6 and historical climate.
- Run the LCM under baseline conditions and climate change scenarios.
- Run the LCM under with-Project conditions from Task 6 and climate change scenarios.
- Compare management metrics (Task 1) under baseline and with-Project operational scenarios, paired by climate scenario. Evaluate effects on population dynamics for the Project relative to baseline conditions for a given climate scenario.

4.1.5.8 Proposed Deliverables and Schedule

Task 1

Report defining the relevant model outputs, metrics, and thresholds that reflect the important management Project effects that can be used to define risk to the Nuyakuk population and Nushagak fishery.

Task 2

Report defining the LCM structure in terms of model states (e.g., abundance of specific life stages) and the model transition functions, their dependencies on environmental factors (e.g., flow) and the methods by which the metrics identified in Task 1 will be calculated from the LCM.

Task 3

Report defining the sources of useful information on population vital rates and levels of density dependence. The report would include a series of tables identifying the information, caveats, and source for population vital rates. The report would also include a table describing the abundance data, period of record, type of data collection, life history stage surveyed, location, source, and caveats.

Task 4

Report describing the statistical fitting approach and how the model incorporated the information on population vital rates and abundance data sources in Task 3. Report will also describe the results from fitting the statistical model and the parameter estimates obtained from the model fitting.

Task 5

Report that will define the baseline model and the sensitivity of important management metrics to variation in model parameters.

Task 6

Report describing the expected Project effects, the mathematical relationships between Project effects and population vital rates (e.g., survival, movement, and reproduction), and the description of all process-based models.

Task 7

Report defining the approach used for developing flow and temperature data under future climate change, how those data are being incorporated into the LCM, and the patterns in the future climate change relative to the baseline hydrologic conditions.

Task 8

Report describing the results of running the baseline scenario with historical climate conditions, Project effects with historical climate conditions, baseline with climate change conditions, and Project effects with climate change conditions. The output of the model will be in terms of the management- relevant metrics developed in Task 1.

Schedule

Figure 4-18 below depicts the projected schedule for conducting the Nuyakuk Falls LCM study.

			Year 1				Year 2			
Task	**Description**		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Task 1	Management Metrics									
Task 2	Model Development									
Task 3	Data Acquisition									
Task 4	Model Calibration				T1, T2, T3					
Task 5	Sensitivity Analysis				T1, T2					
Task 6	Project Effects									
Task 7	Climate Scenarios									
Task 8	Evaluate Project						T4, T6, T7			

* References to other tables in the schedule refer to dependencies on previous tasks. For example model calibration is dependent on Tasks 1-3 (T1, T2, T3)

Figure 4-18. Nuyakuk Falls Fish Life Cycle Modeling Study Schedule. 2023 and 2024 are projected to be Year 1 and Year 2, respectively.

4.1.5.9 Level of Effort and Cost

The Cooperative agrees with stakeholders that this study will need to be a multi-year effort (starting in 2022 into 2024) to adequately model the existing condition near the Project site and the potential impacts (positive and negative) to fish populations because of Project operations.

The estimated cost for this study is approximately $230,000 - 275,000.

4.1.6 Integrated Risk Assessment of Fish Populations

4.1.6.1 General Description of Proposed Study

An integrated risk assessment (IRA) is proposed by the Aquatic Resources Working Group to address to evaluate potential Project impacts to fisheries resources at the fish population/ fish community level. The IRA will integrate population responses to a range of environmental and Project conditions or scenarios, such that we can evaluate the likelihood of certain benefits and costs associated with the Project across a range of environmental and operational conditions. This assessment will allow the Cooperative, agencies, and stakeholders to decide what impacts to the populations are acceptable or not.

The study will develop a semi-quantitative evaluation of risk that integrates the accumulated knowledge from available expert, local, empirical sources, and ranging from professional judgment to Life Cycle Models (LCM; Fletcher, 2015). The ultimate outcome is a ranked risk assessment that highlights the most negative risk issues for further evaluation and mitigation. The risk assessment framework includes an explicit consideration of uncertainty by including the likelihood of risks of varying magnitude.

4.1.6.2 Geographic Scope

Direct effects of the Project to fish populations may occur within its hydraulic zone of influence which is approximately 0.5 miles upstream and downstream of the Nuyakuk Falls. In some cases, any effects in that zone have the potential to influence the abundance and productivity of fish populations that migrate through, or temporarily reside, there. Potential impacts can therefore indirectly influence those populations in time and space outside the Project Area through density dependent processes that may buffer or amplify direct Project effects on fish.

4.1.6.3 Study Goals and Objectives

The overarching goal of this study is to provide a framework for quantifying and/or qualifying the relative risk of Project-related impacts to fish population dynamics over the course of the life cycle of fish, and over the life of the Project. This project will address target fish species including Pacific Salmon, other migratory fishes and resident fish species that utilize the Project Area.

The primary objectives for this study are to:

1. Define the management objectives for the fish population/community, which could be a single objective for each species, or could be multiple objectives for some species (i.e., what is at risk? abundance, sustainability). The management objectives have respective elements (e.g., habitat, predation, passage) that can influence achieving the objectives, and indicators (metrics for survival, passage success, habitat suitability, injury/stress) that measure change to the elements.

2. Define specific risk sources (Project structures or operations, climate change variables).

3. Define risk ranking criteria (thresholds of consequence and likelihood).

4. Convene a workshop(s) with agencies and stakeholders (public) for input on objectives and risk analysis. Refine risk analysis as needed.

5. Conduct a quantitative risk evaluation using Life Cycle Modeling for Sockeye and Chinook to assess the potential magnitude of impacts as based on what-if scenarios, sensitivity analysis (variation of relative Project or environmental effect from baseline conditions) and supported by empirical / process-based studies.

6. Conduct a qualitative risk evaluation (e.g., low, moderate, high) for target species, by management objective, elements, and risk sources. Analyses will rank the potential impact of risk sources on the target species population. This approach to assessing risk is particularly useful for species for which there are too few data to develop a reasonable LCM.

4.1.6.4 Relevant Resource Management Goals

Five species of anadromous salmonids and multiple resident species are known to utilize the Nuyakuk River at some point during their life cycle. Limited data exists documenting the extent to which they utilize the proposed Project area and/or upstream reaches of the watershed.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources." According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

Further, NMFS's relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. NMFS involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.1.6.5 Existing Information and Need for Additional Information

The IRA process is partly informed by the regional community (stakeholders, agencies, outfitters, industry) input on management objectives, elements and risk criteria. These intrinsic, social and economic values of the Nuyakuk fisheries resource may be available in regional, state, and federal management plans that document the answer to the question of "what's most important" to the community. However, these perspectives also need to be directly solicited from the community to ensure the completeness and relative value of aspects of the aquatic resource are included in the analysis.

The risk assessment approach outlined here has been adapted from international standards developed for ecosystem approaches to fisheries and aquatic management (Fletcher, 2015). A similar process was used for a qualitative ecosystem-level risk assessment for the U.S. Mid-Atlantic Fishery Management Council that included economic, social, and other types of risks along with fish production and mortality metrics (Gaichas et al. 2018). The process proposed for the Nuyakuk River is smaller in scope than that study but is amenable to expansion including additional types of risk for the Project. Bradford (2020) reviewed methods used to assess the effects of large hydropower Projects on aquatic ecosystems in British Columbia, Canada, particularly under the term of adaptive management. Bradford (2020) recommends a structured approach to incorporating expert, local and empirical knowledge, specifically mentioning Bayesian Belief Networks (BBNs). The approach proposed here is less formal than a BBN, but the elements are similar in that they provide a means of quantifying risk as estimated from different levels of information for different elements. Also, the structure is again amenable to expansion into a BBN if necessary (see Barton et al. 2020 for an example of a BBN used for a hydropower application).

New or existing information will be collected by, or generated from, the other proposed fisheries studies and/or the broader Proposed Study Plan for the Project. For example, the results produced from the 2-D flow model combined with the individual-based passage model will provide information on risk to several species in terms of upstream and downstream passage success. For Chinook and Sockeye salmon, an LCM will provide a quantitative risk assessment. The same information that feeds the LCM will also be used in qualitative risk assessment for other species. The LCM and the qualitative risk assessment will rely on existing information from the Nushagak, other Bristol Bay watersheds, results from PSP process-based studies, the evaluation of direct effects and those derived from future flows and temperature regimes, and from the literature.

4.1.6.6 Project Nexus

The physical Project and its operation have the potential to have good or bad effects on fish populations that reside in or pass through the Project Area. Water diversion from the river and through the powerhouse is the fundamental action from which potential impacts of the Project originate. Water diversion has the effects of reducing flow through the Falls Reach, creating an additional downstream passage route for fish via the power tunnel/penstock, and relocating bulk flow of the river below the Falls to a localized discharge point from the tailrace on the right bank of the river. These hydraulic changes may affect the timing, distribution, passage and survival of resident and migratory fish populations (adults and juveniles) and their long-term sustainability. In the case of salmon, the fundamental questions related to this nexus are a) what effect does the Project have on the number of successful spawners and the number of juvenile outmigrants, and b) what magnitude of this effect is necessary to jeopardize the sustainability of the populations. These questions are assessed within the context of environmental and harvest effects. Details on Project nexus for fish and aquatic habitats are presented in Appendix C.

4.1.6.7 Methodology

Within the integrated risk assessment framework for Nuyakuk River fish populations, the question to be addressed is: what is the risk to achieving management objectives for fish species present in the Project Area, considering all activities involved with the Project and climate change?

To answer that question, several steps are required:

1. Define management objectives or questions for each target species;

2. Identify the elements that are measured as indicators of impact to a population;

3. Identify the potential risk sources from the Project and environment (e.g., climate) to achieving species management objectives;

4. Gather, collect, evaluate, and analyze available knowledge on the likelihood and magnitude of impact from each potential risk to each management objective;

5. Developing and implementing an appropriate method for summarizing identified risks into a semi-quantitative scale; and

6. Evaluate the potential risk of Project and environmental factors affecting fish populations.

Clear management objectives or questions for each population must first be established. For example, the management objectives for this Nuyakuk River fisheries risk assessment might include a particular population abundance or escapement number for each species present in the system, or it might be a more general objective of sustainable populations. A specific management question may be "what magnitude of an effect by the Project on juvenile and adult passage success will it take to cause a continual decline of abundance in the returning adult population?".

In addition, indicator elements must be selected to represent processes and conditions. These elements may be metrics that may be indicate potential impact to fish populations. These elements are of primary interest in the process-based studies of the fish and aquatics PSP.

The identification of risk sources will be accomplished with an ecosystem approach that evaluates potential risks over life stages and geographic location. For example, entrainment is a potential risk to downstream migrants through the Project reach. Additional risks may be added as stakeholders are consulted within the IRA process.

The collection and gathering of data, and modeling where possible, will be accomplished through a series of fish and aquatic studies currently developed and presented in this PSP. Under this integrated risk assessment study, workshops with stakeholders are proposed to augment these expert and empirical data sources with local knowledge.

Developing an appropriate methodology for implementing an integrated risk assessment with a common scale is a major task of this study. Below, we outline a proposed process based on the adaptation of methods used in relevant literature (Bradford 2020, Fletcher 2015, Gaichas et al. 2018).

Approach for a Qualitative Integrated Risk Analysis

Management objectives and risk sources form the basis of a risk assessment summary (Table 4-6). In this table, the management objectives (developed under Step #1 in the process outlined above) are the columns labeled by fish species, and the risk sources (developed under Step #2 in the process outlined above) are the rows. Each cell in a completed table will contain a semi-quantitative risk value. The risk values in each cell of Table 4-6 are derived from the risk analysis tables, with each table representing a paired analysis of a single risk source versus a single element of the objective. For example, using a sustainable Chinook salmon population as one objective, risk analysis tables for each risk source are partitioned into the elements of rearing habitat, downstream passage success, predation, etc. Using these elements will inform the analysis of risk based on different types of information and data.

Each risk analysis, performed for a risk-element pair (risk sources and management objective elements) will include an examination of the magnitude of the potential consequences to the objective and the likelihood that those consequences will occur (given the current state of knowledge) under planned operations, with consideration of climate change (Table 4-7). Data from indicator metrics will support the evaluation. This part of the risk analysis will produce a consequence–likelihood matrix that combines the magnitude of potential impacts (consequences) with the likelihood of those impacts occurring. Consequences can be negative (-2, -1), no consequence (0) or positive (1, 2), and likelihoods range from no possibility (score 0) to likely (score 4).

For example, the 2-D flow model combined with the individual-based passage model will provide information to populate a risk analysis table for Chinook Salmon downstream passage due to modifications to the flow regime. Presented selections of consequence-likelihood in this example matrix were highlighted in yellow to show this scenario (Table 4-6). The value indicating the maximum negative risk of the selected magnitude-likelihood combinations (in this example, the lowest numerical value of -4 described as a minor negative impact of likely occurrence) becomes the risk value in Table 4-8 for the downstream migration flow regime row, with some probability of other magnitudes of effect (i.e., uncertainty). The results of a single risk analysis table (Table 4-7) will fill a single cell in the risk source-element table, i.e., the highlighted cells in Table 4-8 correspond to the risk analysis in Table 4-7.

There will likely be multiple elements (i.e., predation, migration delay, loss of habitat) or a given management objective impacted by each risk source (Table 4-8). The columns in Table 4-7 are example elements for the Chinook Salmon objective. As in Table 4-7, the values for the elements are integrated by selecting the value of maximum negative risk (i.e., the lowest value for each risk source). When risk analysis Tables 4-7 and 4-8 are populated for each element and risk source, the management objective element with the most negative value is used to represent the risk level for a management objective and species, by risk source (i.e., column in Table 4-6). In this step, we are assuming the element with the lowest value represents the value of maximum negative risk for a specific management objective, species, and risk source.

For Chinook and Sockeye salmon, life cycle modeling will provide a quantitative integrated risk assessment for those populations (see proposed study plan for Life Cycle Modeling). This approach will provide the ability to simulate strategic scenarios (what-if questions) for Project and environment (e.g., climate) related factors that may affect the abundance and long-term sustainability of those populations, as well as provide an indication of how sensitive the populations to changes in those factors. The results of the LCM will inform the qualitative integrated risk assessment (for these two species) and results will be compared to evaluate consistency. The two methods are complementary, but the LCM is species-specific. The qualitative approach is most applicable for the other species where the available fish resource information is not appropriate for use in the LCM.

Important points for completing the risk analysis tables:

1. Consequences, as viewed for the risk analysis step (Table 4-7), must be viewed as potential consequences to the overall stated management objective. This is the step that insures common currency amongst species and risk sources. For example, it is not necessarily a major increase in mortality that we are concerned with, but whether the level of mortality that is expected would constitute a major impact to the sustainability of a population (if that is the decided objective).

2. It is important to assess the risk associated with an issue even when there is a perceived lack of information. Otherwise, the current level of action or inaction is, by default, rated as acceptable. The approach outlined here can incorporate clear uncertainties into the justifications for the final scores that are selected. The justifications should include a detailed narrative that refers to, and to the extent possible, is consistent with available lines of evidence, including their levels of uncertainty.

The IRA concludes with an evidence-based summary that has translated different levels of available information into a common currency of risks that can be evaluated by stakeholders.

Table 4-6. Hypothetical risk assessment summary with example risk values for Chinook Salmon and potential risk sources. Values are imported from Table 4-8.

		Management Objective (e.g., sustainable population)										
		Sockeye Salmon	**Chinook Salmon**	**Coho Salmon**	**Pink Salmon**	**Chum Salmon**	**Arctic Char**	**Northern Pike**	**Burbot**	**Whitefish**	**Sculpin**	**Total?**
Risk Sources	**Change to Flow regime during upstream migration**		0									
	Change to flow during downstream migration		-4									
	False attraction at tailrace		-4									
	Rates of flow change (stranding/trapping)		0									
	Entrainment		0									
	….											
	Change to flow regime during rearing		-2									
	Total?		-4									

Table 4-7. Hypothetical risk assessment table for one risk source impacting one specific management objective element. This example is concerned with expected reductions in downstream passage success for Chinook salmon from modifications to the flow regime. The values in the table are possible outcomes calculated by multiplying the ranking of likelihood by the ranking of consequence. Each consequence level is evaluated for a likelihood. Highlighted cells provide example selections for an individual risk source and element pair, including uncertainty. The lowest highlighted value (-4) is used in Table 4-8 to represent the consequence-likelihood of maximum risk (in this case, a minor negative impact that is likely) for this risk source / element pair.

Risk Source: Flow regime	**Element: Downstream passage success**		**Likelihood of occurrence**				
			No Possibility	**Remote**	**Unlikely**	**Possible**	**Likely**
	Magnitude of impact	**Rank Value**	**0**	**1**	**2**	**3**	**4**
Consequence Level	**Major negative**	**-2**	0	-2	-4	-6	-8
	Minor negative	**-1**	0	-1	-2	-3	-4
	No consequence	**0**	0	0	0	0	0
	Minor positive	**1**	0	1	2	3	4
	Major positive	**2**	0	2	4	6	8

Table 4-8. Hypothetical risk assessment table for one management objective and species (population sustainability of Chinook), by risk source and ranked elements. The values for each element column are derived from an individual risk analysis table (e.g., highlighted consequence and likelihood value of -4 from Table 4-7. All other values for demonstration only). The values of this table will be used in Table 4-6 respective of management objective, risk source and species.

Chinook		Elements of the management objective						
	Nexus:	1,2	1,2	1,2,3	1,2,3	1,4	2,3	
		Predation	Stress/ Energetics	Spawning Habitat Area	Rearing Habitat Area	Upstream passage success	Downstream passage success	Maximum Risk
Risk Source	Change to flow regime during upstream migration	0	0	0	0	2	0	2
	Change to flow regime during downstream migration	0	0	8	8	0	-4	-4
	False attraction at tailrace	-4	-2	0	0	-4	0	-4
	Rates of flow change (stranding/trapping)	0	0	0	0	0	0	0
	Entrainment	0	0	0	0	0	0	0
	Change to flow regime during rearing	-1	0	0	-2	0	0	-2

4.1.6.8 Deliverables and Schedule

Assuming approval of the RSP, the Cooperative plans on beginning the study in late 2022. Upon implementation, study results will be documented in the ISR and USR. It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.1.6.9 Level of Effort and Cost

A multi-year study (2022-2024) coordinating with other studies in the Proposed Study Plan to describe the potential impact of the Project on target fish species.

The estimated cost for this study is approximately $150,000 - $210,000.

4.1.7 Future Flows Study

An understanding of future flows and stream temperatures will assist in informing the design of Project infrastructure, including fish passage protection measures, and Project operations. The best available science indicates temperature, precipitation, and stream flows will increase in the Bristol Bay region, and much of south-central Alaska (IPCC 2018; Walsh 2014; Walsh 2018). Thus, higher stream flows and volume are likely within the Project area during the prospective license term. Peer-reviewed, publicly available downscaled climate model projections have been developed for this region. These model projections will be analyzed to support flow analysis for this Project. Peer reviewed climate model predictions will be used to model future discharges and water temperatures for the Nuyakuk River, in accordance with peer-reviewed published methods and generally accepted practice. This information will inform the development of license articles guiding operation and maintenance, including mitigation measures, as well as the development of a climate resilient Project design.

It is notable that this study has been requested by NMFS and that the Cooperative has agreed to implement it regardless of FERC's ultimate determination on its necessity, based on their internal evaluation of the global study plan document. Further methodological specifics will be incorporated into the RSP based on further collaboration between NMFS and the Cooperative in the interim. That said, the general parameters associated with the study are described below.

To the extent possible, a study similar to the future flow and temperature analyses in (Wobus 2015), (Leppi 2014), and (Mauger et al. 2016) will be implemented. The steps and data available to do these analyses, are described below. New climate modeling is not needed. Rather, an analysis of existing, publicly available and peer-reviewed datasets (Walsh 2018), using peer-reviewed and generally accepted practices, as described in those articles and cites therein will be utilized. The basic analysis needed will move from GCM outputs to predicted flows and water temperatures from a hydrologic model for the Nuyakuk River.

(Walsh 2018) is the peer-reviewed publication that presents the methods and related data from the Scenarios Network for Alaska and Arctic Planning (SNAP), which is available for download at this website: https://www.snap.uaf.edu. Their product provides monthly values of projected future air temperature and precipitation. Monthly values are needed for analyses of future flows. Wobus et al (2015) generated daily values, and thus were able to discern shorter time scale features in river flows. If technically feasible and available for the Nuyakuk River, this daily scale will be utilized. If by the time this study is executed, a daily downscaled product is available from SNAP or by a researcher such as Dr. Wobus (Lynker Technologies), it may be used.

- The Walsh 2018 dataset, an existing, peer-reviewed and publicly available monthly downscaled climate projection dataset will be used along with related data from the Scenarios Network for Alaska and Arctic Planning (https://www.snap.uaf.edu/Project for Alaska). This dataset is based on the latest IPCC generation of global climate models, and along with related data is available for download at https://www.snap.uaf.edu/. The Walsh product analyzed the over 35 GCMs to assess which five best represent climates in Alaska as a whole. See (Lader 2017) or (Bieniek et al. 2015) for a more detailed description of the downscaling model procedure and an evaluation against historical temperature and precipitation data. Wobus 2015 selected five GCMs, including most of the same GCMs as Walsh 2018, to best represent the climate for the Bristol Bay region.

If a daily product becomes available, it may be viewed as the priority for utilization due to the finer time scale changes that daily analyses would detect.

- Monthly predicted temperature and precipitation data will be analyzed for the first 1/3 of the potential license term, 2027 – 2045; the middle 1/3, 2045-2062; and the final third 2062 to 2077 for the Nuyakuk watershed. This will allow consideration of flow trends over the period, and potentially different operations as projected conditions change.

- An accepted hydrologic model will be used to translate these downscaled climate outputs (precipitation/temperature) into other hydroclimate variables (evaporation, soil percolation, surface runoff) and ultimately the timing and volume of runoff into the Nuyakuk River, and stream temperatures. A hydrologic model such as the MIKE/SHE MIKE 11 modeling system which was used by Wobus et al (2015) in the upper Nushagak watershed will be utilized for this effort.

  The MIKE SHE system (Graham DN 2005) is a fully distributed, parameter integrated, hydrologic code that simulates the flow of water within and among surface water, groundwater, and the unsaturated zone. Atmospheric conditions, including precipitation, air temperature, and evapotranspiration drive continuous flows within the hydrologic system. A modified degree-day snowmelt method, the code simulates snow accumulation if air temperatures fall below a freezing threshold (typically 0°F), and it also simulates snowmelt processes including evaporation (sublimation and wet-snow evaporation), rain-on-snow, changes in wet and dry snow storage, and refreezing of wet snow. The Wobus et al (2015) effort, also implemented a heat balance algorithm to simulate stream temperatures (Loinaz et al. 2013). The hydrologic models then project monthly (or daily) water temperatures based on predicted air temperature and the relative river contributions from surface water versus groundwater sources versus snowfields sources.

- The potential climate change effects will then be summarized in a Climate and Flows Technical Report. This technical report will include a description of the assumptions made, models used, and other background information. The report will provide interpretation and guidance based on the analysis conducted, in order to translate them into useable translational products to address the hydropower, water, and fishery habitat needs at the Project site, assuming Project development occurs. Additionally, this report will include an analysis of the impacts of projections on the Project nexus, and hydropower facilities. The report will include an electronic supplement that makes the data used in this study available for the use of other studies.

4.2 Water Resources

4.2.1 Water Quality Assessment – Dissolved Oxygen and Water Temperatures

4.2.1.1 General Description of Proposed Study

Section 5.2.2. of the PAD listed "Water Quality and Water Temperature Assessment of the Nuyakuk River near the Project Site" as a potential water resource study.

In their PAD comment letter dated February 4, 2020, ADFG was supportive of this study topic because it has "a direct impact on fish resources". ADFG did not submit a detailed study request but offered to work with the Cooperative to ensure a water quality assessment would be carried out in a way that the quality and relevance of the data collected informs the decision-making process.

The Royal Coachman Lodge also submitted comments on the PAD to FERC in a letter dated February 3, 2020. Specifically, representatives from the lodge requested the following to be studied:

"Study the oxygenation provided by the Falls and its benefit to the fish in the system. With water temps rising (due to climate change), changing the oxygenation levels of the river could cause damage to the fishery and the ability of the anadromous fish to proceed upstream on their spawning runs. Given that warmer water carries less oxygen for the fish, oxygen levels could become more important to fish survival in the future."

Based on these comments, the Cooperative is proposing to collect dissolved oxygen (DO) and water temperature data in the vicinity of the proposed Project.

4.2.1.2 Geographic Scope

The DO and water temperature study will include two main study locations. Study location 1 will be upstream of Nuyakuk Falls in proximity to the intake structure. Study location 2 will be downstream of the Falls in an area near the proposed Project tailrace (Figure 4-2).

4.2.1.3 Study Goals and Objectives

The primary goals of this study are the following:

1. Collect baseline continuous (DO) data during periods of peak water temperatures (July – August) for a minimum of 72 hours.

2. Collect baseline continuous water temperature data for a minimum of a calendar year (January – December).

3. Determine if DO concentrations are substantially different above and below Nuyakuk Falls.

4. Compare the study results to DO and water temperature criteria established by the Alaska Department of Environmental Conservation (ADEC).

4.2.1.4 Relevant Resource Management Goals

The Nuyakuk River is protected by the following designated use criteria (C): "Growth and Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife" (ADEC 2018). Therefore, DO concentrations must be greater than 7 mg/l in waters used by anadromous or resident fish. In addition, ADFG details two agency mandates that provide oversight to the water resources of the Nuyakuk River.

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

4.2.1.5 Existing Information and Need for Additional Information

Available water quality data were summarized in the PAD upstream and downstream of the proposed Project. Although historical data indicates excellent water quality conditions for nutrients, trace metals, turbidity, and coliform bacteria there were limited DO data above and below the Nuyakuk Falls.

4.2.1.6 Project Nexus

The proposed Project would create a bypass reach and divert a percentage of water volume away from the Falls and into a penstock for power production. Understanding the baseline conditions of how dissolved oxygen concentrations vary upstream and downstream of the Falls is critical to understanding if Project diversion for power production would impact DO concentrations.

4.2.1.7 Methodology

The Cooperative will deploy calibrated, continuous DO and temperature loggers at two locations, one upstream and one downstream of Nuyakuk Falls. The data loggers will be set to record DO and temperature data at 30-minute intervals and be deployed for a minimum of 72 hours. Field calibration readings will consist of taking measurements of DO and water temperature at the beginning and end of the deployment period. This will be achieved by collecting spot DO and temperature readings from a calibrated multiparameter sonde adjacent to the deployed logger.

4.2.1.8 Proposed Deliverables and Schedule

Study results will be summarized in time series graphics and in tables for each unique 72-hour study period. The 2023 results will be presented in an ISR and collaboratively discussed with stakeholders during both mandated process meetings and regular status calls/meetings scheduled by the Cooperative to determine if additional data collection is needed for a second monitoring season.

4.2.1.9 Level of Effort and Cost

The Cooperative believes that the proposed study effort is appropriate to assess potential effects the Project may have on DO concentrations. A single year of study is all that would be necessary to meet baseline study objectives.

The estimated cost for this study is approximately $35,000 to $45,000.

4.2.2 Flow Duration Curve Assessment

4.2.2.1 General Description of Proposed Study

This study will help identify trends in flow conditions to provide an analysis of the historical flow duration curve for the Nuyakuk River immediately below Tikchik Lake. Data from this study can be used to inform the licensing process with specific application to Project design, operation and fish protection measures.

4.2.2.2 Geographic Scope

The flow duration change analysis is a desktop exercise. The assessment encompasses the Nuyakuk River watershed with an approximate drainage area of 1,510 square miles.

4.2.2.3 Study Goals and Objectives

The goal of the study is to evaluate changes in the flow duration curve for the Nuyakuk River that have happened during the available 57-year USGS 15302000 gage record. This study request will not analyze climate projections or future flows. The objectives of this study are:

- Determine if flow pattern observable for the USGS Nuyakuk River gage record exhibit stationarity
- Determine if Nuyakuk River results are consistent with other gage records in Northern climates where a non-stationarity analysis has been completed (if available)
- If the 57-year record exhibits non-stationarity, assess seasonal flow pattern changes for the last 20 years.

4.2.2.4 Relevant Resource Management Goals

The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in NOAA's strategic plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

4.2.2.5 Existing Information and Need for Additional Information

The existing flow duration curve relies on methods developed prior to our current understanding of climate, especially that rainfall and temperature are variable between years and months, but overall tied to a static horizontal line (stationarity). This analysis will indicate if stationarity (Milly 2008) exists at the Nuyakuk gage. This evaluation has not been completed for this USGS gage record. This analysis may only apply to the months in which sufficient hydrograph data are available.

4.2.2.6 Project Nexus

River flow and its seasonal patterns directly influence Project design and operations, and mitigation measures intended to protect public trust resources. As this is a new project development, the applicant should consider the changing environmental conditions on which their project is dependent for successful operation. As flow patterns change, changes in project operations often occur. The Bradley Lake Project (P-8221) licensee decided to stop diverting water on November 1 based on records from the historical record. Historical data indicated no flow worthy of diversion during mid-winter. In 2019, both November and December saw 1,000's of acre feet flow down Battle Creek as large precipitation events arrived primarily as rain. Likewise, project operations influence the behavior of migrating fish within the project area. The information collected by this study would support the analysis of direct and cumulative effects of the proposed Project on migratory fish and aid in the development of any necessary license articles regarding measures to achieve fish passage. If this watershed runoff pattern is non-stationary, then design consideration, operations models and license articles should be flexible enough to deal with change.

4.2.2.7 Methodology

Studies should use current literature, existing data from the USGS gage (USGS No. 15302000), and standard practices accepted by the scientific community. A change analysis is a standard Bureau of Reclamation analysis method. Many utilities with hydropower projects are employing it for their decision-making processes.

4.2.2.8 Proposed Deliverables and Schedule

Results from the change analysis will be summarized as annual and monthly flow duration curves and tables. The updated flow duration curves will also be compared to results from the historical streamflow record directly calculated from USGS gage 15302000. Assuming approval of the RSP, the Cooperative plans on beginning the study in the spring/summer of 2023 and will continue to supplement this effort with additional hydrologic information during the study years.

4.2.2.9 Level of Effort and Cost

All the data necessary to complete this study are available. The analysis could be completed within two to four months. The level of effort and cost is commensurate with the proposed Project size and the likely license term.

The estimated cost for this study is approximately $100,000 to $125,000.

4.2.3 Ice Processes Assessment

4.2.3.1 General Description of Proposed Study

Per PAD comment and study request letters, including from NMFS, the Cooperative received a request to conduct an Ice Processes Assessment and looks forward to collaborating with all interested stakeholders in further defining the appropriate desktop methods and analysis tools to utilize in assessing existing conditions and determining potential impacts (positive and negative) related to operations of the Project.

4.2.3.2 Geographic Scope

The geographic focus of the Ice Processes Assessment will be the entire span of the river from the hydraulic control for the Nuyakuk Falls upstream approximately 1500 feet with an emphasis on the area near the proposed Project intake (see Zone 1 on Figure 4-2).

4.2.3.3 Study Goals and Objectives

The primary goal of this study is to utilize literature and data supplemented by site-specific photos and video to gain a better understanding of both existing ice formation processes and the potential localized modifications to these processes as a result of Project operations.

4.2.3.4 Relevant Resource Management Goals

As it relates to this particular study, the primary resource management goal is associated with NOAA fisheries strategic Plan which describes, “the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.”

4.2.3.5 Existing Information and Need for Additional Information

Relevant regional satellite footage for the area does exist and a series of Alaska-based studies have been conducted over the past 40 years which should prove valuable to assess precedent and to correlate the Project’s proposed operational regime to potential impacts for ice formation. This existing data will be the foundation of the study and once fully evaluated, will be supplemented with additional site-specific data, if necessary.

4.2.3.6 Project Nexus

The proposed Project would divert water from the existing channel of the Nuyakuk river and potentially alter the flow dynamics of the bypass reach. This alteration during winter months may modify the natural ice formation processes that occur immediately upstream of the proposed intake each year. Understanding the level of change and associated impact (if any) to ice processes and Project operations during winter months will assist in determining the appropriate Project layout and operational regime.

4.2.3.7 Methodology

The Cooperative has a vested interest in developing a collaborative study that effectively meets the needs of the stakeholders while at the same time focuses on the area of potential impact. As such and per commitment from stakeholders such as ADFG and NMFS, the Cooperative plans on working with stakeholders over the spring and summer of 2022 to define the appropriate methods to be utilized to ensure both effective documentation of existing conditions and a safe study design for necessary field efforts.

The Cooperative has developed a preliminary list of potential methods to utilize with a focus on desktop efforts. These methods include:

- Review of recent (past 20 years) of satellite images for the Nuyakuk Falls area to document existing natural conditions and year to year variation.
- Conduct a literature review of existing hydropower facilities in Alaska and other cold weather environments to evaluate their methods for continued winter operation in harsh environments with substantial temperature variations.
- Potentially, establish locations for video and/or frequent photo data to be collected near the Nuyakuk Falls during the winter and early spring of the 2022 and 2023 study seasons to document ice process at the Project site.

Again, NETC looks forward to collaborating with stakeholders to define the appropriate methodological regime for this Project site.

4.2.3.8 Proposed Deliverables and Schedule

Assuming timely issuance of the Study Plan Determination, the Cooperative plans conducting the study in 2023 and 2024. Upon implementation, study results will be documented in the ISR and USR. It is notable that the Cooperative anticipates ongoing collaboration with stakeholders throughout the study process so that determinations related to efficiency of methodology, any study modifications that may be necessary and/or the need for extending studies can be discussed and efficiently implemented. This collaborative process will also allow the Cooperative to provide stakeholders with periodic status updates when results, anomalies, etc. warrant.

4.2.3.9 Level of Effort and Cost

The estimated cost for this study is approximately $35,000 - $50,000.

4.3 Terrestrial Resources

4.3.1 Botanical and Wetlands Survey

4.3.1.1 General Description of Proposed Study

The Cooperative proposes to conduct a study to gather baseline botanical and wetlands data, including surveying vegetation types, wetlands, BLM Special Status plant species, and non-native plant species in the proposed Project vicinity. The study will consist of both desktop and field-based data collection methods.

4.3.1.2 Geographic Scope

The desktop portion of the study will cover the entire proposed Project boundary, as shown in Figure 2-2. Field data collection will be focused on the intake and powerhouse facility vicinity shown in Figure 2-3, where the majority of impacts to terrestrial resources are expected to occur. Because no access roads are proposed as part of this Project, impacts to terrestrial resources outside of the intake and powerhouse facility area are generally limited to transmission line placement.

4.3.1.3 Study Goals and Objectives

Study goals and objectives include the following:

- Refine existing vegetation and wetland mapping available for the Project vicinity, both through desktop analysis and field data collection, in order to be able to assess Project impacts on these resources.
- Identify any BLM Alaska Special Status plant species that may occur in the area where Project impacts to terrestrial resources may occur.
- Locate any populations of non-native vegetation species in the Project facilities vicinity, so that appropriate management practices can be developed, if needed.
- Identify and classify wetlands in the proposed Project boundary and other Waters of the United States in accordance with U.S. Army Corps of Engineers (USACE) practices to define areas subject to federal regulation and policies.

4.3.1.4 Relevant Resource Management Goals

The proposed Project boundary includes land owned by the State of Alaska, Native villages or corporations, BLM, and private or municipal entities. The proposed Project facilities will be located on land owned by the State of Alaska, within Wood-Tikchik State Park. The Wood-Tikchik State Park Management Plan describes the coniferous and mixed coniferous-deciduous forests, willow-alder thickets, tundra, and alpine meadows that characterize the vegetation within the park. Vegetation in the State Park provides wildlife habitat and is sometimes utilized for firewood collection or subsistence harvesting. Wetlands and Waters of the U.S. are subject to federal government regulations and policies, although some waters and shorelands within Wood-Tikchik State Park are owned by the State of Alaska (ADNR 2002).

4.3.1.5 Existing Information and Need for Additional Information

High-resolution, site-specific botanical and wetlands data currently does not exist for the proposed Project location. General descriptions of types of terrestrial vegetation and wetlands were provided in the Project's PAD. Detailed surveys of non-native vegetation species or Special Status plant species have not been conducted in the proposed Project vicinity to date. Site-specific data are necessary in order to assess any potential impacts to these resources.

4.3.1.6 Project Nexus

Construction and operation of the Project will require ground disturbance that may impact botanical resources or wetlands. Impacts to these resources need to be assessed using data collected during the proposed botanical and wetland mapping and field survey efforts. Project design and management plans will rely on information collected during this study, and study data may aid in the development of mitigation plans to avoid, minimize, reduce over time, and compensate for impacts to botanical or wetland resources.

4.3.1.7 Methodology

Study Component #1 – General Vegetation Type/Wetland Mapping

Desktop analysis of the best available aerial imagery and existing wetland and vegetation Geographic Information System (GIS) datasets from available sources including federal, state, and local entities will be used in this analysis. Using these data, refined GIS layers covering the entire proposed Project boundary will be developed. This information will subsequently be used to guide field data collection efforts, including wetland delineation locations and areas for sensitive and non-native plant surveys. A final map will be produced which will display vegetation type polygon boundaries, specific Project components, and impact areas.

Study Component #2 – Field Vegetation Surveys/Wetland Delineation

A field vegetation survey and delineation of wetlands and Waters of the U.S. will be conducted in the area where Project facilities are proposed for construction. The field vegetation survey will include the following:

- Identification and mapping of any BLM Alaska Special Status plant species occurring in the vicinity of the proposed Project facilities.
- Identification and mapping of any non-native plants appearing on the list maintained by University of Alaska Anchorage/Alaska Center for Conservation Science (UAA 2020).

The wetland delineation will include the following:

- Collect detailed information on soil conditions, hydrology, and plant community composition in representative upland and wetland sites using guidelines from the 1987 wetland delineation manual (USACE 1987) and 2007 Alaska Regional Supplement (USACE 2007).

- Collect functional assessment data for each wetland. The functional assessment method used will be discussed with the USACE prior to field sampling.
- Coordinates of wetland boundaries will be collected by GPS in the field.
- Prepare a final wetland and waters of the U.S. map for areas potentially disturbed by Project activity using field delineation results. Map will include wetlands and other waters by National Wetlands Inventory (NWI) class (Cowardin 1979), and field data collection locations. Prepare a table of acres per NWI class using data and maps.
- Prepare a wetland and waters of the U.S. report that will include a detailed map of areas potentially disturbed by Project activity, the general map of the entire study area, methods and findings, a wetland functional assessment, and copies of the field data forms.

4.3.1.8 Proposed Deliverables and Schedule

Study Component #1 – General Vegetation Type/Wetland Mapping

Desktop mapping of vegetation types and wetlands will occur in advance of field vegetation surveys and wetland delineation in 2023. Deliverables from this study component include GIS layers of vegetation types and wetlands located in the proposed FERC Project boundary and maps displaying the GIS data for presentation purposes. The results of this study component will be included in the Project's ISR and presented to stakeholders at the ISR meeting.

Study Component #2 – Field Vegetation Surveys/Wetland Delineation

Field vegetation surveys and wetland delineation will occur in summer 2023, during the season of peak flowering in Alaska. Deliverables from this study component will include a written report summarizing the results from the detailed field vegetation survey and wetland delineation, field data sheets including standard USACE Alaska Region wetland delineation forms, and GIS data containing the location of delineated wetlands, Special Status plant populations, and non-native plant populations. Results of the field vegetation survey and wetland delineation will be included in the Project's USR. Results will be presented at the Project's USR meeting.

4.3.1.9 Level of Effort and Cost

The Cooperative estimates that the cost to conduct this study is approximately $150,000 - $200,000.

4.3.2 Caribou Population Evaluation

4.3.2.1 General Description of Proposed Study

The Cooperative proposes to conduct a study to evaluate caribou data from ADFG's Division of Wildlife Conservation ongoing Mulchatna caribou herd (MCH) Survey and Inventory (S&I) program (Barten and Watine 2020). The Cooperative has initiated preliminary discussion with ADFG to establish collaboration and mechanisms for data sharing. ADFG manages an expansive caribou S&I program for the MCH and collects data on an annual basis to document migration, productivity, health, population size and composition, and calf survival. ADFG has expressed a willingness to share the data from their ongoing study with the Cooperative for the purposes of conducting and impact assessment related to Project development and operations. The Cooperative proposes to analyze ADFG's dataset to evaluate potential impacts to caribou as a result of the proposed Project.

4.3.2.2 Geographic Scope

The study area will encompass the entire proposed FERC Project boundary and surrounding areas within Game Management Units (GMUs) 17B and 17C (Figure 4-19, Barten and Watine 2020). ADFG's caribou S&I program for the MCH covers a large area within southwest Alaska corresponding to the range of the MCH (Figure 4-11). The proposed Project facilities are located within GMU 17B, and proposed transmission lines extend into GMU 17C (Figure 4-19). Therefore, this study will focus on the MCH S&I data collected by ADFG within GMUs 17B and 17C.

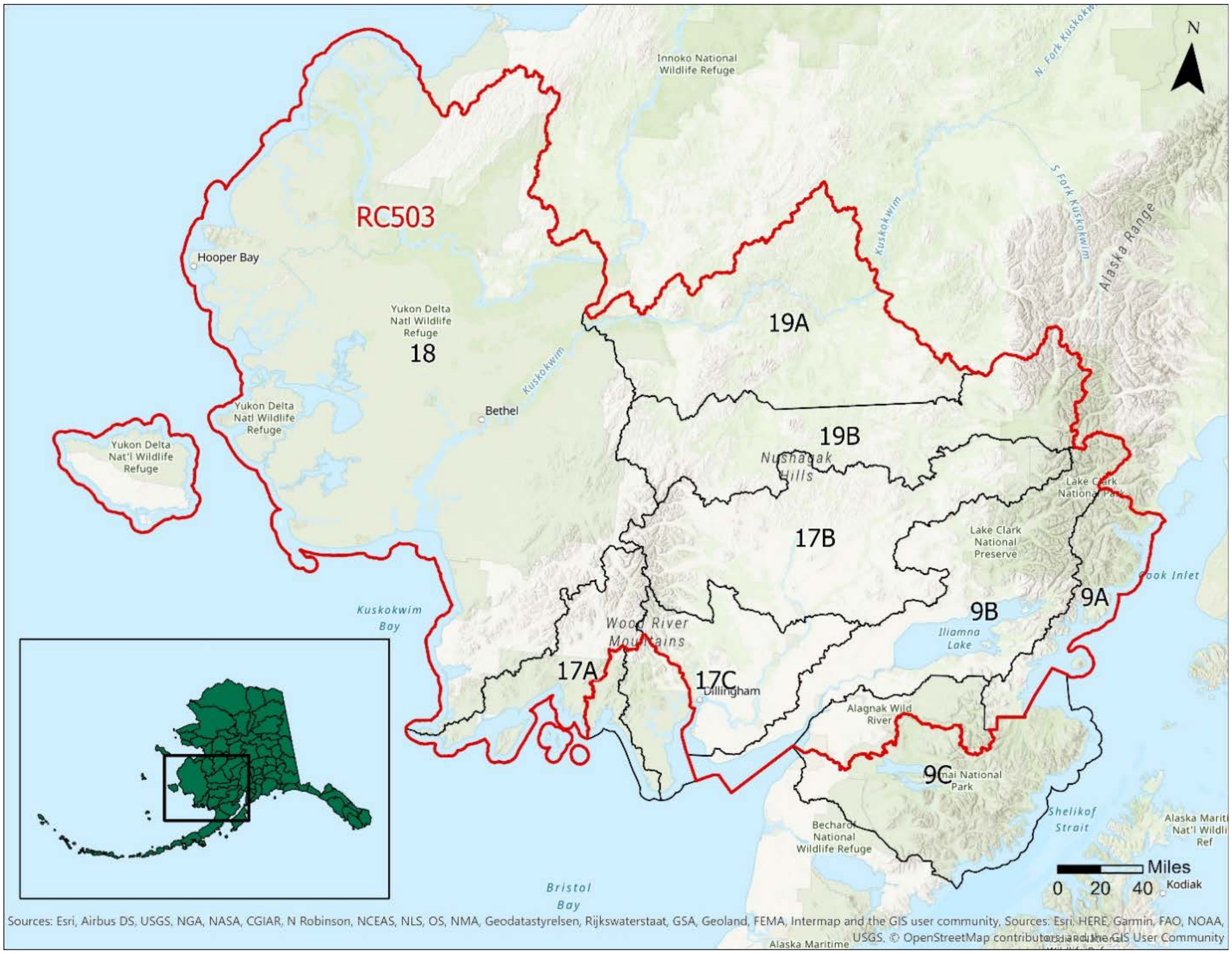

Figure 4-19. Range of the Mulchatna caribou herd (MCH) and permitted hunt area specific to this herd (RC503) in Southwest Alaska (Barten and Watine 2020).

4.3.2.3 Study Goals and Objectives

The goals of the study are to evaluate any potential impacts to the MCH as a result of the proposed Project. Study objectives include:

- Evaluate the MCH population status and trends, including population size, population composition, and breeding trends within GMU 17B and 17C
- Evaluate caribou health within GMU 17B and 17C, including body condition, calf survival, and mortality rates
- Evaluate caribou habitat assessment within GMU 17B and 17C and by monitoring the condition and productivity of captured female caribou
- Evaluate MCH land use within GMU 17B and 17C, including migration corridors, calving areas, and foraging patterns

4.3.2.4 Relevant Resource Management Goals

Federal and state agencies, including U.S. Fish and Wildlife Service (USFWS) and ADFG, cooperatively manage the MCH, seeking to balance subsistence harvesting and protection of the population. The population has seen steep declines in recent years, leading to early closures of hunting season on federal lands (Macarthur 2019). Federal and state managers closely monitor the population of the MCH through ADFG's S&I program for conservation purposes. ADFG administers an intensive management (IM) program for the MCH due to the declining herd population size in recent years. ADFG partners with ADNR, USFWS, BLM, and National Park Service (NPS) to manage the MCH according to the Mulchatna Caribou Monitoring Plan, with goals related to both caribou conservation and maintenance of the herd for subsistence use (Barten and Watine 2020).

4.3.2.5 Existing Information and Need for Additional Information

Section 4.5.1.2 of the PAD presented the existing information for the MCH in the vicinity of the proposed Project. As discussed in the PAD, caribou herds experience long-term population fluctuations and changing patterns of range use. To meet these information needs, ADFG conducts its extensive MCH S&I program on an annual basis (Barten and Watine 2020). ADFG maintains these diverse and long-ranging MCH datasets, covering much of southwest Alaska including the proposed Project vicinity. Through the data-sharing agreement that the Cooperative proposes to establish with ADFG, the Cooperative will have access to a robust dataset documenting MCH population health, demographics, and use of the proposed Project vicinity over time.

4.3.2.6 Project Nexus

Construction and operation of the proposed Project may impact habitat that caribou use seasonally or annually for foraging, migration, or calving. Habitat impacts have the potential to affect the overall MCH population in terms of size and composition. Development of any necessary mitigation measures for the Project's construction and operation will be based on MCH population statistics and documented use of the proposed Project vicinity on an annual basis.

4.3.2.7 Methodology

The study will consist of a desktop analysis of ADFG MCH S&I datasets (Barten and Watine 2020). The Cooperative intends to obtain available MCH S&I data from ADFG to analyze caribou population size, migration, and habitat utilization in the Project vicinity (GMU 17B and 17C). ADFG conducts the following activities under the annual S&I program, which will be used in the desktop analysis (Barten and Watine 2020):

- Population Status and Trend:
  - Activity 1.1 – Maintain a sample of radiocollared caribou
  - Activity 1.2 – Conduct partuition surveys each spring using radiocollared female caribou of known age to determine age-specific pregnancy rates

  - Activity 1.3 – Conduct an annual photo survey of the MCH to obtain a population estimate

  - Activity 1.4 – Conduct fall composition surveys to estimate sex ratio, age ratios, and recruitment of calves to fall

  - Activity 1.5 – Investigate and monitor calf survival to determine factors responsible for calf mortalities

- Habitat Assessment-Enhancement

  - Activity 3.1 – Evaluate the condition of the Mulchatna caribou range by monitoring the condition and productivity of captured female caribou

Data collected will be analyzed and correlated with proposed Project infrastructure location and operational parameters to determine what impacts (if any) related to current caribou behavior and success can be expected as a result of Project development.

4.3.2.8 Proposed Deliverables and Schedule

The desktop portion of the study will be conducted from fall 2023 through fall 2024. The desktop study will also incorporate historic ADFG S&I data for the MCH and will include the data collected during the study period (2022-2023), as available.

Data will be synthesized in the Project’s ISR and USR filings. The findings will be presented to stakeholder at the ISR and USR meetings.

4.3.2.9 Level of Effort and Cost

The study will be conducted over approximately two years’ time by a qualified wildlife biologist in collaboration with ADFG Division of Wildlife Conservation. The Cooperative estimates that the cost to conduct this study is approximately $50,000 - $75,000.

4.4 Cultural Resources

4.4.1 Subsistence Study

4.4.1.1 General Description of Proposed Study

Based on the study request received from ADFG, it is the Cooperative's understanding that ADFG intends to assist the Cooperative by conducting a subsistence study to update information about subsistence use in the proposed Project vicinity last gathered in 2005. The Cooperative will be responsible for funding the study, which, based on the study request, the Cooperative expects will be executed by ADFG using their standard methodology for collecting this type of information. The Cooperative will consult further with ADFG regarding the planning and execution of this study and will consult with ADFG regarding the funds required to undertake the work.

4.4.1.2 Geographic Scope

The Cooperative will consult further with ADFG but expects that the geographic scope of the Project will focus on the use of the proposed Project vicinity by people living in the villages in the Bristol Bay region. It is understood that ADFG's overall geographic scope for their global subsistence survey may be beyond the bounds of the dataset needed for the Cooperative's assessment. As such, the subset of data within the proposed Project's boundary will be utilized.

4.4.1.3 Study Goals and Objectives

The goal of this study is to document traditional and contemporary subsistence harvest and use in the Project area in order to provide a basis for impact assessment, avoidance, minimization, and development of PME measures and to provide the information that will serve as the basis for compliance with FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

Study Objectives include the utilization of subsistence data collected by ADFG to assess current subsistence uses and document anticipated impacts (if any) resulting from the construction and development of the Project. Key survey areas from a subsistence perspective will be:

1. Koliganek
2. New Stuyahok
3. Ekwok
4. Aleknagik
5. Levelock
6. Dillingham

4.4.1.4 Relevant Resource Management Goals

The Fish and Game Act requires ADFG to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADFG – Division of Subsistence Mission is "to scientifically gather, quantify, evaluate, and report about customary and traditional uses of Alaska's fish and wildlife resources". One of the core services of the division is to assist fisheries and wildlife managers in preparing management plans to ensure information on customary and traditional uses and fish and wildlife harvests is incorporated.

4.4.1.5 Existing Information and Need for Additional Information

Subsistence surveys were carried out in the vicinity of the Project in 2005. That data is now fifteen years old and should be updated to more accurately reflect contemporary subsistence harvest and use patterns. In particular, subsistence harvest surveys for the communities of Koliganek, New Stuyahok, Ekwok, and Aleknagik would provide the necessary information to determine potential effects of the proposed Project.

4.4.1.6 Project Nexus

Residents of Koliganek, New Stuyahok, Ekwok, and Aleknagik may use the Project area for subsistence hunting, fishing and gathering. Project construction and operation could lead to impacts on subsistence use of the Project area. The proposed study will assess the timing and location of subsistence use and would be necessary to develop PME measures with regard to the timing of activities, particularly during Project construction.

4.4.1.7 Methodology

Community subsistence surveys have been performed throughout the state of Alaska for many years; they are both well-accepted and cost-effective means of understanding subsistence use of fish and game resources.

ADFG Division of Subsistence will conduct this study using standard Division methodology involving systematic household surveys conducted by community-based survey technicians in cooperation with Division subsistence resource specialists. Specific methods include:

- Development of a survey instrument to produce updated comprehensive baseline information about subsistence hunting, fishing, and gathering and other topics that address subsistence needs and are compatible with information collected in past household interviews.
- Community consultation to identify community liaisons and seek study support.
- Household surveys to record the following information: 1) demographic information; 2) involvement in use, harvest, and sharing of fish, wildlife, and wild plants in their study year; 3) estimate of amount of resources harvested in their study year; 4) information about employment and cash income; 5) assessments of changes in

subsistence harvest and use patterns based on data available from past study years; and 6) location of fishing, hunting, and gathering activities in their study year.

The Cooperative intends to establish a data-sharing agreement with ADFG to permit data transfer between ADFG and the Cooperative. ADFG Division of Subsistence maintains datasets documenting subsistence use of species such as caribou from the MCH that are applicable to the proposed subsistence study.

4.4.1.8 Proposed Deliverables and Schedule

The Cooperative will determine the study deliverables and schedule during consultation with ADFG.

4.4.1.9 Level of Effort and Cost

The Cooperative will refine the level of effort and anticipated cost during consultation with ADFG.

4.4.2 Section 106 Evaluation

4.4.2.1 General Description of Proposed Study

Definition of an Area of Potential Effects (APE) will need to begin early in the process to facilitate and focus subsequent Cultural Resource planning, literature review, and fieldwork. The APE will be defined in cooperation with all consulting parties.

Probability areas will be established prior to field survey, based on topographic features and the locations of previously recorded sites. Pedestrian surveys will be conducted in areas considered to have higher probability for cultural resources.

A survey report will be prepared that includes formal recommendations of National Register of Historic Places (National Register) eligibility for FERC review, and subsequent review and concurrence by consulting parties. A Historic Properties Management Plan (HPMP) will also be prepared for the Project.

The Historical and Archaeological Field Study will include an inventory and assessment of Traditional Cultural Properties (TCPs). The requirement for identification of TCPs is included in 54 USC 302102-302108, *Protection of Historic Properties* (Federal Register, Volume 65, Number 239, December 12, 2000). A TCP is eligible for inclusion in the National Register "because of its association with cultural practices or beliefs of a living community" (Parker and King 1990). TCPs are historic properties (as defined by the National Historic Preservation Act (NHPA)) and as such are subject to the same Section 106 process as other archeological and historical sites. A TCP is a tangible property that meets one or more of the four basic criteria set forth in the National Register regulations (54 USC 100101).

4.4.2.2 Geographic Scope

Based on the current knowledge of the Project, the cultural resources survey will focus on the Powerhouse, Diversion & Intake structures, and the Conveyance Tunnels. The proposed airstrip and access roads would also require archaeological survey. Consultation may also identify other areas that should be archaeologically surveyed.

4.4.2.3 Study Goals and Objectives

The goal of the study is to comply with Section 106 of the NHPA. Because it involves the acquisition of a FERC license, the Project is a federal undertaking under Section 106 of the NHPA. A cultural resource study report will be produced that presents information relative to the scope and context of potential effects of the Project. This information will be used to analyze Project impacts and propose protection, mitigation, and enhancement measures in the draft and final license applications for the Project.

4.4.2.4 Relevant Resource Management Goals

For hydropower licensing actions, FERC typically complies with Section 106 by entering into a Programmatic Agreement (PA) or Memorandum of Agreement (MOA) with the license applicant, the Advisory Council on Historic Preservation, and the State Historic Preservation Office (SHPO). This agreement is then incorporated by reference into the Project license when it is issued. Because it is not always possible for FERC to determine all of the effects of various activities that may occur over the course of a license, the PA or MOA typically provides, and FERC typically requires as a license condition, that the licensee develop and implement a HPMP that includes consideration and appropriate management of effects on historic throughout the term of the license.

4.4.2.5 Existing Information and Need for Additional Information

The following information regarding Project area cultural resources comes from the Alaska Historic Resources Survey (AHRS) and the Nuyakuk PAD (NETC 2019). The Nuyakuk PAD also includes a discussion of the prehistory and history of the Project region.

There are no reported AHRS sites within one mile of Nuyakuk Falls, although this is likely because of a lack of previous survey. There are eight reported sites between the outlet of Tikchik Lake and the Falls. These sites include a historic cabin, semi-subterranean houses, and three sites for which there is no information other than their location.

4.4.2.6 Project Nexus

The proposed Project could have a number of potential effects on historic properties within the APE. The study plan described above is intended to provide sufficient information regarding the nature of historic properties located in the APE so that potential effects can be adequately assessed. Findings of Effect on historic properties in the APE will be included in the study report and reviewed with consulting parties. Study information will aid in developing measures to be proposed in the draft and final license applications to protect or minimize adverse effects on historic properties.

4.4.2.7 Methodology

Cultural Resources Consultants, LLC (CRC), an Alaska-based cultural resources consulting firm, will assist Nushagak Cooperative in complying with its obligations under the National Historic Preservation Act (16 U.S.C. § 300101) as it applies to federally funded projects. Much of CRC's work in researching and identifying cultural resources will follow the steps of the Section 106 process as outlined in 54 U.S.C.§ 36108. The Cooperative's subconsultant will be primarily to advise and assist Nushagak Cooperative, especially by providing adequate documentation to support determinations, findings, and/or agreements under the Section 106 procedures. Such documentation could include historic contexts, recommendations for findings of eligibility and effect, draft agreement documents, data recovery or other mitigation (including monitoring) plans, and a Historic Properties Management Plan (HPMP). The Cooperative's subconsultant will be responsible for:

- responding to project notifications,
- attending meetings,
- conducting literature reviews to identify known cultural resources within a project study area,
- assisting in determining areas of potential effect,
- consulting with Tribal groups, local entities, and State and Federal agencies,

- conducting cultural resource field surveys,
- completing appropriate analyses, and
- preparing reports and other documents.

All services and products developed during the cultural resources study process will meet industry standards, largely codified in the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation*, National Register Bulletins, the Office of History and Archaeology *Historic Preservation Series*.

Methods for completing environmental documentation will include:

- a review of existing information;
- a field survey of the project area to identify and document potential historic properties located within the defined study area or area of potential effects;
- draft, and final reports, including any determinations of eligibility and recommendations on the project's potential effects, if requested.
- completion of a Historic Properties Management Plan

The scope of any field activities will be determined after evaluating the project area's potential for known cultural resources and the proposed project description. The number of field personnel and their technical expertise will be weighed against time and cost constraints to provide the highest quality survey and subsequent analysis possible, while also maintaining the safety and health of personnel. The type of survey and testing used will be contingent on the level of documentation needed to support the project moving forward.

Cultural resources surveys and reports will be accomplished or supervised by personnel who meet the Secretary of the Interior's *Professional Qualification Standards (48 FR 4473 - 44739)*. The cultural resources subconsultant will comply with applicable laws and regulations and will follow the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716-18)* and identification and testing procedures presented in *Guidelines for Evaluating and Registering Archaeological Properties (National Park Service 2000)*.

Identified archaeological and historic resources will be referenced to the project plans and in GPS coordinates. Identified sites will be evaluated for historic significance and integrity using established National Register eligibility criteria. The Cooperative's subconsultant will obtain an AHRS number from the Alaska Office of History and Archaeology (OHA) for any potentially significant archaeological or historical property.

The Cooperative's subconsultant will complete sufficient investigation and research on the significance of such properties to support recommendations of National Register eligibility. These recommendations will provide the basis for the agency's determinations of eligibility to be submitted to the State Historic Preservation Officer (SHPO) for concurrence. Reports will meet contemporary professional standards and follow the OHA's *Standards and Guidelines for investigating and reporting archaeological and historic properties in Alaska (Historic Preservation Series Number 11)* and the Secretary of Interior's *Standards and Guidelines for Reports (FR Vol. 48, No. 190, pp. 44734-44737)*. A completed OHA Cultural Resources Report Coversheet will be submitted with each report.

In the early phases of the Project, the Cooperative should receive delegation of consultation authority from FERC. Consultation will then begin with interested parties, a cultural resources working group will be created, and the APE will be defined. Consultations with Tribal governments, Native organizations, the SHPO, and other interested parties will be initiated in the Spring of 2020 and will continue throughout the duration of the Project. Additional interested consulting parties will be included as they are identified.

The proposed undertaking has the potential to affect historic properties near the powerhouse and associated features. Additionally, construction of the intake, penstock, access road, airstrip, and transmission line could also potentially disturb cultural sites that will be identified through consultation, literature review, and field survey. Evaluations of National Register eligibility will be required for any previously known and newly documented historical and archaeological sites.

The cultural resources expert will complete a draft report and draft HPMP after fieldwork is completed. The report and HPMP will be disseminated to the Cooperative and consulting parties for review. Following review, final drafts will be completed.

4.4.2.8 Proposed Deliverables and Schedule

- Winter/Spring 2023:
    - Write study plan
    - Propose any revisions to the study plan
    - Receive delegation of consultation authority from FERC
    - Consultation meetings as appropriate, including consultation on APE and TCPs
    - Literature review
    - Determine permits needed
    - Letters to consulting parties
    - Establish cultural resources working group
    - Field survey planning.
    - Update study plan with any changes to Project design
    - Review background information and research

    - Establish survey strategy
    - Permitting, as required

- Summer/Fall 2023: conduct field studies and evaluation, as appropriate.
- Summer/Fall 2023: finish evaluations and begin draft report and DOEs
- December 2023: draft study report to consulting parties.
- Winter 2023/2024: consultation meetings to discuss Project, field findings, DOEs, and address additional concerns.
- Spring 2024: prepare draft Historic Properties Management Plan for eligible properties
- Summer 2024:
    - Finalize report based on field studies and consultation
    - Prepare Finding of Effect, as appropriate, for review, submittal and concurrence to consulting parties.
    - Finalize Historic Properties Management Plan

4.4.2.9 Level of Effort and Cost

The study will be conducted over approximately two years' time by a cultural resources expert. The Cooperative estimates that the cost to conduct this study is approximately $175,000 - $300,000.

4.5 Recreation and Aesthetic Resources

4.5.1 Noise Study

FERC identified the need for a noise study after reviewing the PAD and identifying a gap between information presented in the PAD and information needed to assess Project effects. FERC provided the seven study request criteria to the Cooperative in a letter on January 23, 2020.

4.5.1.1 General Description of Proposed Study

The goal of this study is to characterize the existing ambient sound environment in the vicinity of the proposed Project and estimate the potential impacts associated with construction and operational activities.

4.5.1.2 Geographic Scope

The study will be conducted in the vicinity surrounding the Project facilities, including upriver to Tikchik Lake, where Royal Coachmen lodge is located. Additional areas of study will include the area of Wood-Tikchik State Park surrounding the proposed Project facilities, shown in Figure 4-20.

4.5.1.3 Study Goals and Objectives

The specific objectives of the study and subsequent report are to:

1. Define existing noise levels in identified sensitive wildlife habitat, recreation and cultural areas within the Wood-Tikchik State Park including trails, the Royal Coachman Lodge, fishing and hunting areas, and areas used for subsistence and other traditional cultural practices.

2. Describe, through the use of sound models, the expected noise levels in the identified sensitive areas during Project construction and operation.

3. Develop measures to avoid or lessen sound impacts during Project construction and operation.

4.5.1.4 Relevant Resource Management Goals

Section 4(e) and 10(a) of the Federal Power Act require that the Commission give equal consideration to all uses of the waterway on which a Project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the Project, as well as power generation and other developmental values.

Project-generated noise during construction or operation, if not properly controlled, could have a negative effect on wildlife and the public in the surrounding area; therefore, it is important to understand the existing ambient noise levels in the Project vicinity and possible noise effects from Project-related activities. Ensuring that potential measures associated with minimizing noise impacts are analyzed is relevant to the Commission’s public interest determination.

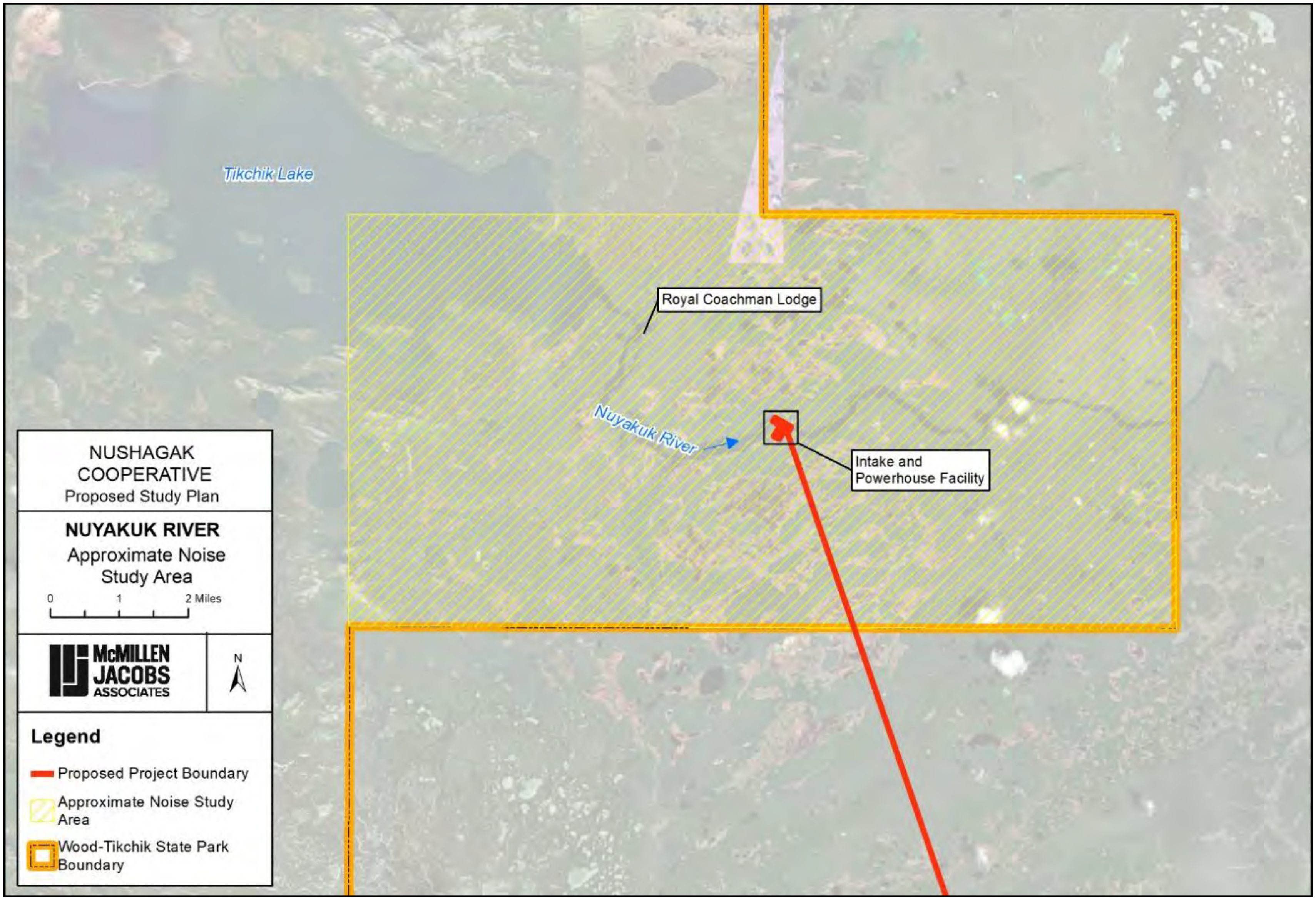

Figure 4-20. Proposed Noise Study Area.

4.5.1.5 Existing Information and Need for Additional Information

During scoping, ADNR, Division of Parks and Outdoor Recreation and the owner of the Royal Coachman Lodge (a fishing outfitter located about 3 miles upstream of the Project site) raised concerns about Project-generated noise during construction and operation disrupting wildlife and visitor uses within Wood-Tikchik State Park and at the lodge. No information is included in the PAD regarding ambient noise levels from which to gauge potential adverse effects of Project-generated noise on existing uses.

4.5.1.6 Project Nexus

Construction is planned to take place over a 2-year period and would include the use of noise-generating equipment to carry out activities such as drilling, boring, blasting, and compaction. In addition, the Cooperative proposes to construct an airstrip that would fly in equipment, materials, and personnel during construction and continue to be used for Project maintenance. Each of these sources of noise has the potential to disrupt wildlife and their uses of adjoining habitats or degrade visitor recreation and cultural experiences and practices. An understanding of ambient noise levels and projected noise generation is needed to assess how Project-generated noise may affect these uses and to identify potential mitigation measures.

4.5.1.7 Methodology

A systematic sound study should be conducted to characterize the existing ambient sound environment in the vicinity of the proposed Project and estimate the potential noise effects from construction, operation, and maintenance of the proposed. The study should include the following steps:

1. Review the most current Project description, operating and construction equipment rosters, construction schedules, and construction methods to identify the types of excavation or blasting expected to occur and where Project noise is likely to be heard by the public;

2. Identify the type and expected frequency of maintenance activities that would generate noise in the Project vicinity (e.g., helicopter or airplane use);

3. Identify sensitive noise receptor areas (i.e., wildlife habitat, recreation and cultural areas) where sound data needs to be collected;

4. Collect ambient sound level measurements at the identified noise receptor sites and document observations of perceived and identifiable sources of sound contributing to ambient sound levels at these sites;

5. Use an acoustic model to predict sound levels during Project construction, operation, and maintenance at the noise receptor sites, estimated in A-weighted decibels (dBA), and indicate the duration of these sound levels;

6. Superimpose predicted sound level isopleths or "sound contours" on aerial photographs or maps of the Project area and include specific sound level predictions at the selected measurement locations; and

7. Develop measures to avoid or lessen Project-generated sound effects.

The study should be developed in consultation with the ADNR, Division of Parks and Outdoor Recreation; ADFG; local outfitters; and Native Alaskan tribes that use the Project area for subsistence or other traditional cultural practices.

These methods are consistent with sound analyses used by applicants and licensees and relied upon by Commission staff in other hydroelectric licensing proceedings.

4.5.1.8 Proposed Deliverables and Schedule

The study will be conducted between spring and fall 2023. The results of the study will be synthesized in the Project's ISR and USR filings. The findings will be presented to stakeholder at the ISR and USR meetings.

4.5.1.9 Level of Effort and Cost

The Cooperative intends to retain a recreation and aesthetics expert once the Study Plan has been finalized. The anticipated cost for the noise study is estimated to be about $45,000.

4.5.2 Recreation Inventory by Season

4.5.2.1 General Description of Proposed Study

Section 4.8 of the PAD described recreational use in the Project vicinity, which includes skiing, off-road vehicle use, boating, sightseeing, hiking, hunting, and fishing, among other uses. It is expected that the volume of recreational use in the area immediately surrounding the river infrastructure is low, due to the remote location of the proposed Project. The proposed Project is located within Wood-Tikchik State Park. The Cooperative proposes to inventory recreational use of the Project vicinity by season, so that any potential Project impacts (both positive and negative) can be identified, and any necessary mitigation measures can be developed.

4.5.2.2 Geographic Scope

The recreation inventory will focus on use in the area immediately around the river infrastructure (intake, tunnel, powerhouse, etc.). It is anticipated that recreational use within this area generally consists of boating, fishing, hunting and potential use of the portage trail around Nuyakuk Falls, flight/sightseeing, and hiking.

4.5.2.3 Study Goals and Objectives

The goal of the study is to inventory and quantify the type and volume of recreational use by season in the vicinity surrounding the proposed Project facilities on the Nuyakuk River.

4.5.2.4 Relevant Resource Management Goals

The proposed Project is located within Wood-Tikchik State Park, managed by ADNR. The purpose of Wood-Tikchik State Park is described in the legislation establishing the park (AS 41.21.160):

"The primary purposes of creating the Wood-Tikchik State Park are to protect the area's fish and wildlife breeding and support systems and to preserve the continued use of the area for subsistence and recreational activities. The state park is also created to protect the area's recreational and scenic resources."

Therefore, understanding any potential Project impacts (positive or negative) to recreation within Wood-Tikchik State Park near proposed Project infrastructure is essential for ensuring that ADNR is able to manage and protect resources within the Park.

4.5.2.5 Existing Information and Need for Additional Information

The PAD summarized existing recreational use in Wood-Tikchik State Park, but the specific activities and volume of recreational use in the immediate Project vicinity that may be impacted either positively or negatively by Project development is unknown. FERC will need site-specific recreational use information for the Environmental Assessment (EA) of the proposed Project.

4.5.2.6 Project Nexus

Construction and operation of the proposed Project may impact recreational use of the area surrounding the Project facilities. Site-specific recreational use information may be used to develop mitigation measures for Project construction and operation, if necessary.

4.5.2.7 Methodology

The Cooperative will collaboratively conduct a comprehensive recreational survey to be employed in Dillingham and the same 4 villages outlined in the subsistence survey in Section 4.4.1 (Koliganek, New Stuyahok, Ekwok and Aleknagik). Beginning in 2022, the Cooperative will develop an online portal by which seasonal (4 times per year), recreational surveys will be submitted. Contacts on the existing Project licensing contact list will be invited to submit survey responses via the online portal. The Cooperative will also invite participants to submit survey responses via social media outlets and the Project licensing website. Surveys will begin in the Spring of 2022 and continue through the winter of 2022/2023. It is understood that supplemental methods to the online portal may be necessary to reach a robust enough data set to make conclusive determinations related to potential recreational impacts associated with Project development. As such, a series of supplemental survey distribution methods may be utilized to access as many interested individuals in these communities as possible. Supplemental distribution methods may include:

- Seasonal village site visits by the Cooperative to conduct surveys
- Mailing of surveys to public individuals with instructions on mailing back to the Cooperative
- Phone calls by the Cooperative to conduct surveys
- Distribution of a survey package at local meeting places with instructions on mailing back to the Cooperative

While it is anticipated that comments received on the PSP will include requested additions/modifications to the proposed survey, survey focus will be placed on the following:

- <u>Name</u>
- <u>Location</u>
- <u>Number of people in household participating various recreational activities in the household</u>
- <u>Perceived primary benefits to the Nuyakuk Falls</u>
    - Recreationally
    - Aesthetically
    - Other?
- <u>Primary recreational activities conducted (each season) near proposed Project infrastructure on the Nuyakuk River:</u>
    - <u>Hunting</u>
        - Species
        - Number of days
    - Fishing
        - Species
        - Number of days
    - Trapping
        - Species
        - Length of time the trap line in place (if applicable)
    - Gathering
        - What?

        - Number of times
    - Flight Seeing
        - Departure location
        - Any landing spots other than departure location
        - Primary areas of visual focus
    - Hiking
    - Other?
- Number of times household has utilized the "Portage Trail" during the season the survey pertains to
    - Used for hiking?
    - Portage a boat?
    - Other?

It is notable that the surveys conducted by the Cooperative will be supplemented by on-site opportunistic recreation observations by natural resource study personnel, regardless of discipline. All individuals conducting studies near the proposed Project location at Nuyakuk Fall will be briefed prior to departing on recreational data to collect and will record any recreational activities they observe while on-site.

Once all comments on the PSP are reviewed and incorporated (where appropriate), the Cooperative will develop a recreational survey data sheet template to be provided with the RSP. This data sheet (once finalized) would be used for both the online portal and any supplemental survey sheets utilized for in-person or versions distributed via mail to ensure synonymous data collection regardless of the response option used.

4.5.2.8 Proposed Deliverables and Schedule

The study will be conducted seasonally throughout 2023. Results from the seasonal surveys will be provided in the Project's ISR and supplemented in the USR with additional detail along with a comprehensive impact assessment related to all four study periods. The findings will be presented to stakeholder at the ISR and USR meetings. The surveys will be conducted as follows:

- Survey Schedule:
    - January 2023
    - April 2023
    - July 2023
    - October 2023

4.5.2.9 Level of Effort and Cost

The Cooperative intends to retain a recreation expert once the Study Plan has been finalized. The estimated cost to complete this study is approximately $100,000 - $200,000.

5.0 STUDY SCHEDULE AND PROCESS

As required by 18 CFR §5.15, the Cooperative will prepare and file with FERC annual progress reports, file an ISR, and hold an ISR Meeting with stakeholders and FERC staff to discuss the initial study results. Upon completion of the study program, the Cooperative will prepare and file a USR and convene an associated USR Meeting to discuss the final study results.

Each proposed study schedule has been detailed in its respective subsection of Section 4.0. All study reports will be filed with FERC in electronic format. Annual progress reports, the ISR, and USR will be filed with FERC in electronic format. Licensing Participants will be notified via email of the availability of reports and any associated information, along with information about accessing and downloading the information.

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APPENDIX A:
PAD Comment Responses

Table 1. Comments received on the Pre-Application Document (PAD) for the Nuyakuk River Hydroelectric Project (P-14873) and Nushagak Cooperative's responses.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
1	ADFG	3.3.2: Nuyakuk Falls Diversion & Intake	The concrete gravity diversion structure above the falls requires careful study. Its effects on both upstream and downstream movement of fish will have to be evaluated. The diversion structure may also create some new slow-water habitat. The PAD states that the diversion and intake geometry will depend upon further studies. The design of the intake and associated structures should minimize the likelihood of fish entrainment, particularly of out-migrating salmon smolt.	The Cooperative agrees with ADFG's statement that the proposed intake will require careful study. To accomplish this, the Cooperative has proposed a study titled "Fish Entrainment and Impingement Study" (PSP Section 4.1.3) to assess the potential for fish entrainment and impingement at the proposed Project intake. One of the primary goals of the proposed study is to inform the intake design to minimize entrainment of juvenile salmonids in the proposed Project intake and maximize survival within the Project area.
2	ADFG	3.3.6: Tailrace	False attraction of fish to the tailrace is always a concern, particularly for waterbodies with migrating salmon. ADF&G is supportive of a design that reduces tailrace velocities and considers fish exclusion barriers at the tailrace.	The Cooperative agrees that false attraction of fish to the proposed Project tailrace is a concern. The Cooperative has proposed a study titled "Assessment of False Attraction at the Tailrace Fish Barrier" (PSP Section 4.1.4). The primary goal of the study is to evaluate performance of the proposed tailrace location and design to demonstrate which operational alternatives minimize/eliminate attraction for returning adults.
3	ADFG	4.4.6: Potential Adverse Effects to Aquatic Resources	This section and Table 4-9 correctly identify some of the potential adverse effects, such as delayed or prohibited upstream migration of fish and mortality to upstream migrating fish. However, potential adverse effects to downstream migrating fish are not mentioned. Mortality of downstream migrating fish may increase, due either to intake impingement, penstock entrainment or to delays or blockage caused by the concrete diversion structure. Downstream fish migration pathways may be altered due to the decrease in flow; this could potentially concentrate fish and lead to blockage and delays resulting in increased predation and mortality.	The Cooperative agrees that entrainment and impingement of fish is of concern. The Cooperative has proposed a study titled "Fish Entrainment and Impingement Study" (PSP Section 4.1.3) to investigate the potential impacts to downstream migrating fish and inform proposed Project design. See also the Cooperative's response to Comment No. 1.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
4	ADFG	4.8.3.1: Subsistence Uses	Data collected by ADF&G shows that the proposed project area was heavily used for subsistence hunting and fishing activities by residents of Koliganek and New Stuyahok, at least for the year the study was conducted, 2005. To understand possible project effects, this data should be updated; we elaborate on the collection of data on subsistence use in the Study Requests section of this document.	The Cooperative agrees with ADFG's perspective that subsistence data for the area surrounding the proposed Project should be collected as part of the Project licensing study program. The Cooperative has proposed to collaborate with ADFG on a "Subsistence Study" (PSP Section 4.4.1) in order to collect updated subsistence use data for the study area.
5	ADFG	5.2.2: Water Resources (Potential Studies)	Three potential studies are listed in this section: 1) water quality and water temperature assessment, 2) hydrologic data collection, and 3) sediment transport assessment and modeling. Because the topics of these studies have a direct impact on fish resources, ADF&G is supportive of all three of these studies and will work with the applicant to ensure that they are carried out in a way that ensure the quality and relevance of the data collected to inform the decision-making process.	The Cooperative appreciates ADFG's comment and looks forward to collaborating with ADFG throughout the study program.
6	ADFG	5.2.3: Fish and Aquatic Resources (Potential Studies)	Three potential studies are listed in this section: 1) fish species seasonal distribution and abundance, 2) bathymetric modeling (i.e. two-dimensional modeling) of Nuyakuk Falls, and 3) Nuyakuk Falls fish passage evaluation and modeling. Each of these studies is essential to understanding how salmon and other fish pass through the Falls and possible project effects. We will elaborate on each of these in the Study Requests section of this document. Additionally, a study of entrainment mortality, particularly for juvenile salmonids, is necessary to quantify potential project impacts.	The Cooperative appreciates ADFG's comment and has proposed studies to address all of the potential resource impacts ADFG lists here.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
7	ADFG	5.2.4: Wildlife and Botanical Resources (Potential Studies)	Four potential studies are listed in this section: 1) wildlife presence, distribution and migratory assessments, 2) botanical presence and distribution evaluation, 3) invasive weed assessment, and 4) rare, threatened and endangered species assessment. The first proposal is essential to provide site-specific information for the evaluation of wildlife issues related to the project. In particular, the project area is a calving area for the Mulchatna Caribou Herd. The construction of power lines through the area would create linear disturbances and activity that may affect caribou movement patterns, survival of caribou neonates, and caribou predation. For studies numbers 2) and 3) we will defer to other resource agencies with more pertinent expertise. We will work closely with the applicant to ensure that the studies provide the information needed for our decision-making purposes.	The Cooperative appreciates this comment and agrees that conducting a caribou study is necessary. The Cooperative has proposed to conduct a study titled "Caribou Migration Evaluation" (PSP Section 4.3.2) to investigate the use of the proposed Project area by caribou throughout their migratory period(s).
8	AK SHPO	4.10: Cultural and Tribal Resources	Our office recommends revisiting the analysis needs under the National Environmental Policy Act (NEPA) as the term 'cultural resources' is not synonymous with 'historic properties'. NEPA cultural resources impact analysis needs to account for impacts to all cultural resources, whereas review under Section 106 of the National Historic Preservation Act only requires assessing effects to historic properties, as defined in 36 CFR 800.16(1)(1), which are those properties that are eligible for listing in the National Register of Historic Places.	The Cooperative appreciates the comment and will ensure that correct terminology pertaining to cultural resources and historic properties are used in Project licensing documents going forward. The Cooperative intends to retain a cultural resources expert to conduct the cultural resources impact analysis under NEPA. The expert will also conduct the Section 106 Evaluation of the Area of Potential Effects (APE).
9	AK SHPO	4.10: Cultural and Tribal Resources	Our office looks forward to the initiation of Section 106 and future consultation regarding the area of potential effects and the proposed level of effort regarding the identification of historic properties for the undertaking.	The Cooperative appreciates the comment and looks forward to consulting with AK SHPO regarding these important resources.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
10	AK SHPO	4.10: Cultural and Tribal Resources	The PAD appropriately discusses the importance of consultation to the Section 106 process and the document lists federal and state agencies, Tribes, and the State Historic Preservation Office as consulting parties. However, consulting parties should also include local governments and other interested parties as defined in 36 CFR 800.2(c).	The Cooperative appreciates the comment. The Cooperative inadvertently neglected to mention local governments and other interested parties in this section of the PAD. However, the Cooperative has been consulting with local governments and other interested parties as listed in 36 CFR 800.2 and plans to continue this consultation throughout the licensing process.
11	AK SHPO	4.10.2: Ethnographic and Historical Overview	We recommend revising Section 4.10.2 Ethnographic and Historical Overview for clarity through consistent use of terms such as Tradition and Culture and by synthesizing the information to create one chronology with multiple lines of evidence.	The Cooperative appreciates the comment from AK SHPO. The Cooperative does not plan to revise the PAD, but all future Project licensing documents will utilize the correct terminology pertaining to historical, cultural, and tribal resources.
12	AK SHPO	4.10: Cultural and Tribal Resources	Our office recommends execution of a Programmatic Agreement to assist the applicant with compliance under Section 106 and the Alaska Historic Preservation Act regarding the construction, operation, and eventual closure of the project. The PAD current recommends only an Historic Properties Management Plan (HPMP), but stand-alone management plans have proven difficult to implement. Any agreement document and/or management plan used to implement an agreement for the purposes of Section 106 or the Alaska Historic Preservation Act should be created in consultation with consulting parties.	The Cooperative appreciates the comment from AK SHPO. The Cooperative intends to develop the appropriate plans and/or agreement document as required by Section 106 and the Alaska Historic Preservation Act in consultation with the consulting parties. We will be bringing on a Cultural Resource expert to guide this process.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
13	NMFS	3.0: Project Description	The proposed Nuyakuk Hydroelectric Project will be located on the Nuyakuk River at a cascade approximately five river miles downstream from the Tikchik Lake outlet. The Tikchik Lake drains the northern Wood River Mountains, a 1,544 square mile watershed. Alaska Statutes (AS § 41.21.167(e)) allows this project to be constructed within Wood-Tikchik State Park boundary. The Project would divert water out of the river above Nuyakuk Falls, pass it through a tunnel(s) to a powerhouse located at the base of Nuyakuk Falls. The water will be returned to the river via the tailrace at the base of Nuyakuk Falls. Nuyakuk Falls is a ½-mile long cascade with 26 feet of elevation change. From the Project site, the Nuyakuk River runs approximately 40 miles before converging with the Nushagak River, which continues to Bristol Bay. As outlined in the November 14, 2019 Additional Information Request (AIR) response, the proposed powerhouse would contain two Kaplan-style reaction turbine generating units. The rated capacity on each unit would be approximately 5 MW, for a total of 10 MW. The combined maximum design flow is approximately 7,550 cfs. The PAD states a minimum flow of 1,000 cfs will be left in the river for other in-river uses, however AS § 41.21.167(e) states the project must maintain at least 70%of the daily upstream water flow of an affected river along the natural course of the river. This maximum designed flow represents the 75% exceedance flow rate for the months of June, July and August. The PAD states the proposed project will be located at Nuyakuk Falls, however, it is technically a half mile-long cascade. Nuyakuk Falls and Nuyakuk cascade refer to the same river reach in this document.	The Cooperative appreciates NMFS's comment regarding the proposed Project description.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
14	NMFS	n/a	Our statutory responsibilities in this matter are codified under our authorities pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.), which requires that the federal action agency consult and give considerable weight to the comments of federal and state resource agencies; the Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1855(b)) and its implementing regulations (50 CFR § 600.920), which requires consultation between the federal action agency and the National Marine Fisheries Service for projects that affect essential fish habitat; and the Federal Power Act (16 U.S.C. §§803 and 811), for the protection of anadromous fish resources and their habitat affected by the licensing, operation and maintenance of hydroelectric projects.	The Cooperative appreciates NMFS's comment and looks forward to consulting with NMFS throughout the Project licensing process.
15	NMFS	n/a	NOAA's National Marine Fisheries Service is a trustee for coastal and living marine resources, including commercial and recreational fisheries; diadromous species; marine mammals, and marine, estuarine, and coastal habitat systems. Our work is guided by two core mandates: ensure the productivity and sustainability of fisheries and fishing communities, and recover and conserve protected resources through reliance on the best available science. Coastal riverine habitat systems, including rivers such as the Nuyakuk, provide an integral component of ecological functions for the larger marine environment. Species such as Sockeye salmon (Oncorhynchus nerka), Chinook salmon (O. tshawytscha), Coho salmon (O. kisutch), Chum salmon (O. keta), pink salmon (O. gorbuscha) rely on the Nuyakuk River for refuge, spawning, rearing and nursery habitat.	The Cooperative appreciates NMFS's comment and looks forward to consulting with NMFS regarding NOAA trust resources throughout the Project licensing process.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
16	NMFS	Contact List (NOI)	Please remove Susan Walker, Kate Savage, and Thomas Meyer from your contact list. We will file a separate notice to the Commission to update the Mailing List. Communication with our agency should continue through the following contacts: Regional Administrator National Oceanic and Atmospheric Administration National Marine Fisheries Service Alaska Region PO Box 21668 Juneau, AK 99802 Sean Eagan National Oceanic and Atmospheric Administration National Marine Fisheries Service Alaska Region PO Box 21668 Juneau, AK 99802 907-586-7345 Sean.Eagan@noaa.gov	The Cooperative appreciates NMFS's comment and has made the corresponding changes to the Project contact list.
17	NMFS	3.3: Project Facilities	The second paragraph of this section, page 23, indicates that the "combined maximum designed flow is the 75% exceedance flow rate for the months of June, July and August, less 1,000 cfs for instream uses." Appendix B has the monthly flow duration curves showing the 75% exceedance to be ~12,000, 10,000, and 7,500 cfs, respectively, for the months of June through August. This volume of water removed is not consistent with Alaska Statute (AS § 41.21.167(e)), which states "(2) maintains at least 70 percent of the daily upstream water flow of an affected river along the natural course of the river". If 70% is left in the river even in June on many days only 3,600 cfs will be run through the turbines which are being designed with 7,550 cfs of capacity.	The Cooperative appreciates this comment. The Cooperative plans to undertake a number of studies to inform Project feasibility and design specifics. The engineering configurations proposed in the PAD may be modified based on the results of field and feasibility studies in order to meet regulatory requirements. It is anticipated that instream flow requirements will be developed based on the results of field studies. The Cooperative is interested in displacing as much diesel fuel generation as possible, even if generation in lower flow months is diminished due to complying with instream flow regulations.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
18	NMFS	3.3.2: Nuyakuk Falls Diversion & Intake	The applicant proposed to complete two-dimensional river hydraulic modeling for approximately 1,000 linear feet above the falls to aid in development of the intake diversion hydraulic and structural design. Our Study Request 3, objective (e), supports the need for three dimensional computational fluid dynamics (CFD) modelling to evaluate flows vectors under a range of river and operation conditions. This section describes the need for an inclined bar-screen at the intakes to divert debris and ice. The openings between the bars are proposed as 1 to 3 inches. These racks would be oriented parallel to the flow to increase sweeping velocities to promote debris and ice removal. Further, the Additional Information Request response submitted by the applicant (November 14, 2019) provides a conceptual design of the proposed facility. We note the concrete groin has the potential to span half the river's width or more. Adult salmon migrating to the upstream lake habitat for spawning, and juvenile salmon emigrating to the ocean need to safely pass the project intakes. Diverting the first 7,550 cfs above a minimum 1,000 cfs bypass flow, as proposed, would have significant consequences for migratory fish, including salmon. Maintaining 70% of the natural flow in the river would significantly reduce effects on salmon. The Project should be designed and operated to avoid impingement and entrainment of these migrating fish. This may require smaller rack spacing and larger screen surface area to manage intake flows and sweeping velocities. It may also require a screen orientation at a specific angle to the river flow to encourage movement along the screen face. These same considerations apply to ice management. Frazil ice, and to a lesser extent breakup and anchor ice, has the potential to damage the bar rack and reduce intake flow, and affect the overall operation of the Project. Damaged racks or impaired project operations could influence the ability to safely [Comment 18 continues on next page]	The Cooperative appreciates NMFS's comment, and has proposed several studies to address these concerns: • Nuyakuk Falls Fish Passage Study (PSP Section 4.1.2) • Fish Entrainment and Impingement Study (PSP Section 4.1.3) • Ice Processes Assessment (PSP Section 4.2.3) As mentioned in each of the aforementioned proposed studies sections in the PSP, the Cooperative looks forward to working with NMFS on the development of the appropriate methods and analytical tools to adequately assess potential impacts (positive and negative) from Project construction and operation.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
			move fish past the project structure. Features designed to prevent ice damage are important to ensure proper project operations. Our Study Request 3, objective (e), for a 3-D modeling above the falls informed by the 2-D model throughout the project affected area will inform the intake screen design and help to meet this goal of protecting migrating salmon.	
19	NMFS	3.3.3: Conveyance Tunnels	The November 14th AIR response depicts twin 16 foot tunnels leading to the powerhouse. This would seem more practical than the larger single tunnel presented in the PAD.	The Cooperative appreciates NMFS's comment. Project design is still in development and will be informed by Project feasibility studies. The PSP describes the Project configuration as twin 18-foot tunnels. This may be refined based on field studies and ongoing engineering design work.
20	NMFS	3.3.5: Powerhouse	The PAD indicates three vertical shaft Kaplan-type turbines are proposed for the project. The November 14th AIR response states two turbine units each rated at a capacity of 5,000KW. We request analysis of this turbine type on outmigrating smolt at 26-feet of head versus other turbine models. January through March flows averaged approximately ⅕ of summer flows in the last seven years. Climate change could further alter this proportion (see Future Flows, Study Request 5). We recommend investigating whether turbines of different sizes might be the most efficient way to optimize winter power production.	The Cooperative appreciates NMFS's comment. Project design is still in development and will be informed by field and Project feasibility studies. The Cooperative plans to assess optimal power production the proposed turbine configuration. The Cooperative has proposed a study titled "Fish Entrainment and Impingement Study" that will investigate potential impacts on outmigrating juvenile salmonids.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
21	NMFS	3.3.6: Tailrace	The proposed tailrace outlet design is intended to reduce velocities relative to the natural river velocities in the discharge zone. This design feature will help prevent the false attraction of anadromous fish to the tailrace. This section include the potential for evaluation of other measures to meet this goal, such as a vertical picket barriers or other such fish barrier type. We support the inclusion of design features and operations to prevent the false attraction of migrating anadromous fish at the tailrace. Migrating fish need to reach their spawning habitat safely and in a timely manner. The proposed actions will support this goal.	The Cooperative appreciates this comment. The Cooperative has proposed to conduct a study titled "Assessment of False Attraction at the Fish Tailrace Barrier" (PSP Section 4.1.3). This study will provide data used to inform tailrace design in order to minimize the potential for false attraction of fish to the Project tailrace.
22	NMFS	3.3.7: Switchyard/ Transmission Lines	A straight transmission line from Nuyakuk Falls directly to Koliganek and then a second line directly to Stuyahok would appear to minimize the miles of new line that need to be constructed and the environmental disturbance. We assume that there are terrane or land ownership consideration that went into the displayed longer route (AIR Fig 3-3).	The Cooperative appreciates this comment, and is currently refining Project design, including the transmission line route. The conceptual design displayed in the PAD and PAD AIR may be refined, and in the final design the Cooperative will seek to reduce environmental disturbance while balancing other considerations such as land ownership. Further, during the initial feasibility layout of the transmission line, it was determined that the longer route proposed, along ridgelines would cumulatively minimize the overall impact of Project development by avoiding numerous wetland areas utilized by a variety of wildlife and botanical species.
23	NMFS	3.3.8: Proposed Construction and Development Schedule	Many aspects of the mobilization and construction have the potential to affect anadromous species migration and spawning activity. We recommend consideration of erosion and sediment control, timing of in-water activity, hazardous materials control, and invasive species management for each step of the construction and development planning and implementation.	The Cooperative appreciates this comment and agrees with NMFS that Project construction schedules and methods should be planned to minimize environmental disturbance, including anadromous species migration and spawning activity.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
24	NMFS	Figure 3-10: Mean Daily Discharge	We note the use of the full data range from 1953 to present to create the flow duration curve for summer months. It appears USGS gage #1530200 was not operated most years from November through early April from 1953 to 2013. We recommend the applianc[t] describe how the flow duration curve was developed for the winter months. Climate change is impacting hydrologic patterns across the nation. Bristol Bay watershed has already seen an increase of 3.7 °F in air temperature and an increase of 13 % in annual precipitation from 1969 to 2018 (Thoman 2019). Further, increasing precipitation is projected in the project area within even the early period of the license.(Leppi 2014; Wobus 2015). The greatest increases are expected in winter and summer months (USGCRP 2018), and in this watershed, increasing temperatures are projected to lead to multiple freshets, or pulses of flow, during the winter (Wobus 2015). A flow duration curve based on a more precise data set that reflects current conditions and trends would better inform the development of the project, project operations, and mitigation measures. We recommend in our Change Analysis (Study Request 4) to evaluate the flow data for more recent trends in the data from the Nuyakuk USGS gage. The results may influence the project proposal, project capacity and production, and mitigation measures.	The Cooperative appreciates NMFS's comment. The Cooperative used the available winter flow data at USGS gage #1530200 from 1953 to 2017 (54 years of available mean daily discharge data). It is notable that available daily mean winter flow records prior to 2014 were qualified as "estimated" data. The Cooperative queried the USGS via email to determine the basis for estimating winter flow records prior to 2014 and received a response from Chad W. Smith on March 2, 2020: Bob, Historically discharge records have been estimated at this site when ice formation affects the stage discharge relationship. These estimates were based on a combination of climate data, physical discharge measurements, and trends of the stage hydrograph. Advances in the equipment used to make discharge measurements and winter access to the site in recent years have indicated that much of the winter period is not adversely affected by ice. Prior to this new information about winter ice affects we would estimate the daily discharge to be slightly less than what the computed "ice affected" record would be. This resulted in a fairly accurate estimated record. The Cooperative believes Mr. Smith's response confirms that the USGS was actively gaging the site through the winter on the pre-2014 data sets. The USGS had to qualify the streamflow record as "estimated" because their instrumentation was affected by ice and therefore stage/discharge readings were not taken directly from the instrumentation. [Comment 24 response continues on next page]

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
				Also, despite a substantial period of estimated winter flow data, these flow data were slightly ***reduced*** to create an accurate daily flow record. The Cooperative is confident that the winter flow data from USGS gage #1530200 is the most accurate and reliable to generate flow duration curves.
25	NMFS	4.1.2: Climate	Planning for new hydro projects has in the past relied on the assumption that future air temperature and precipitation patterns would be the same as those in the past. Given the increasing certainty of global climate change, this assumption is no longer valid given the current level of scientific certainty of climate change (Milly 2008; Viers and Rheinheimer 2011). Further, long range planning for hydroelectric project operations depends on large-scale, long-term climate predictions. However, for the multi-decadal period of the license, it is important to assess how these variables will change due to trends and natural variability, but also due to climate change. With needs to predict both quantity and timing of precipitation and temperature in an uncertain future, planning for new projects should analyze long-term (multi-decadal) climate and hydrology datasets and assess downscaled climate projections. Such an analysis has become generally accepted practice in the hydropower industry worldwide. [Comment 25 continues on next page]	The Cooperative appreciates NMFS's comment. The Cooperative has proposed a robust study program to be conducted during the Project licensing process. However, the climate change studies proposed by NMFS do not meet the criteria for identifying a nexus between the proposed Project construction or operations and effects (direct, indirect, or cumulative) on the resource to be studied. FERC has been consistent in their treatment of similar requests for studies in hydropower licensing (FERC 2009a, 2009b, 2009c, 2009d, 2011a, 2011b, 2013, 2016).

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
			From an environmental standpoint, failing to consider climate change trends for southwest Alaska can result in not capitalizing on the opportunities for both hydropower planning and fish, given the projections of increasing precipitation, and in design of fish passage and operating conditions that are unrealistic for the range of future flows. This is in line with recent literature that highlights opportunities to design and operate hydropower projects for sustainability of both power production and the riverine environment (Brown et al. 2015; Poff et al. 2016). These flows relate to diverse resources as recreation, aesthetics, subsistence, and tourism, among others. From an economic standpoint, not accounting for climate change can result in less reliable electrical generation, more diesel fuel consumption, higher energy costs, and other negative factors. We recommend the applicant evaluate how anticipated changes in temperature and precipitation may be expected to impact project operations and operational efficiency of the proposed hydropower project. A basis for this assessment can be derived from state specific information generated by the U.S. Global Change Research Program (Chapin 2014; USGCRP 2018) and publications based on global climate models used in that report.	
26	NMFS	4.4.3: Federal and State Designated Habitat	The Nuyakuk River, including Nuyakuk Falls, is designated Essential Fish Habitat for five species of salmon (NPFMC 2018). The Little King Salmon River enters the Nuyakuk just below the Tikchik Lake outlet and adds to the affected area. The Little King Salmon River supports Chinook and coho salmon (ADFG 1994). A second unnamed stream enters the Nuyakuk from the south about one mile above the fall and also supports coho salmon. It is not clear that the watersheds of either of these two streams is included in the applicant's 1,544 square mile watershed assessment.	The Cooperative appreciates NMFS's comment. We will review our previously conducted watershed assessment to verify all relevant tributaries are accounted for in our calculation. We will modify the overall square mileage number based on this assessment, if applicable.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
27	NMFS	4.4.4.1: Fish Passage Barriers	We agree that determining at what flows the falls are and are not a barrier for each species needs further assessment (Upstream Fish Passage, Study 2).	The Cooperative appreciates NMFS's comment. The Cooperative has proposed to conduct a study titled "Nuyakuk Falls Fish Passage Study" (PSP Section 4.1.2) to investigate the relationship between river flow levels and upstream and downstream fish migration.
28	NMFS	4.4.4.2: Sediment, Ice, and Geomorphology	We agree with most aspects of this assessment, however, the statement "the area immediately above and below Nuyakuk Falls consistently remains ice free" needs verification. It is not clear whether the ice free zone above the falls extend to the intake facility all winter. It should be clarified whether frazil ice will form as the river water emerges from under the iced over section. If so, that frazil ice may adhere to the intake structure. See our Ice Processes Assessment, Study 6.	The Cooperative appreciates NMFS's comment, and has proposed to conduct a study titled "Ice Processes Assessment" (PSP Section 4.2.3) to gain a better understanding of ice formation in the Project area and potential impacts to Project facilities.
29	NMFS	4.4.5: Instream Flows	The short bypass reach is not "almost wholly falls" as the gradient averages only 1% and could contain some areas with habitat value. Our Study Request 1, Fish Distribution, objective (d), addresses this need to understand what fish habitat and processes happen in the Nuyakuk cascade.	The Cooperative appreciates NMFS's comment and agrees that Nuyakuk Falls (cascade) requires study during the Project licensing process. To address this, the Cooperative has proposed to conduct the following studies to investigate fish distribution and habitat availability in the falls: • Fish Species Abundance and Distribution Near the Project Area (PSP Section 4.1.1) • Nuyakuk Falls Fish Passage Study (PSP Section 4.1.2)

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
30	NMFS	4.4.6 Potential Adverse Effects	Table 4-9 identifies the potential adverse impacts related to fish and aquatic resources. We note that in-water work has the potential to result in long-term and permanent impacts on spawning and rearing habitat, as well as the short term impacts identified. The scope and scale of impacts depends on the in-water activity. We concur that bypass of a portion of the river flow around the Nuyakuk Falls during operations may impede fish movement during their migration. Evaluating this potential impact on migrating salmon is a priority for our agency, and is considered in our Upstream Fish Passage, Study 2.	The Cooperative appreciates NMFS's comment and agrees that impacts to migrating salmon need to be assessed during Project licensing. To accomplish this, the Cooperative has proposed to conduct a study titled "Nuyakuk Falls Fish Passage Study (PSP Section 4.1.2).
31	NMFS	5.0 Preliminary Issues and Study List	We support the development of environmentally sound, renewable energy that helps communities reduce their reliance on diesel. As indicated in this section of the PAD, a number of data gaps that require evaluation to assess baseline conditions and potential project related impacts. Data from these studies will support the development of protection, mitigation and enhancement measures that address identified project related impacts. Attachment 2 of this document provides our detailed study requests per 18 CFR § 5.9(b).	The Cooperative appreciates NMFS's comment and agrees that a robust study program is essential during the Project licensing process. The Cooperative has proposed to conduct a total of 13 studies designed to evaluate potential impacts (both positive and negative) to natural resources due to proposed Project construction and operation.
32	NMFS	PAD Section 5.3 Relevant Comprehensive Plans	We recommend inclusion as a comprehensive plan the Strategic Conservation Action Plan for Southwest Alaska Watershed. This action plan was developed by the Southwest Alaska Salmon Habitat Partnership and updated in 2017. We filed this document with the Commission as a comprehensive plan on November 21, 2019 (accession # 20191121-5157). We also recommend Nushagak River Watershed Traditional Use Area Conservation Plan by the Nushagak-Mulchatna Watershed Council, which we plan to file on the record.	The Cooperative appreciates this comment.
33	UTBB	n/a	What is the estimated average annual generation capacity of the Project (e.g., is it 72,800 MWh or 55,300 MWh)?	Project design and specifications are still conceptual and evolving based on ongoing analysis. The current average annual generation capacity is estimated to be 58,900 MWh.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
34	UTBB	n/a	How much energy is needed for the fish processing and packaging efforts in the summer versus the heating and electricity needs in the villages?	The Cooperative appreciates this question from UTBB. The Cooperative expects more than half of the load from the Project to be utilized for fish processing during the summer. Using 2019 as an example, over 3 MW were utilized for processing during the commercial fishing season. Heating and electricity demands will obviously increase as a result of the Project, not only supplying Dillingham but also the outlying villages. Seasonal considerations related to processing needs and peak times for heating needs will be a driver in overall demand.
35	UTBB	n/a	Will there just be a single bore tunnel arrangement for the 2 conveyance pipes to the powerhouse? How long and how far underground will it be?	Project design and specifications are still conceptual at this time, and it is unknown whether there will be a single or double tunnel bore arrangement for the 2 conveyance pipes to the powerhouse. Preliminary geotechnical studies will inform the Project's engineering design. Preliminary Project design consists of a total tunnel length of approximately 750 ft. The tunnel(s) will be approximately 20-30 ft below ground at the edge of the water in the forebay above Nuyakuk Falls. The tunnel depth will increase as it travels under the nearby hill and decrease closer to the powerhouse due to above-ground topography.
36	UTBB	n/a	Will there be 2 or 3 Kaplan turbines in the powerhouse?	Project design and specifications are still conceptual at this time, but preliminary design includes 2 Kaplan units in the powerhouse.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
37	UTBB	n/a	What is the amount of flow that will be diverted to the intake structure every month of the year?	The Cooperative appreciates UTBB's question. At this time, the amount of flow diverted to the intake structure during each month of the year is unknown. Field studies, site-specific field gages, and agency consultation will guide instream flow requirements for this portion of the Nuyakuk River. Additionally, the Cooperative will be pursuing a water right with ADNR that will prescribe the volume of water that can be diverted through the proposed Project throughout the year.
38	UTBB	n/a	Where will the gravel source be located for the runway and road construction?	The Cooperative is in the process of identifying sources for various materials necessary for Project construction. Sources for gravel and other necessary materials will be documented as the information becomes available.
39	UTBB	n/a	How will the winter ice and low flow conditions, the potential for ice dams, and high flows during Spring breakup impact the operation of the diversion structure? How will ice and debris issues be mitigated from impacting the intake on the river bank? Will antifreeze be used in winter through the intake structure to avoid ice buildup?	The Cooperative appreciates UTBB's question. The Cooperative has proposed to conduct a study titled "Ice Processes Assessment" (PSP Section 4.2.3) in order to gather information about ice formation in the Project vicinity and in the Project intake structure. The information from this study will be used to guide Project design to minimize any potential issues that may be caused by ice formation.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
40	UTBB	n/a	What are the plans for the construction man camp and will it be used in the winter months? How many people will be needed for the construction phase? Will locals have hiring preference?	The Cooperative is in the process of planning the construction of the man camp. The construction man camp will be addressed when the FERC license is received. The amount of man power for this Project will ultimately be defined by the final design and need for various disciplines. During the construction phase, work will be ongoing through the year. The Cooperative has already hired locals for some of the logistical work and will continue this throughout the Project. The Cooperative plans to have a man camp set up for the studies, including two cabins and 3 docks. The study work will be on-going throughout the year during the study process.
41	UTBB	n/a	When will construction of transmission lines occur, how many streams and acres of wetlands will need to be crossed during construction, and what environmental impacts will there be during the construction of the transmission lines?	The Cooperative appreciates UTBB's question. At this time, it is unknown exactly when Project transmission lines will be constructed. A refined Project construction schedule will be developed upon receiving the FERC operating license and all associated land use permits from requisite state agencies. At this time, detailed mapping of wetlands has not been conducted in the proposed Project vicinity. The Cooperative has proposed to conduct a study titled "Botanical and Wetlands Survey" (PSP Section 4.3.1) that will quantify the type and acreage of wetlands and streams within the proposed Project boundary, which includes all transmission line corridors.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
42	UTBB	n/a	What will be the barging challenges on the Nuyakuk River to bring in heavy equipment and turbines to the site? In the Scoping Meeting it was stated that there are navigational issues near the project site (e.g., only a small 18' boat can reach the site).	The Cooperative appreciates UTBB's question and recognizes that there are logistical challenges to undertaking construction in this remote location. The Cooperative is currently working to identify the best possible means and methods of mobilizing equipment and turbines to the site. As more information becomes available, the Cooperative will provide these details in Project licensing documents and at public meetings.
43	UTBB	n/a	What is the design of and how long will it take to construct the diversion structure or groyne? Will a cofferdam be used for the construction of the groyne? How long will the cofferdam be in place? How will the construction of the groyne impact in- and out-migrating salmon?	Project design and specifications are still conceptual at this time, and exact details regarding the design of the diversion structure and concrete groin are not complete. It is anticipated that a cofferdam will be placed for construction of the concrete groin, but details regarding the length and timing of cofferdam use have not been developed. The Cooperative recognizes that any in-water work has the potential to impact salmonids. The Cooperative intends to consult with agencies to determine the appropriate timing for in-water work in order to minimize impacts to in-and out-migrating salmon.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
44	UTBB	n/a	What are the maintenance requirements for the power plant and transmission lines? Will the power plant need to be shut down annually, if so for how long?	Project design specifications will be refined throughout the licensing process. These refinements will ultimately define the maintenance process for all Project infrastructure. Generally speaking and with the understanding that this plan could be modified, there will likely be an annual maintenance outage associated with the low flow/power output period during which, all standard maintenance activities will take place. Unless anomalous conditions occur, regular shutdowns aside from this period are not anticipated at this time.
45	UTBB	n/a	What other federal and state permits will be needed for the project?	The Cooperative has begun the formal process of consulting with federal and state agencies to identify permits that will be needed to conduct the feasibility studies associated with Project licensing. Assuming the Project receives a license, a similar collaborative process will occur to ensure that all federal and state permits are secured for the construction and operation of the Project.
46	UTBB	n/a	How long will the project provide hydroelectric power to the villages (e.g., 20, 50, 100 years)?	The Cooperative intends to obtain a 40-year license from FERC for Project operation, which is the standard length of license for projects of this size. Similar projects in Alaska have demonstrated their ability to provide a reliable source of renewable power for 100+ years and are still operating. Every expectation is that this Project would operate with a similar life expectancy.

Comment No.	Agency	PAD Section	PAD Comment	Cooperative's Response
47	UTBB	n/a	What are the decommissioning plans for the hydroelectric power plant?	Currently, the Cooperative has not developed decommissioning plans. In the event that the Project requires decommissioning, the Cooperative will create decommissioning plans in consultation with federal, state, and local agencies that meet strict FERC guidelines and all relevant environmental regulations.
48	UTBB	n/a	What are other electricity needs besides the villages along the transmission line corridors (e.g., Aleknagik landfill, Float Plane Road, and Johnny Tugatuk Road) that could benefit from the Project?	In addition to Dillingham and the outlying villages, the Cooperative plans to provide to the Aleknagik Landfill, Float Plane Road, and Johnny Tugatuk Road. At this time, we also anticipate providing power to the new fish processing being developed by Levelock Tribal.
49	UTBB	n/a	When will an economic feasibility study be conducted and how will the Nushagak Cooperative fund this Project (e.g., through funds from the State of Alaska, federal funds and/or bank financing)?	The Cooperative appreciates UTBB's question. The Cooperative is currently refining Project economic feasibility studies. The Cooperative is pursuing a variety of funding sources to assist with the development of the proposed Project, including federal, state, and other sources of funding. As Project funding is established, the Cooperative will provide funding details in Project licensing documents and at public meetings.

REFERENCES

FERC (Federal Energy Regulatory Commission). 2009a. Study Plan Determination for the Lake Powell Pipeline Project (P-12966). January 2009.

FERC. 2009b. Study Plan Determination for the Yuba-Bear Drum-Spaulding Project (P-2310, P-2266). February 2009.

FERC. 2009c. Study Plan Determination for the Toledo Bend Project (P-2305). August 2009.

FERC. 2009d. Study Plan Determination for the Merced Project (P-2179). September 2009.

FERC. 2011a. Study Plan Determination for the Yuba River Project (P-2246). September 2011.

FERC. 2011b. Study Plan Determination for the Don Pedro Hydroelectric Project (P-2299). December 2011.

FERC. 2013. Study Plan Determination for the Susitna-Watana Hydroelectric Project (P-14241). February 2013.

FERC. 2016. Study Plan Determination for the La Grange Hydroelectric Project (P-14581). May 2016.

APPENDIX B:
PAD Comments and Study Requests Filed with FERC

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Fish and Game

Division of Sport Fish
Research & Technical Services

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February 4, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Nuyakuk River (P-14873-001) Hydroelectric Project
Comments and Study Requests

Dear Ms. Bose:

On November 8, 2019, the Federal Energy Regulatory Commission (FERC) published notice soliciting comments and study requests for the Nuyakuk River Hydroelectric Project (FERC No. 14873). The Alaska Department of Fish and Game (ADF&G) has reviewed the Pre-Application Document submitted by Nushagak Cooperative, Inc. and offers the attached comments and study requests.

If you have any questions, please contact me at (907) 267-2836. Thank you for your consideration.

Sincerely,

Kevin D. Keith

Kevin Keith
FERC Hydropower Coordinator
Alaska Department of Fish and Game
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COMMENTS ON THE PRE-APPLICATION DOCUMENT (PAD)

As part of the greater Bristol Bay watershed, the Nuyakuk River supports one of the world's most productive salmon fisheries. The planning of any development in this region must be carried out with a careful eye to how that activity, in this case the construction and operation of a hydropower facility, may affect salmon populations, salmon habitat, and the communities that depend on salmon resources. In addition, assessment of other (non-salmon) fish species, as well as the wildlife in the project area, will also be needed.

Section 3.3.2 Nuyakuk Falls Diversion & Intake
The concrete gravity diversion structure above the falls requires careful study. Its effects on both upstream and downstream movement of fish will have to be evaluated. The diversion structure may also create some new slow-water habitat.

The PAD states that the diversion and intake geometry will depend upon further studies. The design of the intake and associated structures should minimize the likelihood of fish entrainment, particularly of out-migrating salmon smolt.

Section 3.3.6 Tailrace
False attraction of fish to the tailrace is always a concern, particularly for waterbodies with migrating salmon. ADF&G is supportive of a design that reduces tailrace velocities and considers fish exclusion barriers at the tailrace.

Section 4.4.6 Potential Adverse Effects to Aquatic Resources
This section and Table 4-9 correctly identify some of the potential adverse effects, such as delayed or prohibited upstream migration of fish and mortality to upstream migrating fish. However, potential adverse effects to downstream migrating fish are not mentioned. Mortality of downstream migrating fish may increase, due either to intake impingement, penstock entrainment or to delays or blockage caused by the concrete diversion structure. Downstream fish migration pathways may be altered due to the decrease in flow; this could potentially concentrate fish and lead to blockage and delays resulting in increased predation and mortality.

Section 4.8.3.1 Subsistence Uses
Data collected by ADF&G shows that the proposed project area was heavily used for subsistence hunting and fishing activities by residents of Koliganek and New Stuyahok, at least for the year the study was conducted, 2005. To understand possible project effects, this data should be updated; we elaborate on the collection of data on subsistence use in the *Study Requests* section of this document.

Section 5.2.2 Water Resources (Potential Studies)
Three potential studies are listed in this section: 1) water quality and water temperature assessment, 2) hydrologic data collection, and 3) sediment transport assessment and modeling. Because the topics of these studies have a direct impact on fish resources, ADF&G is supportive of all three of these studies and will work with the applicant to ensure that they are carried out in a way that ensure the quality and relevance of the data collected to inform the decision-making process.

Section 5.2.3 Fish and Aquatic Resources (Potential Studies)
Three potential studies are listed in this section: 1) fish species seasonal distribution and abundance, 2) bathymetric modeling (i.e. two-dimensional modeling) of Nuyakuk Falls, and 3) Nuyakuk Falls fish passage evaluation and modeling. Each of these studies is essential to understanding how salmon and other fish pass through the Falls and possible project effects. We will elaborate on each of these in the *Study Requests* section of this document. Additionally, a study of entrainment mortality, particularly for juvenile salmonids, is necessary to quantify potential project impacts.

Section 5.2.4 Wildlife and Botanical Resources (Potential Studies)
Four potential studies are listed in this section: 1) wildlife presence, distribution and migratory assessments, 2) botanical presence and distribution evaluation, 3) invasive weed assessment, and 4) rare, threatened and endangered species assessment. The first proposal is essential to provide site-specific information for the evaluation of wildlife issues related to the project. In particular, the project area is a calving area for the Mulchatna Caribou Herd. The construction of power lines through the area would create linear disturbances and activity that may affect caribou movement patterns, survival of caribou neonates, and caribou predation.

For studies numbers 2) and 3) we will defer to other resource agencies with more pertinent expertise. We will work closely with the applicant to ensure that the studies provide the information needed for our decision-making purposes.

STUDY REQUEST #1: Fish Species Seasonal Distribution and Abundance near the Project Site

§5.9(b)(1) — *Describe the goals and objectives of each study proposal and the information to be obtained.*

<u>Goal:</u>

The goals of this study are to better understand fish timing and use of the project area.

<u>Objectives:</u>

1. Estimate the run timing for all five species of Pacific salmon (Chinook, coho, sockeye, chum, and pink salmon), for both their spawning migration up the Nuyakuk Falls and for the smolt migration down the Nuyakuk Falls.
2. Estimate the magnitude and seasonality of resident fish use of Nuyakuk Falls by both juveniles and adults.

§5.9(b)(2) — *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The Fish and Game Act requires the Alaska Department of Fish and Game (ADF&G) to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADF&G – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

§5.9(b)(3) — *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Not applicable, requestor is a resource agency.

§5.9(b)(4) — *Describe existing information concerning the subject of the study proposal, and the need for additional information.*

ADF&G ran a counting tower on the Nuyakuk River from 1959 to 1988 and from 1995 to 2006. The tower counts provide good information on the magnitude and timing of the adult sockeye salmon spawning migration. However, we do not have good information on the magnitude and timing of the spawning migrations for the other four salmon species (Chinook, coho, chum, and pink salmon). Nor do we have information on the magnitudes and timing of the smolt migration at the project site for any of the five Pacific salmon species.

ADF&G conducted a fish inventory of the Nuyakuk River in August of 2006. This inventory provides of list of those species that may be present at the project site in August. It does not address which species use the falls, either as habitat or as a migration corridor, and at what times of years those species may use the falls. Additional studies are needed to answer these questions.

§5.9(b)(5) — *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project construction and operation has the potential to affect fish populations in a number of ways. Reduced flows in the bypass reach will decrease the amount of habitat. If flows in the bypass reach are too low, fish migration will be seriously impeded or even blocked. Tailrace flows can be a source of attraction for fish migrating up-river and may reduce migration success (particularly for adult salmon). The concrete barrier and intake structure above the falls are both potential sources of mortality for all fish species. Alteration of water velocity within the bypass reach may affect fish habitat and fish behavior in the falls.

The proposed studies of fish seasonal abundance and distribution will be necessary to develop protection, mitigation, and enhancement (PME) measures in terms of required flows in the bypass reach, design and operation of the intake structure and concrete diversion structure, and tailrace design.

§5.8(b)(6) — *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Some combination of fish capture techniques will likely be needed to meet the objectives (e.g. a counting tower for adult salmon, incline plan traps for juvenile salmon, radio tags, electrofishing, etc.). We will work with the applicant to design studies that will provide information needed to inform our decision-making process.

§5.9(b)(7) — *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost will be considered as the studies are designed. There are no proposed alternatives.

STUDY REQUEST #2: Two-Dimensional Hydrodynamic (Bathymetric) Modeling of Nuyakuk Falls

§5.9(b)(1) — *Describe the goals and objectives of each study proposal and the information to be obtained.*

Goal:

The goal of this study is to provide two-dimensional hydrodynamic results for evaluation of the proposed project structures and operational flow scenarios on upstream and downstream fish passage and use of the falls by resident species.

Objectives:

1. Collect detailed survey data of sufficient coverage and resolution over the entire Nuyakuk Falls area for use in a two-dimensional hydrodynamic model.
2. Select appropriate hydrodynamic modeling software for study conditions to achieve model stability and accurate representation of the computational domain and hydraulic conditions.
3. Select appropriate range of flows for model calibration.
4. Calibrate the model and run simulations for evaluation of alternative project designs and operation scenarios for upstream and downstream fish passage and use of the falls by resident fish species.

§5.9(b)(2) — *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The Fish and Game Act requires ADF&G to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADF&G – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

§5.9(b)(3) — *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Not applicable, requestor is a resource agency.

§5.9(b)(4) — *Describe existing information concerning the subject of the study proposal, and the need for additional information.*

To our knowledge, there is no detailed information on river depths and velocities throughout the falls reach. A two-dimensional hydrodynamic model of the falls reach is needed to provide the level of detail necessary to fully inform stakeholders of the effects of project construction and operation on fish passage and habitat use.

§5.9(b)(5) — *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project operation will lower the amount of water flowing down the falls because a certain quantity of water will be diverted through the penstock. If low flows though the falls prevent migration during critical time periods (for example, during the adult salmon spawning migration), fish populations will be seriously impacted. An accurate two-dimensional hydrodynamic model is needed to simulate the complex hydraulic features of the Nuyakuk Falls. Model results will allow simulation of alternative project designs under varying operational scenarios to evaluate fish passage and fish habitat use at different times of the year and to develop PME measures. We expect flows down the falls to be an important issue for evaluation during the licensing process.

§5.8(b)(6) — *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Two-dimensional hydrodynamic models require spatially explicit bathymetry. A combination of state-of-the-art surveying techniques will be needed to acquire sufficient coverage and resolution needed for modeling purposes (of LiDAR, total station survey, etc.) In-river surveys of the falls should be completed when flows are at their annual minimum (between March 15 and April 15). This time period is assumed to also coincide with lowest biological activity in the falls. As fish migrate upstream through the falls, they must navigate a series of ledges and obstacles; this migration requires specific hydraulic conditions in terms of velocity and depth. Ideally, an extensive survey of the falls to measure water velocity, water depth and height of each ledge would be carried out when flows in the river approach their lowest levels; however, we recognize the difficulties and safety issues of conducting field work during winter conditions and will work with the applicant to develop field work tasks and schedules with safety concerns fully considered.

§5.9(b)(7) — *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

ADF&G will work with the applicant to develop a plan to survey the falls reach and develop a bathymetric map that meets stakeholders needs. The level of effort and cost will be determined by the methodology that is ultimately used but is expected to be comparable to that of similar FERC projects of this size. There are no proposed alternative studies.

STUDY REQUEST #3: Nuyakuk Falls Fish Passage Evaluation and Modeling

§5.9(b)(1) — *Describe the goals and objectives of each study proposal and the information to be obtained.*

Goal:

The goals of this study are to determine what flow levels through Nuyakuk Falls are necessary to maintain fish passage (upstream and downstream).

Objectives:

1. Identify key locations in the falls that may restrict upstream fish passage at low water flows.
2. Identify flow levels at which fish will be unable to migrate upstream past the falls.
3. Assess downstream smolt migration and identify potential impingement, obstruction or delay issues that may occur with project instream structures and/or operations.
4. Identify flow levels at which upstream adult salmon migration will be so constrained as to increase mortality.

§5.9(b)(2) — *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The Fish and Game Act requires ADF&G to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADF&G – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

§5.9(b)(3) — *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Not applicable, requestor is a resource agency.

§5.9(b)(4) — *Describe existing information concerning the subject of the study proposal, and the need for additional information.*

To meet the objectives of this study, hydrodynamic modeling results from Study Request #2 will need to be combined with fish swimming and jumping criteria. Information needs include: 1) identification of target fish species and their swimming and jumping criteria, 2) identification of the key locations that may limit fish upstream and downstream passage over the range of operation scenarios, 3) assessment of downstream smolt migration and potential impingement, obstruction, and delay issues due to project structures and operations, and 4) assessment of factors that may affect adult salmon passage over a range of operational flows.

§5.9(b)(5) — *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project operation will lower the amount of water flowing down the falls because a certain quantity of water will be diverted through the penstock. If low flows though the falls prevent migration during critical time periods (for example, during the adult salmon spawning migration), fish populations could be seriously impacted. A thorough evaluation of fish passage (upstream and downstream) at alternative operation scenarios over the period of fish activity is needed to develop PME measures. We expect flows down the falls to be an important issue for evaluation during the licensing process.

§5.8(b)(6) — *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Some combination of a hydrodynamic model, a hydrologic time series, and on-site surveys will be necessary to meet the objectives. We will work with the applicant to design studies that will provide the necessary data to inform our decision-making process.

§5.9(b)(7) — *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort, schedules and cost will be considered as details of the studies are designed. There are no proposed alternative studies.

STUDY REQUEST #4: Fish Entrainment and Impingement Study

§5.9(b)(1) — *Describe the goals and objectives of each study proposal and the information to be obtained.*

Goal:

The goals of this study are to conduct a desktop study to estimate fish injury and mortality due to entrainment and impingement, and to investigate alternatives to reduce these impacts.

Objectives:

1. Conduct a literature review of fish impacts with Kaplan-style reaction turbines as proposed for the project. The focus of the review should be on sockeye salmon smolt, but the other four salmon species and juvenile resident species should also be considered.
2. Conduct a literature review of different methods of preventing fish impingement and entrainment, with an emphasis on sockeye salmon smolt.
3. Conduct a literature review and modeling analysis of different designs for the proposed concrete groin diversion structure, with an emphasis on effective upstream and downstream passage of fish at all flow levels.

§5.9(b)(2) — *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The Fish and Game Act requires ADF&G to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADF&G – Division of Sport Fish Mission is "to protect and improve the state's recreational and fisheries resources". According to the 2015-2020 Division of Sport Fish Strategic Plan, the management priority is to manage Alaska's recreational fisheries for sustained yield and recreational angler satisfaction that is centered on an area-based management system. The division's fish habitat program is directed at protecting and restoring fish habitats for the benefit of fish and current and future recreational anglers.

§5.9(b)(3) — *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Not applicable, requestor is a resource agency.

§5.9(b)(4) — *Describe existing information concerning the subject of the study proposal, and the need for additional information.*

This is envisioned as a desk-top study to gather the existing and relevant information on the mechanisms of fish entrainment and entrainment mortality. Sockeye salmon smolt are emphasized because of the large annual out-migration, on the order of millions of smolts per year. Impingement and entrainment of other species are concerns as well.

§5.9(b)(5) — *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Project construction and operation have a high potential to cause fish impingement and entrainment and resulting injury or mortality. The concrete groin diversion structure, as proposed, may increase fish mortality by forcing a large percentage of out-migrating fish down the penstock and through the turbines. Understanding the mechanisms of fish impingement and entrainment and evaluation of alternative project designs will provide essential information on design capabilities and risks needed to develop appropriate PME measures. Evaluations of the design specifications for the inlet and groin diversion structure will be critical issues of the license process.

§5.8(b)(6) — *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

A thorough literature review is generally a key part of any scientific study.

§5.9(b)(7) — *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost will be considered as the studies are designed. There are no proposed alternative studies.

STUDY REQUEST #5: Subsistence Survey

§5.9(b)(1) — *Describe the goals and objectives of each study proposal and the information to be obtained.*

Goal:

The goal of this study is to document traditional and contemporary subsistence harvest and use in the project area in order to provide a basis for impact assessment, avoidance, minimization, and development of PME measures and to provide the information that will serve as the basis for compliance with FERC's National Environmental Policy Act (NEPA) analysis for the project license.

Objectives:

1. Conduct a subsistence harvest survey for the community of Koliganek.
2. Conduct a subsistence harvest survey for the community of New Stuyahok.

§5.9(b)(2) — *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The Fish and Game Act requires ADF&G to, among other responsibilities, "…manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020).

ADF&G – Division of Subsistence Mission is "to scientifically gather, quantify, evaluate, and report about customary and traditional uses of Alaska's fish and wildlife resources". One of the core services of the division is to assist fisheries and wildlife managers in preparing management plans to ensure information on customary and traditional uses and fish and wildlife harvests is incorporated.

§5.9(b)(3) — *If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Not applicable, requestor is a resource agency.

§5.9(b)(4) — *Describe existing information concerning the subject of the study proposal, and the need for additional information.*

Subsistence surveys were carried out in the vicinity of the project in 2005.[1] That data is now fifteen years old and should be updated to more accurately reflect contemporary subsistence harvest and use patterns. In particular, subsistence harvest surveys for the communities of Koliganek and New Stuyahok would provide the necessary information to determine potential effects of the proposed project.

[1] See T.M. Krieg, D.L. Holen, and D. Koster. 2009. Subsistence harvests and uses of wild resources in Igiugig, Kokhanok, Koliganek, Levelock, and New Stuyahok, Alaska, 2005. Alaska Department of Fish and Game, Division of Subsistence. Technical Paper No. 322, Dillingham.

§5.9(b)(5) — *Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Residents of Koliganek and New Stuyahok use the project area for subsistence hunting, fishing and gathering. Project construction and operation could lead to impacts on subsistence use of the project area. The proposed study will assess the timing and location of subsistence use and would be necessary to develop PME measures with regard to the timing of activities, particularly during project construction.

§5.8(b)(6) — *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field seasons(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Community subsistence surveys have been performed throughout the state of Alaska for many years; they are both well-accepted and cost-effective means of understanding subsistence use of fish and game resources.

ADF&G Division of Subsistence will conduct this study using standard Division methodology involving systematic household surveys conducted by community-based survey technicians in cooperation with Division subsistence resource specialists. Specific methods include:

- Development of a survey instrument to produce updated comprehensive baseline information about subsistence hunting, fishing, and gathering and other topics that address subsistence needs and are compatible with information collected in past household interviews.
- Community consultation to identify community liaisons and seek study support.
- Household surveys to record the following information: 1) demographic information; 2) involvement in use, harvest, and sharing of fish, wildlife, and wild plants in their study year; 3) estimate of amount of resources harvested in their study year; 4) information about employment and cash income; 5) assessments of changes in subsistence harvest and use patterns based on data available from past study years; and 6) location of fishing, hunting, and gathering activities in their study year.

§5.9(b)(7) — *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost will be considered as the studies are designed. There are no proposed alternative studies.

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Natural Resources
DIVISION OF PARKS AND OUTDOOR RECREATION
Office of History & Archaeology

550 West 7th Avenue, Suite 1310
Anchorage, AK 99501-3561
907.269.8700
http://dnr.alaska.gov/parks/oha

February 4, 2020

File No.: 3130-1R FERC / 2020-00138

Julia Kolberg
Federal Energy Regulatory Commission
Office of Energy Projects
888 First Street, N.E.
Washington, D.C. 20426

Subject: Nuyakuk River Hydroelectric Project, FERC No. 14873 – Pre-Application Document

Dear Ms. Kolberg:

The Alaska State Historic Preservation Office (AK SHPO) received the Notice of Intent and Pre-Application Document (PAD) for the Nuyakuk River Hydroelectric Project on November 8, 2019. Following the Daytime Scoping Meeting in December 2019, our office reviewed the PAD and offer the following comments for your consideration.

- Our office recommends revisiting the analysis needs under the National Environmental Policy Act (NEPA) as the term 'cultural resources' is not synonymous with 'historic properties.' NEPA cultural resources impact analysis needs to account for impacts to all cultural resources, whereas review under Section 106 of the National Historic Preservation Act only requires assessing effects to historic properties, as defined in 36 CFR 800.16(l)(1), which are those properties that are eligible for listing in the National Register of Historic Places.

- Our office looks forward to the initiation of Section 106 and future consultation regarding the area of potential effects and the proposed level of effort regarding the identification of historic properties for the undertaking.

- The PAD appropriately discusses the importance of consultation to the Section 106 process and the document lists federal and state agencies, Tribes, and the State Historic Preservation Office as consulting parties. However, consulting parties should also include local governments and other interested parties as defined in 36 CFR 800.2(c).

- We recommend revising Section 4.10.2 *Ethnographic and Historical Overview* for clarity through consistent use of terms such as Tradition and Culture and by synthesizing the information to create one chronology with multiple lines of evidence.

- Our office recommends execution of a Programmatic Agreement to assist the applicant with compliance under Section 106 and the Alaska Historic Preservation Act regarding the construction, operation, and eventual closure of the project. The PAD currently recommends only an Historic Properties Management Plan (HPMP), but stand-alone management plans have proven difficult to implement. Any agreement document and/or management plan used to implement an agreement for the purposes of Section 106 or the Alaska Historic Preservation Act should be created in consultation with consulting parties.

Thank you for the opportunity to comment. Please contact Sarah Meitl at 269-8720 or sarah.meitl@alaska.gov if you have any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner
State Historic Preservation Officer

JEB:sjm

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Natural Resources
Division of Parks and Outdoor Recreation
Wood-Tikchik State Park Management Council
P.O. BOX 1822
Dillingham, AK 99576
907-842-2641

January 15, 2020

Honorable Julia Kolberg
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: (P-14873-001) Pre-Application Document/Scoping Document 1, Study Requests, Public Comment, Request for Acceptance of Regional Plans as Comprehensive Management Plans

Dear Ms. Kolberg,

A primary purpose of the Wood-Tikchik State Park Management Council (Council) is to provide a forum for the collection and expression of opinions and recommendations on matters relating to the Wood-Tikchik State Park. The Council previously requested the Federal Energy Regulatory Commission (Commission) hold one or more public scoping meetings within Southwest Alaska, specifically in Dillingham, to solicit public input for the proposed Nuyakuk River Project No. P-14873-001. We acknowledge the additional travel expenses this would require and sought additional regional input during a public meeting December 20, 2019 to further inform the Commission of public comments, study requests and comprehensive plans.

The public comments may not meet all Study Request Criteria in 18 CFR Section 5.9(b), but the Council requests the Commission utilize these comments when developing study plans considering many members of the public were unable to participate in the evening FERC scoping teleconference on December 11, 2019. Public comments on study areas we recommend for inclusion into the future proposed study plans are summarized below:

- Geologic and Soil Resources
    - Research geotechnical integrity of proposed project site and transmission line corridor.
- Aquatic Resources – Water Quality
    - Research site specific hydro turbine gas entrainment related to ultimate design and operation.
- Aquatic Resources – Fisheries
    - Prioritize studying out-migrating juvenile salmon and resident species in water column and vulnerability to design and intake operation. Noted previous studies completed in the watershed on salmon smolt and fry migration by Alaska Dept. of Fish and Game.
    - Prioritize studying Pink Salmon on years of abundance. Presence of adult and juveniles alternate biennially.
    - Study life stage species specific habitat suitability of water depth, water velocity, substrate and cover affinities.

    - Study potential changes to fish habitat with alterations to water depth and substrate conditions
- Terrestrial Resources
    - Study and assess caribou population, calving range, migration routes and potential impacts of noise during construction and operation.
    - Study potential impacts of noise on furbearer presence, trapping and subsistence use during construction and operation.
    - Assess the effects of predation of fish by birds in the bypass reach area.
- Recreation and Land Use Resources and Aesthetic Resources
    - Evaluate impacts to tourism and commercial businesses impacts during studies, construction, and operation.
    - Evaluate potential impacts to overall recreational experience related to research, equipment, noise and contractor presence.
    - Assess increased access to hunting and effects on hunting regulations.
- Cultural Resources
    - Study cultural and subsistence impacts related to potential changes in land use, terrestrial and fisheries resources.
    - Study potential changes to portage trail, cultural resources, subsistence uses and access.
- Socioeconomic Resources
    - Asses options for transmission route and transportation corridor from Ekwok to Dillingham.

In addition to the study plan comments, the Council requests the Commission accept the following plans as comprehensive plans under Section 10(a)(2)(A) of the Federal Power Act:

- The *Nushagak Mulchatna Subwatershed Prioritization Process* (2001) developed by the Nushagak Mulchatna Watershed Council in cooperation with the USDA Natural Resources Conservation Service.
- *Nushagak River Watershed Traditional Use Area Conservation Plan* (2018) developed by the Nushagak Mulchatna Watershed Council
- *The Strategic Conservation Action Plan for Southwest Alaska Watersheds* (2017) developed under NOAA's National Fish Habitat Partnership in cooperation with the Southwest Alaska Salmon Habitat Partnership which is composed of Federal and State agencies, and regional stakeholders.
- *Bristol Bay Comprehensive Management plan and Final EIS* (1985) developed under directive from Section 1203 of Alaska National Interest Lands Conservation Act
- Southwest Alaska Rainbow Trout Management Plan (1989) published by the Alaska Department of Fish and Game

While these plans are not identified in the *List of Comprehensive Plans May 2019* document, they are specific to the watershed where the project is proposed. The Council recognizes considerable funding, effort, and input from public, tribal, federal and state agencies were expended in the creation and maintenance of these plans. The Council advocates the aforementioned plans have merit and will prove useful in determining appropriate studies and methods when generating the proposed study plan. If the submission criteria are not met, the council recommends the Commission and the applicant utilize them to inform the design of the studies and project assessment.

The WTSP Management Plan permitting matrix in Chapter 8-15 will be employed by the Alaska DNR, Division of Parks and Outdoor Recreation when permitting uses, facilities and structures within WTSP boundaries; the plan advises federal agencies refer to the matrix for potential facility development. The Guidelines for Activities within Land Use Designations in Table 8-1 may also inform the process for the design of studies conducted during the licensing process.

The council recognizes the historical conversation related to hydroelectric development within WTSP has been extensive. In order to suitably fulfill a primary purpose of the Council, we request the Commission utilize Council meeting minutes related to hydroelectric development within WTSP as public comments, as well as previous studies and public comments received during FERC licensing processes P-13238 and P-14356, both hydroelectric facilities proposed within the boundaries of WTSP, when compiling Proposed Study Plans.

Thank you for your considerations in these matters.

Respectfully,

Cody Larson

Cody Larson
Vice-Chair, Wood-Tikchik State Park Management Council

Cc: Ricky Gease – Alaska State Parks Director
Kurt Hensel – Chugach/Southwest Area Superintendent
Robert Himschoot – Nushagak Cooperative GM/CEO
Bobby Armstrong - Nushagak Cooperative Electric Operations Manager
Cory Warnock – McMillen Jacobs Associates
Laura Johnson – McMillen Jacobs Associates

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426
January 23, 2020

OFFICE OF ENERGY PROJECTS

Project No. 14873-001- Alaska
Nuyakuk River Hydroelectric Project
Nushagak Electric & Telephone
Cooperative, Inc.

VIA FERC Service

Bobby Armstrong
Nushagak Electric & Telephone Cooperative, Inc.
PO Box 350
Dillingham, AK 99576

Reference: Study Requests

Dear Mr. Armstrong:

After reviewing the Pre-Application Document (PAD) for the Nuyakuk River Hydroelectric Project, staff have determined that a noise study is likely needed. The study request is discussed in the enclosed Schedule A.

Please include in your proposed study plan a master schedule that includes the estimated start and completion date of all field studies, when progress reports will be filed, who will receive the reports and in what format, and the filing date of the initial study report. All studies, including field work should be initiated and completed during the first study season, and the study reports should be filed as a complete package to avoid piecemeal review. Finally, if you are likely to propose any plans for measures to mitigate project impacts, drafts of those plans should be filed with the initial study report.

If you have any questions, please contact Julia Kolberg at (202) 502-8261, or via e-mail at Julia.Kolberg@ferc.gov.

Sincerely,

David Turner, Chief
Northwest Branch
Division of Hydropower Licensing

Enclosure: Schedule A

STUDY REQUESTS

After reviewing the information in the PAD, we have identified a gap between the information in the PAD and the information needed to assess project effects. As required in section 5.9 of the Commission's regulations we have addressed the seven study request criteria for each of the study requests that follow.

Noise Study

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to characterize the existing ambient sound environment in the vicinity of the proposed project and estimate the potential impacts associated with construction and operational activities. The specific objectives of the study and subsequent report are to:

(1) Define existing noise levels in identified sensitive wildlife habitat, recreation and cultural areas within the Wood-Tikchik State Park including trails, the Royal Coachman Lodge, fishing and hunting areas, and areas used for subsistence and other traditional cultural practices.
(2) Describe, through the use of sound models, the expected noise levels in the identified sensitive areas during project construction and operation.
(3) Develop measures to avoid or lessen sound impacts during project construction and operation.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – if the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Section 4(e) and 10(a) of the Federal Power Act require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Project-generated noise during construction or operation, if not properly controlled, could have a negative effect on wildlife and the public in the surrounding area; therefore, it is important to understand the existing ambient noise levels in the project vicinity and possible noise effects from project-related activities. Ensuring that potential measures associated with minimizing noise impacts are analyzed is relevant to the Commission's public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

During scoping, the Alaska DNR, Division of Parks and Outdoor Recreation and the owner of the Royal Coachman Lodge (a fishing outfitter located about 3 miles upstream of the project site) raised concerns about project-generated noise during construction and operation disrupting wildlife and visitor uses within Wood-Tikchik State Park and at the lodge. No information is included in the PAD regarding ambient noise levels from which to gauge potential adverse effects of project-generated noise on existing uses.

Criterion (5) - Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Construction is planned to take place over a 2-year period and would include the use of noise-generating equipment to carry out activities such as drilling, boring, blasting, and compaction. In addition, you propose to construct an airstrip that would fly in equipment, materials, and personnel during construction and continue to be used for project maintenance. Each of these sources of noise has the potential to disrupt wildlife and their uses of adjoining habitats or degrade visitor recreation and cultural experiences and practices. An understanding of ambient noise levels and projected noise generation is needed to assess how project-generated noise may affect these uses and to identify potential mitigation measures.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

A systematic sound study should be conducted to characterize the existing ambient sound environment in the vicinity of the proposed project and estimate the potential noise effects from construction, operation, and maintenance of the proposed. The study should include the following steps:

(1) Review the most current project description, operating and construction equipment rosters, construction schedules, and construction methods to identify the types of excavation or blasting expected to occur and where project noise is likely to be heard by the public;
(2) Identify the type and expected frequency of maintenance activities that would generate noise in the project vicinity (e.g., helicopter or airplane use);

(3) Identify sensitive noise receptor areas (i.e., wildlife habitat, recreation and cultural areas) where sound data needs to be collected;
(4) Collect ambient sound level measurements at the identified noise receptor sites and document observations of perceived and identifiable sources of sound contributing to ambient sound levels at these sites;
(5) Use an acoustic model to predict sound levels during project construction, operation, and maintenance at the noise receptor sites, estimated in A-weighted decibels (dBA), and indicate the duration of these sound levels;
(6) Superimpose predicted sound level isopleths or "sound contours" on aerial photographs or maps of the project area and include specific sound level predictions at the selected measurement locations; and
(7) Develop measures to avoid or lessen project-generated sound effects.

The study should be developed in consultation with the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation; Alaska Department of Fish and Game; local outfitters; and Native Alaskan tribes that use the project area for subsistence or other traditional cultural practices. The initial Study Report should include study results, data analysis, a description of field investigation activities and methods, and documentation of consultation with the above-named stakeholders.

These methods are consistent with sound analyses used by applicants and licensees and relied upon by Commission staff in other hydroelectric licensing proceedings.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The anticipated cost for the noise study is estimated to be about $45,000.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

February 4, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments on the Pre-Application Document and Study Requests for the Nuyakuk River Hydroelectric Project (P-14873)

Dear Secretary Bose:

On November 8, 2019, Federal Energy Regulatory Commission issued a Notice of Intent to file a license application and filing of the Pre-Application Document (PAD) for the above referenced proposed project. The PAD contains information about the Nuyakuk Project and the environmental resources potentially affected by the project. We are providing the attached comments on the PAD and Scoping Document, and submitting study requests as part of the Integrated Licensing Process.

The stated purpose of the proposed Nuyakuk Hydroelectric Project is to support fish processing and packaging efforts in the local villages, as well as to reduce the reliance on diesel-powered generation. The project would transition six communities from diesel generation to hydroelectric generation. This will drastically reduce the cost of power for each household and provide generation to power salmon processing and other industries. This energy cost savings will support employment in towns with high unemployment. With the affected communities paying as much as $8 per gallon for diesel, this project has the potential to offset more than $1 million dollars annually.

This project purpose is consistent with our agency mission to support resilient ecosystems, communities and economies. We support the development of safe, climate resilient, renewable energy that includes hydropower generation. However, hydropower development can compromise the habitat and sustainability of migratory fish such as salmon; fish upon which the local communities rely. In waterways such as the Nuyakuk River, which support a significant portion of Bristol Bay sockeye salmon and four other salmon species, the impacts of energy development can directly affect fish and habitat. Protection of migratory fish and their habitat warrant equal consideration to energy generation throughout the licensing proceedings. This project is consistent with *Strategic Conservation Action Plan for Southwest Alaska Watershed* which was accepted as a comprehensive plan. Therefore, measures to protect fish and their habitat should be considered integral components of the Nuyakuk River Hydroelectric Project design. Close coordination with us and other state and federal resource agencies will facilitate the review and design process. Specifically, the future flows study request is integral to several studies and informing the design and operation of the proposed project. NOAA Fisheries and its NOAA climate science partners are available and willing to discuss the details of the climate and flow studies to ensure its value for all parties.

Please contact Sean Eagan sean.eagan@noaa.gov or by phone at 907-586-7345 if you have any questions.

Sincerely,

Robert D. Mecum
Deputy Regional Administrator
Alaska Region

Attachment 1: National Marine Fisheries Service's Comments on Nushagak Cooperative's Pre-Application Document and Scoping Documents for the Proposed Nuyakuk Hydroelectric Project (P-14873)

Attachment 2: National Marine Fisheries Service's Study Requests for the Nuyakuk Project (FERC No. P-14873)

Attachment 1:

National Marine Fisheries Service's Comments on Nushagak Cooperative's Pre-Application Document and Scoping Documents for the Proposed Nuyakuk Hydroelectric Project (P-14873)

January 3, 2020

1. Project Description

The proposed Nuyakuk Hydroelectric Project will be located on the Nuyakuk River at a cascade approximately five river miles downstream from the Tikchik Lake outlet. The Tikchik Lake drains the northern Wood River Mountains, a 1,544 square mile watershed. Alaska Statutes (AS § 41.21.167(e)) allows this project to be constructed within Wood-Tikchik State Park boundary. The Project would divert water out of the river above Nuyakuk Falls, pass it through a tunnel(s) to a powerhouse located at the base of Nuyakuk Falls. The water will be returned to the river via the tailrace at the base of Nuyakuk Falls. Nuyakuk Falls is a ½-mile long cascade with 26 feet of elevation change. From the Project site, the Nuyakuk River runs approximately 40 miles before converging with the Nushagak River, which continues to Bristol Bay. As outlined in the November 14, 2019 Additional Information Request (AIR) response, the proposed powerhouse would contain two Kaplan-style reaction turbine generating units. The rated capacity on each unit would be approximately 5 MW, for a total of 10 MW. The combined maximum design flow is approximately 7,550 cfs. The PAD states a minimum flow of 1,000 cfs will be left in the river for other in-river uses, however AS § 41.21.167(e) states the project must maintain at least 70% of the daily upstream water flow of an affected river along the natural course of the river. This maximum designed flow represents the 75% exceedance flow rate for the months of June, July and August. The PAD states the proposed project will be located at Nuyakuk Falls, however, it is technically a half mile-long cascade. Nuyakuk Falls and Nuyakuk cascade refer to the same river reach in this document.

2. Federal Statutory Requirements

Our statutory responsibilities in this matter are codified under our authorities pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.), which requires that the federal action agency consult and give considerable weight to the comments of federal and state resource agencies; the Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1855(b)) and its implementing regulations (50 CFR § 600.920), which requires consultation between the federal action agency and the National Marine Fisheries Service for projects that affect essential fish habitat; and the Federal Power Act (16 U.S.C. §§803 and 811), for the protection of anadromous fish resources and their habitat affected by the licensing, operation and maintenance of hydroelectric projects.

3. NOAA Trust Resources

NOAA's National Marine Fisheries Service is a trustee for coastal and living marine resources, including commercial and recreational fisheries; diadromous species; marine mammals, and marine, estuarine, and coastal habitat systems. Our work is guided by two core mandates: ensure the productivity and sustainability of fisheries and fishing communities, and recover and conserve protected resources through reliance on the best available science. Coastal riverine habitat systems, including rivers such as the Nuyakuk, provide an integral component of ecological functions for the larger marine environment. Species such as Sockeye salmon (*Oncorhynchus nerka*), Chinook salmon (*O. tshawytscha*), Coho salmon (*O. kisutch*), Chum salmon (*O. keta*), pink salmon (*O. gorbuscha*) rely on the Nuyakuk River for refuge, spawning, rearing and nursery habitat.

4. Contact List

Please remove Susan Walker, Kate Savage, and Thomas Meyer from your contact list. We will file a separate notice to the Commission to update the Mailing List. Communication with our agency should continue through the following contacts:

Regional Administrator
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Region
PO Box 21668
Juneau, AK 99802

Sean Eagan
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Alaska Region
PO Box 21668
Juneau, AK 99802
907-586-7345
Sean.Eagan@noaa.gov

5. Comments on the Pre-Application Document

We offer the following comments based on our review of the PAD submitted by Nushagak Cooperative, Inc. for the proposed Nuyakuk Hydroelectric Project.

PAD Section 3.3 Project Facilities

The second paragraph of this section, page 23, indicates that the "combined maximum designed flow is the 75% exceedance flow rate for the months of June, July and August, *less 1,000 cfs for instream uses*." Appendix B has the monthly flow duration curves showing the 75% exceedance to be ~12,000, 10,000, and 7,500 cfs, respectively, for the months of June through August.

This volume of water removed is not consistent with Alaska Statute (AS § 41.21.167(e)), which states "(2) maintains at least 70 percent of the daily upstream water flow of an affected river along the natural course of the river". If 70% is left in the river even in June on many days only 3,600 cfs will be run through the turbines which are being designed with 7,550 cfs of capacity.

PAD Section 3.3.2 Nuyakuk Falls Diversion & Intake

The applicant proposed to complete two-dimensional river hydraulic modeling for approximately 1,000 linear feet above the falls to aid in development of the intake diversion hydraulic and structural design. Our Study Request 3, objective (e), supports the need for three dimensional computational fluid dynamics (CFD) modelling to evaluate flows vectors under a range of river and operation conditions.

This section describes the need for an inclined bar-screen at the intakes to divert debris and ice. The openings between the bars are proposed as 1 to 3 inches. These racks would be oriented parallel to the flow to increase sweeping velocities to promote debris and ice removal. Further, the Additional Information Request response submitted by the applicant (November 14, 2019) provides a conceptual design of the proposed facility. We note the concrete groin has the potential to span half the river's width or more.

Adult salmon migrating to the upstream lake habitat for spawning, and juvenile salmon emigrating to the ocean need to safely pass the project intakes. Diverting the first 7,550 cfs above a minimum 1,000 cfs bypass flow, as proposed, would have significant consequences for migratory fish, including salmon. Maintaining 70% of the natural flow in the river would significantly reduce effects on salmon. The Project should be designed and operated to avoid impingement and entrainment of these migrating fish. This may require smaller rack spacing and larger screen surface area to manage intake flows and sweeping velocities. It may also require a screen orientation at a specific angle to the river flow to encourage movement along the screen face. These same considerations apply to ice management. Frazil ice, and to a lesser extent breakup and anchor ice, has the potential to damage the bar rack and reduce intake flow, and affect the overall operation of the Project. Damaged racks or impaired project operations could influence the ability to safely move fish past the project structure. Features designed to prevent ice damage are important to ensure proper project operations. Our Study Request 3, objective (e), for a 3-D modeling above the falls informed by the 2-D model throughout the project affected area will inform the intake screen design and help to meet this goal of protecting migrating salmon.

PAD Section 3.3.3 Conveyance Tunnels

The November 14th AIR response depicts twin 16 foot tunnels leading to the powerhouse. This would seem more practical than the larger single tunnel presented in the PAD.

PAD Section 3.3.5 Powerhouse

The PAD indicates three vertical shaft Kaplan-type turbines are proposed for the project. The November 14th AIR response states two turbine units each rated at a capacity of 5,000KW. We request analysis of this turbine type on outmigrating smolt at 26-feet of head versus other turbine models. January through March flows averaged approximately ⅕ of summer flows in the last seven years. Climate change could further alter this proportion (see Future Flows, Study Request 5). We recommend investigating whether turbines of different sizes might be the most efficient way to optimize winter power production.

PAD Section 3.3.6 Tailrace

The proposed tailrace outlet design is intended to reduce velocities relative to the natural river velocities in the discharge zone. This design feature will help prevent the false attraction of anadromous fish to the tailrace. This section include the potential for evaluation of other measures to meet this goal, such as a vertical picket barriers or other such fish barrier type.

We support the inclusion of design features and operations to prevent the false attraction of migrating anadromous fish at the tailrace. Migrating fish need to reach their spawning habitat safely and in a timely manner. The proposed actions will support this goal.

PAD Section 3.3.7 Switchyard / Transmission lines

A straight transmission line from Nuyakuk Falls directly to Koliganek and then a second line directly to Stuyahok would appear to minimize the miles of new line that need to be constructed and the environmental disturbance. We assume that there are terrane or land ownership consideration that went into the displayed longer route (AIR Fig 3-3).

PAD Section 3.3.8 Proposed Construction and Development Schedule

Many aspects of the mobilization and construction have the potential to affect anadromous species migration and spawning activity. We recommend consideration of erosion and sediment control, timing of in-water activity, hazardous materials control, and invasive species management for each step of the construction and development planning and implementation.

PAD Figure 3-10, Mean Daily Discharge

We note the use of the full data range from 1953 to present to create the flow duration curve for summer months. It appears USGS gage #1530200 was not operated most years from November through early April from 1953 to 2013. We recommend the appliance describe how the flow duration curve was developed for the winter months.

Climate change is impacting hydrologic patterns across the nation. Bristol Bay watershed has already seen an increase of 3.7 °F in air temperature and an increase of 13 % in annual precipitation from 1969 to 2018 (Thoman 2019). Further, increasing precipitation is projected in the project area within even the early period of the license.(Leppi 2014; Wobus 2015). The greatest increases are expected in winter and summer months (USGCRP 2018), and in this watershed, increasing temperatures are projected to lead to multiple freshets, or pulses of flow, during the winter (Wobus 2015). A flow duration curve based on a more precise data set that reflects current conditions and trends would better inform the development of the project, project operations, and mitigation measures. We recommend in our Change Analysis (Study Request 4) to evaluate the flow data for more recent trends in the data from the Nuyakuk USGS gage. The results may influence the project proposal, project capacity and production, and mitigation measures.

PAD Section 4.1.2 Climate

Planning for new hydro projects has in the past relied on the assumption that future air temperature and precipitation patterns would be the same as those in the past. Given the increasing certainty of global climate change, this assumption is no longer valid given the current level of scientific certainty of climate change (Milly 2008; Viers and Rheinheimer 2011). Further, long range planning for hydroelectric project operations depends on large-scale, long-term climate predictions. However, for the multi-decadal period of the license, it is important to assess how these variables will change due to trends and natural variability, but also due to climate change. With needs to predict both quantity and timing of precipitation and temperature in an uncertain future, planning for new projects should analyze long-term (multi-decadal) climate and hydrology datasets and assess downscaled climate projections. Such an analysis has become generally accepted practice in the hydropower industry worldwide.

From an environmental standpoint, failing to consider climate change trends for southwest Alaska can result in not capitalizing on the opportunities for both hydropower planning and fish, given the projections of increasing precipitation, and in design of fish passage and operating conditions that are unrealistic for the range of future flows. This is in line with recent literature that highlights opportunities to design and operate hydropower projects for sustainability of both power production and the riverine environment (Brown et al. 2015; Poff et al. 2016). These flows relate to diverse resources as recreation, aesthetics, subsistence, and tourism, among others. From an economic standpoint, not accounting for climate change can result in less reliable electrical generation, more diesel fuel consumption, higher energy costs, and other negative factors.

We recommend the applicant evaluate how anticipated changes in temperature and precipitation may be expected to impact project operations and operational efficiency of the proposed hydropower project. A basis for this assessment can be derived from state specific information generated by the U.S. Global Change Research Program (Chapin 2014; USGCRP 2018) and publications based on global climate models used in that report.

PAD Section 4.4.3 Federal and State Designated Habitat

The Nuyakuk River, including Nuyakuk Falls, is designated Essential Fish Habitat for five species of salmon (NPFMC 2018). The Little King Salmon River enters the Nuyakuk just below the Tikchik Lake outlet and adds to the affected area. The Little King Salmon River supports Chinook and coho salmon (ADFG 1994). A second unnamed stream enters the Nuyakuk from the south about one mile above the fall and also supports coho salmon. It is not clear that the watersheds of either of these two streams is included in the applicant's 1,544 square mile watershed assessment.

PAD Section 4.4.4.1 Fish Passage Barriers

We agree that determining at what flows the falls are and are not a barrier for each species needs further assessment (Upstream Fish Passage, Study 2).

PAD Section 4.4.4.2 Sediment, Ice and Geomorphology

We agree with most aspects of this assessment, however, the statement "the area immediately above and below Nuyakuk Falls consistently remains ice free" needs verification. It is not clear whether the ice free zone above the falls extend to the intake facility all winter. It should be clarified whether frazil ice will form as the river water emerges from under the iced over section. If so, that frazil ice may adhere to the intake structure. See our Ice Processes Assessment, Study 6.

PAD Section 4.4.5 Instream Flows

The short bypass reach is not "almost wholly falls" as the gradient averages only 1% and could contain some areas with habitat value. Our Study Request 1,Fish Distribution, objective (d), addresses this need to understand what fish habitat and processes happen in the Nuyakuk cascade.

PAD Section 4.4.6 Potential Adverse Effects

Table 4-9 identifies the potential adverse impacts related to fish and aquatic resources. We note that in-water work has the potential to result in long-term and permanent impacts on spawning and rearing habitat, as well as the short term impacts identified. The scope and scale of impacts depends on the in-water activity.

We concur that bypass of a portion of the river flow around the Nuyakuk Falls during operations may impede fish movement during their migration. Evaluating this potential impact on migrating salmon is a priority for our agency, and is considered in our Upstream Fish Passage, Study 2.

PAD Section 5.0 Preliminary Issues and Study List

We support the development of environmentally sound, renewable energy that helps communities reduce their reliance on diesel. As indicated in this section of the PAD, a number of data gaps that require evaluation to assess baseline conditions and potential project related impacts. Data from these studies will support the development of protection, mitigation and enhancement measures that address identified project related impacts. Attachment 2 of this document provides our detailed study requests per 18 CFR § 5.9(b).

PAD Section 5.3 Relevant Comprehensive Plans

We recommend inclusion as a comprehensive plan the *Strategic Conservation Action Plan for Southwest Alaska Watershed*. This action plan was developed by the Southwest Alaska Salmon Habitat Partnership and updated in 2017. We filed this document with the Commission as a comprehensive plan on November 21, 2019 (accession # 20191121-5157). We also recommend *Nushagak River Watershed Traditional Use Area Conservation Plan* by the Nushagak-Mulchatna Watershed Council, which we plan to file on the record.

6. Comments on FERC's Scoping Document 1

SD1 Section 3.1 No-Action Alternative

We concur with the stated purpose of the no-action alternative for establishing the baseline condition. The Nushagak Cooperative's proposal for the Nuyakuk Project is an entirely new project. This presents a favorable opportunity to establish baseline conditions without previous development impacts influencing the river environment or the fish habitat. Our study requests, Attachment #2 are derived from this circumstance.

SD1 Section 3.2.2 Proposed Project Operation

The PAD states "a minimum instream flow of 1,000 cfs will be provided through the bypassed reach, while the remainder of the available flow will be passed through the powerhouse." This is in conflict with the Alaska Statute AS § 41.21.167(e) allowing this to be built in the state park, but requiring the utility to leave 70% of the flow in the river.

SD1 Section 3.2.3 Proposed Environmental Measures

The section only identifies protection measures for terrestrial resources. The PAD and additional information request response include proposed measures for fisheries resources that includes a minimum flow in the bypass reach, barrier fencing at the tailrace, and a concrete water diversion groin to deflect upstream migrating adult salmon away from the intakes. These features all need evaluation for their potential merit.

In addition to screening other measures should be investigated to keep smolt away from the intakes. Smolt of the five salmon species vary in size and swimming ability, and smolt size varies within a species based on the amount of time they have reared in fresh water. Keeping the smallest smolt out of the intake will be challenging. It would be preferable to explore methods to move the majority of smolt to river left and away from the intake.

SD1 Section 4.1 Cumulative Effects

The project will reasonably result in foreseeable future actions. The addition of >100 miles of transmission lines may result in improved access to undeveloped and pristine habitats. Also, the reliable and low cost electricity may result in additional settlement at existing villages. Inexpensive power could make mining more viable, and this would affect water quality, fisheries and habitat.

SD1 Section 4.2.2 Resource Issues, Aquatic Resources, Fisheries

Project operations will affect the movement of juvenile salmon during their out migration. This list of resource issues should include effects of the project diversion structure and reduced flows in the bypassed reach during project operation on downstream fish passage.

Effects of the project diversion and intake structures and reduced flows in the bypassed on fish passage should include success of passage past the project area as well as the potential for delay during adult upstream migration (e.g., how long it takes to pass the project area).

This project is highly unlikely to affect water temperatures. There is no impoundment and the water will pass through the tunnel, penstock and turbines in less than a minute.

SD1 Section 5.0 Proposed Studies

We support the identified studies in Table 1 for Water Quality and Quantity, and Fisheries Resources. We offer additional recommended studies in Requested Studies below.

SD1 Section 9.0 Plans

Please include the *Nushagak River Watershed Traditional Use Area Conservation Plan* by the Nushagak-Mulchatna Watershed Council in the list of plans.

Attachment 2

National Marine Fisheries Service's Study Requests for the Nuyakuk Project (FERC No. P-14873)

February 3, 2020

The National Oceanic and Atmospheric Administration's, National Marine Fisheries Service hereby files these seven study request for additional information and study with the Federal Energy Regulatory Commission for Dillingham Cooperative's (Applicant) Nuyakuk River Project (P-14873) in Alaska.

We recommend the following seven studies be conducted during the study phase of the relicensing activity. Each study is supported using the Commission's study plan criteria 18 CFR 5.9(b). Several of these studies compliment data gaps identified by the Nushagak Cooperative in the Pre-Application Document (PAD). Information derived from each of these studies will inform the decision process during this licensing action.

Study 1: Fish Distribution, Timing of Migration, and Abundance

Study 2: Upstream Fish Passage through Nuyakuk Falls

Study 3: Downstream Passage and Intake Design

Study 4: Flow Duration Curve Change Analysis

Study 5: Future River Flows and Water Temperatures

Study 6: Ice Processes Assessment

Study 7: Assessment of False Attraction at the Tailrace Fish Barrier

Study Request 1
Fish Distribution, Timing of Migration, and Abundance

Background

The PAD indicates 24 fish species are present in the larger Nushagak Watershed, approximately 11 of which are anadromous. Not all 11 species will pass Nuyakuk Falls or even be in the Nuyakuk River. Determining the timing of upstream and downstream migration and estimating the approximate run size of each anadromous species will inform the decision process for developing protection measures. There is extensive data on the presence of sockeye salmon especially on the lower stretches of Nuyakuk River (Brennan et al. 2019). The Alaska Department of Fish and Game (ADF&G) counting tower has data on returning sockeye from 1959-1988 and then from 1995-2006. The Fisheries Research Institute (now called Alaska Salmon Center) at University of Washington has collected data on a variety of species in Wood Tikchik State Park and the Nushagak Watershed since the 1940s.

Content of Study Request (18 CFR § 5.9 (b))

1. **§ 5.9 (b): 1.0 Goals and Objectives of Request**

   The goal of this study is to determine which anadromous species are present in the Nuyakuk River in the five miles between Tikchik Lake and the bottom of Nuyakuk falls, the timing of returning adult and outmigrating smolt of each anadromous species. Four objectives are:

   a. Determine which anadromous species exist above Nuyakuk falls.
   b. Determine run timing for the returning adults and outmigrating smolts. This assessment could be based on previous work in other Bristol Bay rivers with similar characteristics (e.g., drainage area, lake size, elevation). It is important to have migration timing dates from several years on each species to evaluate inter-annual variation.
   c. Determine the relative run size of each anadromous species passing above the falls. The study should incorporate historical data (such as the ADF&G counting tower), as well as present day data.
   d. Determine if any other lifecycle process/stages, besides migration, occur in the project's boundary (micro-habitat considerations).
      i. Are there pools that function as holding areas within the cascade where fish rest between burst of energy to make it through successive difficult cascades?
      ii. How close is the nearest red and rearing area to the top of the falls?
      iii. Are there any areas within the cascade reach that potentially support spawning (overlap with Study 2, criteria 6, step b)?
      iv. Do redds exist in the proposed area for the tailrace, intake structure, or groin?

2. **§ 5.9 (b): 2.0 Resource Management Goals**

   The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans which support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

   Section 18 authority of the Federal Power Act (16 U.S.C.§ 811) allows the Department of Commerce to either prescribe fishways at the project or to reserve its prescriptive authority.

3. **§ 5.9 (b): 3.0 Relevant Public Interest Considerations**

   The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. **§ 5.9 (b): 4.0 Existing Information and Need for Additional Information**

   Data are available about fish presence/absence in the Nuyakuk River from both ADF&G and Fisheries Resource Institute at University of Washington. The ADF&G counting tower has data on sockeye escapement from 1959-1988 and then from 1995-2006.The counting station is located approximately twenty miles downriver of the project. Data also exists at the same institutions on the timing of returning adults of some species.

   For addressing the smolt outmigration timing question, information from the outlet of other large lake at a similar elevation in the Bristol Bay watersheds would be useful. Data being collected on the Kvichak River during the springs of 2020 and 2021 should be taken into account (Igiugig, P-13511). Particular attention should be paid to the start of smolt outmigration which is often prior to breakup, however, this time period has rarely been studied. The smolt which have a predisposition to emigrate earliest may actually be the most important ones to protect, as that is the adaptive trait they may need as the trends of climate change progress.

   Most studies have focused on sockeye, with much less focus on Chinook, coho, chum and pink salmon. Until studies indicate differently, we consider all five species present in the Nuyakuk River with substantial runs. While Dillingham's canneries currently process primarily sockeye and pink, it should not be assumed that only those species will be processing throughout the 50-year license. We need to know the timing of migration for every anadromous species and design the intake and tailrace to avoid harm to any of the species.

   The PAD implies that fish pass through the cascade as quickly as possible. This may not be the case. The slower sections of the ½ mile long reach should be investigated for spawning, rearing or holding areas. These areas could be critical for passage as fish likely do not make it up a ½ mile long cascade in a single expenditure of energy.

5. **§ 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements**

The proposed project will affect the volume of water flowing through the Nuyakuk cascades. Therefore, the project will directly affect the habitat characteristics that support anadromous fish migration through this river reach. Different species have different sustained and burst swimming speeds, and require different habitat characteristics to pass successfully through a cascade or up a falls. Knowing which fish species are present and when will inform the quantity of water necessary to ensure suitable habitat function during the salmon migration periods. Some of these fish will swim through Tikchik and Nuyakuk Lakes to spawning areas in tributary streams many miles away, therefor, delaying adults a week or two below the falls could lead to a decrease in spawning success with implications on the productivity.

The project intake could entrain and impinge smolt outmigrating to the ocean. This represents new hazards created by the project. It will be important to understand the chance of blade strike or other injuries if fish pass through the turbines. Without knowing which smolt species are likely to be present, there is no efficient way to design fish screens or other physical deterrents to entrainment, and no means for evaluating blade strike probability. Also, lifecycle and behavioral characteristics vary among species. The intake screen design and behavioral deterrents need to consider these differences.

An improved understanding of which species pass at which times, and how they use the cascade will be critical for determining how much water must be left in the river during migration periods, and the design of mitigation measures.

6. **§ 5.9 (b): 6.0 Consistence with Generally Accepted Practice**

Determining species presence, migratory timing, and abundance is standard practice for new hydropower development and licensing actions. This data helps identify potential project impacts and the baseline condition. Site specific monitoring should be completed seasonally over at least two years as fish runs vary greatly among years. Current data should be collected to supplement any older data sets.

Standard fish inventory methods such as fish towers, fish wheels, acoustic counts, mark-recapture and snorkel surveys are common practice for adult escapement. Minnow traps, acoustic counts, and video coupled with artificial intelligence for enumerating fish are used to count outmigrating smolts. We support all these methods and looks forward to discussion on specifics in technical work group meetings.

Environmental DNA (eDNA) is a new method that might be a cost effect method for presence and abundance. We encourage the fisheries working group to consider this method especially to learn more about rare species.

Objectives (a), (b), and (c) do not need to happen in the falls reach. The safer work areas well above the cascade would yield the same species, migration timing, and abundance estimates. Study d does need to happen in or close to the cascade. We understand that it will not be possible to study every part of the cascade.

7. § 5.9 (b): 7.0 Considerations of Level of Effort and Cost

The required effort is commensurate with the size of the project and the requirements of an original license. The stated purpose of this project is to power canneries that process multiple species of anadromous fish. We are seeing with the collapse of the Pacific Cod fishery, a once thriving industry. Even though the Dillingham canneries process primarily sockeye and pink today, they may be reliant on another species during the 50-year license term.

Anadromous fish counting methods require surveys for migrating fish at the proper time of the year. This may require automated methods and personnel staying on site for extended periods that cover the adult and juvenile migration season. We recommend some combination of automation and people on the ground as automated systems often need human intervention. Two years of data may provide the applicant with a reasonably defined timing window and a robust estimate of abundance for most species; for one or two species more targeted methods would need to extend into a third year. Additionally, unanticipated problems often cause the first year of fish surveys to be less informative. ADF&G has proven effective at fish studies on the Nuyakuk and Nushagak rivers over the several decades and we will work closely with them and other interested parties to determine the best methods and the level of effort required.

Study Request 2
Upstream Fish Passage through Nuyakuk Falls

Background

Pacific salmon and other fish species are able to migrate up the fall with flows from 15,000 to 4,000 cfs (July – October typical flows). The applicant proposed leaving a minimum of 1,000 cfs in the river reach between the project intake and tailrace. River flow conditions are critical to supporting fish migration, and other ecological functions. No data exists to indicate the proposed bypass base flow will provide safe, timely, and effective passage for returning adult salmon and maintain the channel characteristics and baseline aquatic connectivity. Therefore, it is imperative that the applicant determine which species can pass up the cascade at which flows. We recommend the applicant complete a study to assess the relationship between river discharge and the accessibility of habitat for migrating fish. Data collected during this study will inform recommendations for optimal instream flow requirements for fish passage during different seasons of the year.

Content of Study Request (18 CFR § 5.9 (b))

1. **§ 5.9 (b): 1.0 Goals and Objectives of Request**

   The goal of this study is to determine an appropriate flow regime that will protect anadromous fish migratory habitat in the bypass reach between project intake and tailrace. The objectives of this study are:

   a. Document zone of passage habitat characteristics within the bypass reach.
   b. Assess the effects of proposed project instream flows on the wetted area and optimal passage habitat for target species.
   c. Determine optimal and minimal flows to maintain migratory habitat in the bypass reach. The target fish species used to evaluate habitat value should include all diadromous species that pass through the cascade (see Study Request 1).

2. **§ 5.9 (b): 2.0 Resource Management**

   The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in NOAA's Strategic Plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

   Furthermore, Section 18 authority of the Federal Power Act (FPA) allows the Department of Commerce either to prescribe fishways at the Project or to reserve its prescriptive authority.

3. **§ 5.9 (b): 3.0 Relevant Public Interest Considerations**

   The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. **§ 5.9 (b): 4.0 Existing Information and Need for Additional Information**

   Presently, there are no data available relating adult passage suitability through the cascade to river flow for any of the five salmon species through the cascade. Data generated by this study request does not currently exist. We know that the cascade drops 26 feet over a half mile reach. Some salmon, pass through the falls at flows between 4,000 cfs and 15,000 cfs

5. **§ 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements**

   The Nuyakuk River supports sockeye, Chinook, chum, coho and pink salmon, and a few additional anadromous fish. These Bristol Bay salmon stocks have evolved to reach suitable spawning/rearing habitat to complete their life cycle with natural river conditions. Their migration behavior is adapted to a variable hydrograph both within the year and between years. These natural conditions form the baseline condition.

   The proposed project will divert substantial flow from a critical reach in the Nuyakuk River where returning adult salmon are challenged by a series of cascades and small falls. This represents a direct project related impact on valuable public trust resources. Presently, there are no data to indicate how that change in flow conditions will affect fish migration. Absent site specific data, we are unable to determine the scope of impacts on migration behavior and the need for mitigation measures. The requested study characterizing the relationship between flow and passage suitability in the bypassed reach is needed to establish baseline; evaluate potential effects (e.g., delay, stranding) of project operations on migration of adult and juvenile salmon in the proposed bypass reach; and inform the development of protection measures for fisheries resources.

6. **§ 5.9 (b): 6.0 Consistency with Generally Accepted Practice**

   Bypass flow habitat assessments are commonly employed in developing instream flow requirements intended to mitigate project related impacts on aquatic resources and their habitat. Given the length of the bypassed reach (0.5 miles) and the millions of culturally and commercially important fish known to pass through the reach (sockeye, Chinook, coho, chum and pink salmon), a combination of field measurements, modeling, and professional judgement should be used. At a minimum, the study design should involve modeling wetted perimeter, depth and velocity data within a range of flows along cross sections located in the reach of river between the intake and the tailrace. Cross section locations should be assessed on site to select the most informative locations. This information then should be synthesized to quantify habitat suitability (using mutually agreed upon Habitat Suitability Index curves) of each flow, as appropriate, and for target species/life stages identified by the resource agencies. Habitat modeling using Physical Habitat Simulation Modeling System's one-dimensional modeling is a possible method.

We recommend the following tasks to meet the goals of this study request:

a. Complete a detailed survey of channel bathymetry from 1,000 feet above the intake to 100 feet below the tailrace. Use sufficient point cloud coverage to produce 1 foot contours. This channel bathymetry could be obtained with water-penetrating green light LIDAR. We recommend using green LIDAR at two flows to assess the precision of the technology used at different water depths.

b. Identify the channel bottom substrate to the extent possible: bedrock, boulder, large cobble, or gravels to assess potential spawning areas and channel permanence.

c. Install pressure transducer at the two boundary cross sections (1,000 feet above and below the falls) and check them approximately every two weeks. The transducers should be maintained in place until flows from approximately 1,500 - 15,000 cfs have been recorded. This data will be used for model calibration.

d. Develop a two-dimensional physical flow model to assess velocities and depths throughout the cascade at a range of flows.

    i. Boundary conditions cross sections should be set up 1000 feet above and below the falls.

    ii. There should be sufficient detail for the model to determine water depths to within 6 inches and velocities to within 2 feet/sec through the cascade at discharges from the minimum proposed instream flow to 50th percentile flow in the highest month.

    iii. Calibrate the model using the boundary stage measurements and two flows: one within 10% of the lowest flow at the USGS gage in the 2021 - 2022 water years; one approximately the 50th percentile flow for the highest flow month (July).

    iv. Validate the model at two flows: Measure velocity and depth throughout the cascade to validate the model. This could be done by attaching a floating acoustic Doppler current profiler (ACDP) vessel to a fixed line strung across the cascade. In general, these lines should be spaced 300 feet apart, but in sections with consistent bathymetry they could be more spread out. Validate at one flow which is the least amount of water the applicant is requesting to leave in the river mid-winter; validate a second time at the mean late summer flow the applicant plans to leave in the river when adults sockeye return. We recommend the applicant receive prior agreement from the resources agencies that the target validation flows are acceptable to all parties.

e. Run model simulations at 1000 cfs, 2000 cfs, 4000 cfs, 8000 cfs and the 2-year return flow (or bank-full flow). If it comes to debating the minimum flows for the license, the resources agencies may ask for another simulation.

f. Analyze the ability of each target species to swim through the cascade given their swimming/jumping abilities in peer reviewed literature during each model simulation.

g. Analyze whether any current spawning areas will be inaccessible to fish or whether any holding pools will become disconnected from the main flow during each simulation.

h. Velocity and depth measurements can be completed from an unmanned watercraft with a ADCP moved across multiple fixed lines strung perpendicular to the channel. Any methods used should consider safety first.

7. § 5.9 (b): 7.0 Considerations of Level of Effort and Cost

This effort may require a three-person team to make four trips to the site. An initial multiday trip to fix the lines perpendicular to the cascade, followed by additional shorter trips. An ACDP remote vessel cost approximately $25,000 or could be rented. We are open to discussing alternatives that meet the objectives to the stated levels of precision. The cost and level of effort of this study is commensurate with a project being proposed on a river that has an average return of 370,000 sockeye in addition to four other returning salmon species.

Study Request 3
Downstream Passage and Intake Design

Background

The Nuyakuk River supports a regionally important commercial, subsistence, and recreational fisheries run of sockeye salmon, as well as the four other Pacific salmon species and other anadromous species. In order for these runs to continue, juvenile life stages must pass downstream unharmed. The applicant must demonstrate that the proposed project will neither impinge nor entrain smolts at the project intakes. The proposed project will need to incorporate design features that support safe, timely and effective passage past the project works. We recommend referring to our agency's design criteria for screening intakes (NMFS 2011) to evaluate design features for the proposed action.

The proposed intake structure as described in the PAD and the applicant's additional information request response (accession # 20191114-5100) illustrates a 100-foot wide intake associated with a concrete groin. While the concrete groin is shown to have a sluice gate, there are no defined measures for preventing the migration delay, entrainment, or impingement of juvenile Pacific salmon. We are also concerned that this groin may exacerbate frazil ice development near the intake. As a newly proposed project, the applicant has the opportunity to incorporate design features that protect juvenile pacific salmon that are critical to sustenance harvest, and are commercially and recreationally valuable in this region.

The applicant proposes to complete a two-dimensional river hydraulic model for approximately 1,000 linear feet above the Nuyakuk Falls to aid in proper development of the intake diversion hydraulic and structural design (see study request 2). Complex flow fields can occur upstream of the entrance to powerhouse intakes. With respect to downstream fish passage, it is imperative to understand the direction and magnitude of flow fields that are upstream of the turbine intakes in order to inform license conditions that may improve downstream passage. In addition, three-dimensional CFD modeling can be used to identify where and during what operational circumstances excessive velocities occur at the turbine intakes – a project-related effect that can lead to entrainment or impingement related injury or mortality to downstream migrating fish. Three-dimensional CFD modeling is a precursor to downstream fish passage concept designs, as water velocities and flow directionality are an important component to guiding fish towards a safe downstream passage.

The screened intake is the most critical design element of this project and is extremely important for protecting the salmon run. If the applicants contends that some smolt can pass through the turbine with neither blade strike nor other injuries, we recommend they provide examples from studies from other existing similar with similar turbines.

Intake structure icing has created significant issues for the Tazimina Project; we encourage the applicant to contact Iliamna Newhalen Nondalton Electric Cooperative, Inc. (INNEC) to discuss icing with their operators and designers.

Content of Study Request (18 CFR § 5.9 (b))

1. **§ 5.9 (b): 1.0 Goals and Objectives of Request**

   The goal of this study request is to evaluate conceptual alternatives in concert with the CFD modeling, for design features that protect outmigrating salmon smolt. The study objects include:

   a. Complete a literature search of intake designs with and without designated bypasses that mitigate entrainment of salmon smolt in areas subject to frazil ice. Evaluate physical exclusion measures.

   b. Complete a literature search of any behavioral or upstream measures that would move the majority of smolt to river left away from the intake. Evaluate behavioral exclusion measures.

   c. Propose multiple project intake designs with screens, and with and without designated bypass facilities based on other functioning hydropower intakes to eliminate or minimize entrainment of smolt and address frazil ice.

   d. Do a feasibility analysis and select an intake design in consultation with the resources agencies.

   e. Obtain bathymetry data sufficient for 1-foot contour intervals or 15% of the average river depth at 2,000 cfs, whichever value provides more precision. The area covered should be the top of the falls to three river widths above the intake structure. The bathymetry data collected during the Upstream Passage Study Request 2 may be sufficient.

   f. Develop a CFD model that simulates three-dimensional flow from the top of the falls to three river widths above the intake facility. At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain shall be of sufficient size and mesh to characterize the hydraulic environment. The final product from this objective is a series of layered drawings that show velocity magnitudes at intake flows that have been agreed upon by the resource agencies and the applicant. Run simulations at the following flows:

      i. River flow vectors in the intake vicinity at full powerhouse capacity plus proposed minimum flow (1,000 cfs) in the river;

      ii. River flow vectors in the intake vicinity at 50% powerhouse capacity, and proposed minimum flow (1,000 cfs) in the river;

      iii. River flow vectors in the intake vicinity at 80% exceedance on the existing April through November flow duration curve and 70% of the flow left in the river. Most climate models predict higher flows in May and October. This will not change the total range of flow analyzed.

      iv. The CFD modeling should also be conducted for at least these ten operation modes for the selected intake design. If these CFD model results indicate substantial entrainment during smolt outmigration, we may ask the applicant to consider another intake/screen design. The results will demonstrate velocities and flow orientations at the intake. If the 80% exceedance flow is substantially the same in two months, it may not be necessary to model both flows.

v. This CFD model must also be calibrated with existing conditions. We will work with the applicant to agree on specific methods and standards.

g. Use the CFD model to simulate how the velocities into the selected intake structure will be less than the sweep (perpendicular velocities) allowing smolt to be washed downstream rather than impinged on the intake screen surface. Please refer to our fish passage design criteria (NMFS 2011).

h. Field test a scaled down screen and intake exclusion device and place it in the river and run it with pumps for a trial winter and spring to assess the potential for ice development. Tagged smolt could be evaluated to see which ones manage to avoid the intake. If the full-scale sized screen ices up the first or second winter, diesel cost for six communities will mount quickly.

2. § 5.9 (b): 2.0 Resource Management Goals

The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019b) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

Section 18 authority of the Federal Power Act (16 U.S.C.§ 811) allows the Department of Commerce either to prescribe fishways at the Project or to reserve its prescriptive authority.

3. § 5.9 (b): 3.0 Relevant Public Interest Considerations

The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. § 5.9 (b): 4.0 Existing Information and Need for Additional Information

An extensive record is available pertaining to downstream passage of juvenile salmon. However, the site specific conditions need documentation to develop the appropriate screen design. The influence of ice in this part of the country needs consideration as well. Presently there are no data to address the flow field in the project area. The proposed volume of water withdrawal and the project's remoteness make this project unique. This project may also experience a wider range of mid-winter and spring temperatures than more inland projects. Temperature that can fluctuate between above freezing to negative 10° Fahrenheit in the same week greatly complicates understanding ice formation at intakes. The applicant has not provided a functional design of the intake at the proposed facility.

5. § 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements

The proposed project intake will affect migratory fish as they move through the project area. Outmigrating smolt are susceptible to injury or death via entrainment and impingement – a direct nexus to project-related effects. If fish protection measures are not considered during design, the potential project related mortality will have a direct effect on fish populations by reducing population size and capacity for future reproduction and population growth. Results of this study are essential for a complete understanding of the project's effects to downstream migrating juvenile salmon. Data derived from this study will contribute to the development of an administrative record in support of the Commission's licensing process and mitigation opportunities.

Data from this CFD model objective of this study will also be crucial to the Ice Processes Assessment (Study Request 6).

6. § 5.9 (b): 6.0 Consistency with Generally Accepted Practice

This study request will require a review of existing downstream fish passage technologies that meet our fish passage design guidelines (NMFS 2011) for intake screening and downstream fish passage structures. This work will also consist of conceptual engineering designs of fish passage protection alternatives that include physical screening of fish to minimize entrainment, and relative velocities directing fish to the downstream passage. The applicant should develop downstream fish passage alternatives for the project based upon current guidelines (NMFS 2011) The options being studied, the depth and breadth of the conceptual design, the need to combine with the requested CFD modeling, should be agreed upon with the resource agencies in a study plan prior to conducting the study.

Three-dimensional CFD modeling is a common analysis at hydroelectric projects around the nation. Example from the northeast region where these models were developed include the Holyoke (P-2004), Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534), and Weston (P-2325) Projects. We would expect to consult with the applicant and other resource agencies to determine the appropriate area and flows modeled. Given the large number of ways that output from these models can be presented and the near infinite number of flows that could potentially be modeled, we would expect to consult with the licensee to reach agreed upon modeling efforts and scenarios to be examined.

Fish passage engineering alternative studies are an established and a typical means to evaluate options in the decision making process. This type of assessment has been used by the Commission in many licensing proceedings to support decisions at hydro projects during licensing.

7. § 5.9 (b): 7.0 Considerations of Level of Effort and Cost

The level of effort and cost is commensurate with a project the size of the Nuyakuk Project and the likely 50-year license term. Subsistence harvest of salmon provides a significant portion of these communities' diet and processing fish is the main economic driver for several of the downstream communities. The expense to understand the effects on outmigrating smolt and protecting this valuable resource is reasonable. No alternatives were proposed. Objective (a) through (e) will likely take a year and involve meeting with the resource agencies multiple times. Objectives (f) and (g) may take an additional 6 months. The cost of developing, running, and testing a CFD model is variable. If the first runs suggests a different design needs to consideration, this will take more time. Proactive communication with resource agencies will reduce the cost and iterative effort. Objective (h) will take approximately one year to design, fabricate, and install, and then need testing during a winter/spring season.

Study Request 4
Flow Duration Curve Change Analysis

Background

Published studies indicate shifting climate conditions for Bristol Bay watershed over the next century as a result of climate change (Wobus 2015). During the term of any new license for this project, Southwest Alaska will experience increasing temperatures and increasing annual precipitation (Walsh 2018). The resulting changes in environmental conditions during the next 30-50 years will influence project operations, scope and scale of project related impacts, and the effectiveness of mitigation measures (e.g., fish passage). This study will help identify trends in flow conditions to provide a forward-looking evaluation of the flow duration curve. Data from this study can be used to inform the licensing process with specific application to project design, operation and fish protection measures. The applicant suggested this study, or a very similar one, during the November 18, 2019 project kickoff meeting.

Content of Study Request (18 CFR § 5.9 (b))

1. § 5.9 (b): 1.0 Goals and Objectives of Request

The goal of the study is to evaluate changes in the flow duration curve for the Nuyakuk River that have happened during the 67-year USGS 15302000 gage record. This study request will not analyze climate projections or future flows. The objectives of this study are:

a. Determine if flow pattern observable for the USGS Nuyakuk River gage record exhibit stationarity as hydrologist assumed for decades, or if there is a statistically significant trend (Milly 2008) consistent with other gage records in Northern climates where a change analysis has been completed.

b. Use the appropriate data to inform the development of climate resilient license articles. This is a statistical study using peer reviewed existing USGS flow data.

2. § 5.9 (b): 2.0 Resource Management Goals

The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019b) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in NOAA's strategic plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

3. § 5.9 (b): 3.0 Relevant Public Interest Considerations

The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. **§ 5.9 (b): 4.0 Existing Information and Need for Additional Information**

   The existing flow duration curve relies on methods developed prior to our current understanding of climate, especially that rainfall and temperature are variable between years and months, but overall tied to a static horizontal line (stationarity). The analysis that will indicate if stationarity (Milly 2008) exists at the Nuyakuk gage. This evaluation has not been completed for this USGS gage record. This analysis may only apply to the months in the sufficient hydrograph data are available.

5. **§ 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements**

   River flow and its seasonal patterns directly influence project design and operations, and mitigation measures intended to protect public trust resources. As this is a new project development, the applicant should consider the changing environmental conditions on which their project is dependent for successful operation. As flow patterns change, changes in project operations often occur. The Bradley Lake Project (P-8221) licensee decided to stop diverting water on November 1 based on records from the historical record. Historical data indicated no flow worthy of diversion during mid-winter. In 2019, both November and December saw 1,000's of acre feet flow down Battle Creek as large precipitation events arrived primarily as rain. Likewise, project operations influence the behavior of migrating fish within the project area. The information collected by this study would support the analysis of direct and cumulative effects of the proposed project on migratory fish and aid in the development of any necessary license articles regarding measures to achieve fish passage. If this watershed runoff pattern is non-stationary, then design consideration, operations models and license articles should be flexible enough to deal with change.

6. **§ 5.9 (b): 6.0 Consistency with Generally Accepted Practice**

   Studies should use current literature, existing data from the USGS gage (USGS No. 15302000), and standard practices accepted by the scientific community. A change analysis is a standard Bureau of Reclamation analysis method. Many utilities with hydropower projects are employing it for their decision making processes.

7. **§ 5.9 (b): 7.0 Considerations of Level of Effort and Cost**

   All the data necessary to complete this study are available. The analysis could be completed within two to four months. The level of effort and cost is commensurate with the proposed project size and the likely license term. No alternatives have been proposed.

Study Request 5
Future River Flows and Water Temperatures

Background

An understanding of future flows and stream temperatures is necessary to inform the design of project infrastructure, including fish passage protection measures, and project operations. The best available science indicates temperature, precipitation, and stream flows will increase in the Bristol Bay region, and much of south central Alaska (IPCC 2018; Walsh 2014; Walsh 2018). Thus, higher stream flows and volume are likely within the project area during the prospective license term. Peer-reviewed, publicly available downscaled climate model projections have been developed for this region. These model projections should be analyzed to support flow analysis for this project. We request that the existing peer reviewed climate model predictions be used to model future discharges and water temperatures for the Nuyakuk River, in accordance with peer-reviewed published methods and generally accepted practice as described below. This information will inform the development of license articles guiding operation and maintenance, including mitigation measures, as well as the development of a climate resilient project design.

The Nuyakuk River supports a commercial, subsistence and recreational sockeye fishery, as well as the four other Pacific salmon species. These species rely on these riverine systems for refuge, spawning, rearing and nursery habitat. The Nuyakuk River and Tikchik Lake supports the second largest sockeye run in the world; second only to the Kvichak River and Lake Iliamna. Adult sockeye pass through the Nuyakuk cascade to spawn in the lakes above. Smolts pass back down the cascade on route to the ocean to mature. Furthermore, the timing of adult escapement and smolt outmigration is keyed to water temperature, which is strongly affected by air temperature (Mauger et al. 2016) and projected to change with increasing air temperature.

Many of the climate change effects described below have likely impacts on salmonids (Leppi 2014; Wobus 2015). Given that increased flows are projected by the five member ensemble of global climate models (GCM) best fitted for Alaska, these increases provide opportunities to benefit both the hydropower generation and fish management and protection. Therefore, it is critical to have estimates of future flows and stream temperatures to assess the combined effects of the project and climate on these trust resources. This study is at the core of producing more evenly distributed year-around hydropower generation, while at the same time protecting and maintaining this salmon fishery. This is in line with recent literature that highlights opportunities to design and operate hydropower projects for sustainability of both power production and the riverine environment (Brown et al. 2015; Poff et al. 2016). Thus, our study request will identify forward looking, climate resilient outcomes for hydropower development and fisheries.

Trends in the Region

We included published literature and first hand observations from 2019 for the Bristol Bay Watershed. Documented trends include (Thoman 2019):

- Increase of 3.7º F in air temperature in the Bristol Bay region, 1969-2018
- Increase of 13 percent increase in annual total precipitation in Bristol Bay Region, 1969-2018

- Lowest sea ice extent in Bering Sea in February 2019 in last 170 years
- Nearby King Salmon had 26 record warm daily temperatures and a single record low from 2014-2018

Bristol Bay has rarely frozen in the last decade; people and animals used walk or sled to the nearby islands mid-winter on a regular basis (Markoff 2019).

Nuyakuk Watershed Hydrology

The proposed project will be located on the Nuyakuk River at a cascade approximately five river miles downstream from the Tikchik Lake outlet which drains the northern Wood River Mountains, a 1,544 square mile watershed. The watershed contains six large lakes which comprise 12 percent of the land area. An additional 50 percent of the watershed is below 1000 feet in elevation. While the highest peak is over 5,000 feet, the vast majority of the watershed is below 3,000 feet in elevation. There are no significant glaciers; permanent snowfield make up less than 1% of the watershed. The proposed project would divert water out of the river above Nuyakuk Falls, pass it through a tunnel(s) to a powerhouse located at the base of Nuyakuk Falls. Nuyakuk Falls is a ½ mile long cascade with only 28 feet of elevation change. Below the project site, the Nuyakuk River meanders and braids 40 miles before converging with the Nushagak River, which flows to Bristol Bay. The Nuyakuk watershed drains the west side of the Nushagak River basin. The Koktuli River, another tributary to the Nushagak that was modeled in a project discussed below, drains from the east side of the Nushagak.

There is a 67-year USGS gage record at Tikchik Lake outlet for spring through early fall flows and a shorter, more intermittent, record for winter flows. The lowest mean daily winter flows this decade are approximately 2,000 cfs, with the flows dropping below 1,500 cfs during two winters. A broad, snowmelt-driven peak arrives in early June and remains through mid-August. The flow typically remains above 10,000 cfs for two months with a peak flow between 15,000 and 22,000 cfs. Half of the Octobers in the last decade have had a second peak over 10,000 cfs lasting days to two weeks. The Nuyakuk River hydrograph is not flashy, because it has six large upstream lakes.

Relevant Climate Studies

Future River Flows and Water Temperatures study request would employ the data from an existing peer-reviewed ensemble of downscaled GCMs (Walsh 2018; Wobus 2015) and use a hydrologic model to project mean monthly (at a minimum) or daily Nuyakuk River discharges and stream temperature. The Wobus and Walsh climate projections, each based on five state of the art models developed for the Intergovernmental Panel on Climate Change (IPCC), provide mean monthly precipitation and air temperatures in the Nushagak watershed during the license term. They project a range of plausible future scenarios.

Recent peer-reviewed studies have described the changes projected by the most recent generations of IPCC models. Wobus et al (2015) used downscaled climate data to assess flow changes in other parts of the Nushagak basin, finding large changes in monthly temperature and precipitation projected based on five global climate models (Figure 1). Furthermore, numerous high flow events (green and red lines) would be expected throughout the winter (Figure 2). Leppi et al (2014) linked climate scenarios from GCMs and habitat models for the Chuitna River basin in south central Alaska and used this in a coho salmon population model to assess how projected climate change could affect survival at each freshwater life stage and, in turn, production of coho salmon smolts. Relevant for the Nuyakuk basin, this study finds a significant increase in peak discharge, temperature and other stream variables at several points in the salmon migration and development period.

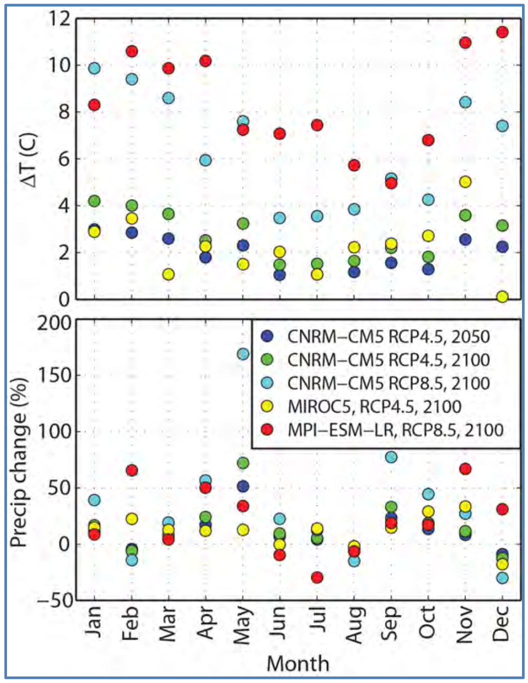

Figure 1. Monthly Changes in future temperature and precipitation projected for five GCMs (Figure 3 in Wobus et al. 2018).

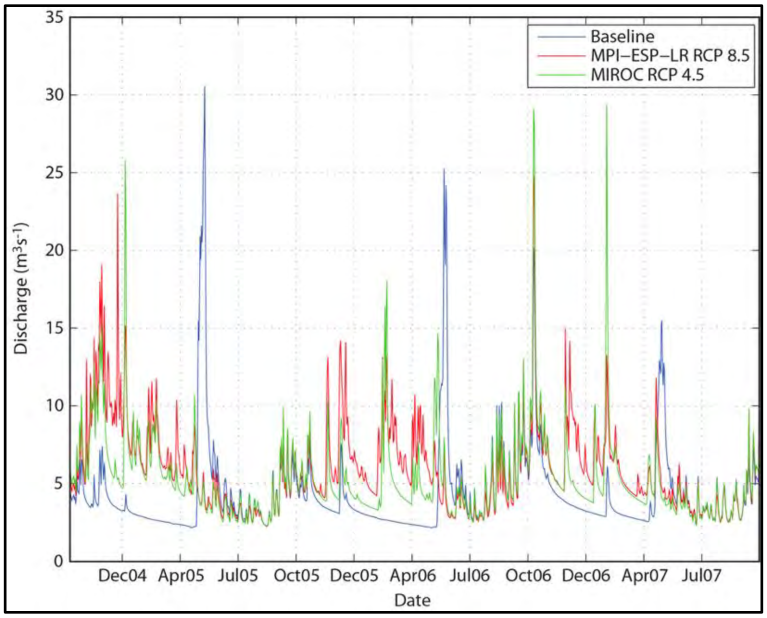

Figure 2. Changes in Hydrograph for Upper Talarik Creek Gage Site in 2100, for Lowest and Highest Temperature Scenarios. Note the loss of the spring pulse (freshet) in both future climate simulations. (Figure 6 in Wobus 2015). Talarik Creek is on the east side of the Nushagak River drainage, while Nuyakuk is on the west side. While the two are 70 of miles from each other, the Nuyakuk has higher mountains in its headwaters and the watersheds are different in other ways, so while the results provide an estimate, they cannot replace analysis of the Nuyakuk basin.

Content of Study Request (18 CFR § 5.9 (b))

1. § 5.9 (b): 1.0 Goals and Objectives of Request

The goals and objectives of this study are to determine mean flows and water temperature during the term of the license, at least at a monthly time scale, and daily if feasible. Details of the recommended study are provided in the Generally Accepted Practices section below. NOAA Fisheries and its NOAA climate science partners are available and willing to discuss the details of the climate and flow studies to ensure its value for all parties. We assume a 50-year license will be issued, and total development time will be 8 years, so evaluate 2027 to 2077. The objectives of this study are:

1. Use existing climate projections (Walsh 2018; Wobus 2015) to model and predict Nuyakuk River flow and temperatures during the license term. These should be done at least at a monthly time scale and daily if feasible.
2. Use this information to determine the future timing of returning adult salmon and when water will be needed in the river (license conditions) to support fish passage up the falls. This information will inform the Upstream Passage (Study Request 2) and Tailrace False Attraction (Study Request 7).
3. Use this information to project timing of outmigrating smolt. This information will inform the Ice Process (Study Request 6) and Intake Design (Study Request 3).

4. Use future flow information to inform turbine sizing and maximize winter, spring and fall energy production.
5. Use future flow information to inform project design and operation including tunnel design, groin design and any attempt to mesh winter hydropower with other electric generation facilities to meet domestic winter power demands of the six communities.

2. § 5.9 (b): 2.0 Resource Management Goals

The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019b) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in this plan is the long-term goal of healthy oceans support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

3. § 5.9 (b): 3.0 Relevant Public Interest Considerations

The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. § 5.9 (b): 4.0 Existing Information and Need for Additional Information

Existing, baseline flows in the Nuyakuk River are likely to change in the coming decades due to the effects of climate change. The climate-induced changes to baseline conditions will interact with the project diversion of substantial flow from a this critical Nuyakuk Falls reach where migrating fish are challenged by a series of cascades and falls. Thus the project related changes to the baseline condition will interact with the effects of climate change.

Information exists for the support of this study request. Walsh 2018, in a project at the University of Alaska, have recently published downscaled monthly climate data for Alaska that includes this region. A hydrologic model of future flows exists for the Koktuli River (Wobus 2015), a tributary of the Nushagak, that could be adapted for the Nuyakuk. Wobus (2015) developed projections of air temperature and precipitation for the upper Nushagak and Kvichak rivers; they do not project flows or temperature in the Nuyakuk River. Several studies have documented climate induced changes in flows and stream temperature in other areas of southcentral (Leppi 2014; Winfree 2014). The methods from these studies could be replicated. The steps and data available to complete the analyses are described below at the end of this study request.

Projected future daily flow values would better inform the project design and license review process than projected future monthly flows. For example, knowing the projected average March flow in the Nuyakuk will be 3,000 cfs, is less useful than knowing most days in March the flow will be between 2,200 and 2,600, but a two-day rain on snow event causing 8,000 cfs is likely (figure 2), and in the last week of March flows will average 3,200 cfs caused by the onset of spring melt.

5. § 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements

The proposed project will affect the volume of water flowing through the Nuyakuk cascades. Therefore, the project will directly affect the habitat characteristics that support anadromous fish migration through this ½ mile river reach. Different species have different sustained and burst swimming speeds, and require different habitat characteristics to successfully pass through a cascade or up a falls. Projections of a range of flow volumes at different times of the year will inform the quantity of water necessary to ensure suitable habitat function during the salmon migration periods. Because some of these fish will swim through Nuyakuk Lake to spawning areas in tributary streams many miles away, delaying adults a week or two below the falls could lead to a decreased spawning success.

Thus, results of this Future Flows Study are essential for a complete understanding of the combined effect of the project and climate change effects on salmon migrating upstream as adults and downstream as juveniles, and these results support each of the other studies that use flow. Developing the requested data at the onset will also help limit the need for revisiting project design features, including mitigation measures, as future environmental conditions change.

The Nuyakuk project proposes to remove different amounts of water from the Nuyakuk River at different times of the year. The timing and volume of flows are projected to change due to climate warming. During some time periods this could have a significant effect on salmon productivity such as during smolt outmigration. However, given that overall flows are projected to increase, operations could be designed, and conditioned in the license, to maintain appropriate fish passage protection measures. This study will help estimate how much water will be available for power generation in each month during the license term. It will provide the flow analysis to indicate how salmon migration timing (both upstream and downstream) will change due to water temperature changes. Finally, it will contribute to the Ice Processes (Study 6).

River flow and its seasonal patterns directly influence project operations and mitigation measures intended to protect aquatic resources. As flow patterns change, changes in project operations often occur. Likewise, project operations influence the behavior of migrating fish within the project area. The information collected by this study would support the analysis of direct and cumulative effects of the proposed project on migratory fish and aid in the development of any necessary license articles regarding measures to achieve fish passage.

6. § 5.9 (b): 6.0 Consistency with Generally Accepted Practice

It has become generally accepted practice to consider climate change among planners and designers of dams for hydropower and water supply. The best available science now includes the presently observed and projected future impacts of climate change on water resources, as demonstrated by Congress directing the Secretary of Interior, via the Secure Water Act, to coordinate with NOAA and its programs to ensure access to the best available information on climate change [Secure Water Act (§) 9503 (c)] Some examples:

- Non-federal water managers and planners incorporate the risks of climate change in their long-range planning. The Water Utility Climate Alliance (WUCA), twelve of the Nation's largest water providers, was formed to provide leadership and collaboration on climate change issues affecting the country's water agencies, most of which also generate hydropower. WUCA and its member cities advocate the use of climate projections. They include a set of case studies of how climate change is shifting water utility planning (Stratus_Consulting_and_Denver_Water 2015) and producing actionable climate information for utility modeling applications (Vogel et al. 2015). Globally, a number of peer-reviewed studies were published on use of climate projections in hydropower planning, including (Cherry et al. 2010; Hamlet et al. 2013; Lee 2016; Taner 2017) in the U.S. and in Northern Europe (Finger et al. 2012; Frigon 2007).
- The American Society of Civil Engineers (ASCE) recommended the use of climate change in in design criteria. The ASCE recently reissued a policy statement in 2018, indicating a growing need for engineers to incorporate future climate change into project design criteria (http://www.asce.org/issues-and-advocacy/public-policy/policy-statement-360---impact-of-climate-change).
- The U.S. Bureau of Reclamation and Army Corps of Engineers both use climate projections in their long range operations planning and design, including hydropower generation, flood control, and water supply. These agencies jointly commissioned and released a report that identifies the needs of local, state, and federal water management agencies for climate change information and tools to support long-term planning (Brekke 2009). Reclamation and a consortium of agencies funded downscaled hydrologic projections for use in planning for reservoirs and hydropower operations (Bureau_of_Reclamation 2009) which were then subsequently updated for the next generation of IPCC global climate models (Brekke 2013), and continue to be updated as the science of downscaling and bias correction has advanced (Pierce 2014; Pierce et al. 2015).

The downscaled projections we recommend using (see Proposed Study below) follow in this tradition, based on the same IPCC global climate models. In particular, the University of Alaska Fairbanks' Alaska Climate Research Center (http://akclimate.org/) has produced the Scenarios Network for Alaska and Arctic Planning (SNAP, https://www.snap.uaf.edu).

In its July 18, 2014, Order rejecting the National Marine Fisheries Service and the Center for Water Advocacy's requests for rehearing of the formal study dispute determination regarding Susitna, "as climate change modeling continues to advance, it may eventually yield data and knowledge that can and should be used to formulate license requirements that respond to environmental effects caused by climate change." That time has come. Another generation of IPCC models has shown consistency with previous IPCC and U.S. National Climate Assessment analysis, while also providing more detailed and relevant information for natural resource planners. Downscaled climate projections datasets developed for Alaska (Walsh 2018) and elsewhere are being used in the design and operational planning for hydropower.

Proposed study

We request a study similar to the future flow and temperature analyses in (Wobus 2015), (Leppi 2014), and (Mauger et al. 2016). The steps and data available to do these analyses, are described below. New climate modeling is *not* needed. Rather, we request analyses of existing, publicly available and peer-reviewed datasets (Walsh 2018), using peer-reviewed and generally accepted practices, as described in those articles and cites therein. The basic analysis needed is to move from GCM outputs to predicted flows and water temperatures from a hydrologic model for the Nuyakuk River specifically.

(Walsh 2018) is the peer-reviewed publication that presents the methods and related data from the Scenarios Network for Alaska and Arctic Planning (SNAP), which is available for download at this website: https://www.snap.uaf.edu. Their product provides *monthly* values of projected future air temperature and precipitation. Monthly values are the *minimum* needed for analyses of future flows, but may average out changes. Wobus et al (2015) generated *daily* values, and thus were able to discern shorter time scale features in river flows. If technically feasible and available for the Nuyakuk River, this daily scale is preferable. If by the time this study is executed, a daily downscaled product is available from SNAP or by a researcher such as Dr. Wobus (Lynker Technologies), that would be preferable. Furthermore, a dynamically downscaled product for all of Alaska may be available soon. Both Walsh 2018 and Wobus 2015 provide good discussions of the choices involved in downscaling and their choices of GCMs.

a. We recommend use of the Walsh 2018 dataset, an existing, peer-reviewed and publicly available monthly downscaled climate projection dataset, and related data from the Scenarios Network for Alaska and Arctic Planning (https://www.snap.uaf.edu/Project for Alaska). This dataset is based on the latest IPCC generation of global climate models, and along with related data is available for download at https://www.snap.uaf.edu/. The Walsh product analyzed the over 35 GCMs to assess which five best represent climates in Alaska as a whole. See (Lader 2017) or (Bieniek et al. 2015) for a more detailed description of the downscaling model procedure and an evaluation against historical temperature and precipitation data. Wobus 2015 selected five GCMs, including most of the same GCMs as Walsh 2018, to best represent the climate for the Bristol Bay region.

   If a daily product becomes available, that would be preferable because of the finer time scale changes that daily analyses would detect. Below, where monthly is used, daily is meant if that product becomes available.

b. Monthly predicted temperatures and precipitation should be analyzed for the first 1/3 of the license, 2027 – 2045; the middle 1/3, 2045-2062; and the final third 2062 to 2077 for the Nuyakuk watershed. This will allow consideration of flow trends over the period, and potentially different operations as projected conditions change.

c. An accepted hydrologic model should be used to translate these downscaled climate outputs (precipitation/temperature) into other hydroclimate variables (evaporation, soil percolation, surface runoff) and ultimately the timing and volume of runoff into the Nuyakuk River, and stream temperatures. We recommend a hydrologic model such as the MIKE/SHE MIKE 11 modeling system which was used by Wobus et al (2015) in the upper Nushagak watersed.

The MIKE SHE system (Graham DN 2005) is a fully distributed, parameter integrated, hydrologic code that simulates the flow of water within and among surface water, groundwater, and the unsaturated zone. Atmospheric conditions, including precipitation, air temperature, and evapotranspiration drive continuous flows within the hydrologic system. A modified degree-day snowmelt method, the code simulates snow accumulation if air temperatures fall below a freezing threshold (typically 0°F), and it also simulates snowmelt processes including evaporation (sublimation and wet-snow evaporation), rain-on-snow, changes in wet and dry snow storage, and refreezing of wet snow. The Wobus et al (2014) effort, they also implemented a heat balance algorithm to simulate stream temperatures (Loinaz et al. 2013). The hydrologic models then projects monthly (or daily) water temperatures based on predicted air temperature and the relative river contributions from surface water versus groundwater sources versus snowfields sources.

d. The potential climate change effects should be summarized in a Climate and Flows Technical Report. This technical report should include a description of the assumptions made, models used, and other background information. The report will provide interpretation and guidance on the science knowledge developed, in order to translate them into useable knowledge, through syntheses and translational products developed to address the hydropower, water, and fisher habitat needs. Additionally, this report will include an analysis of the impacts of projections on the project nexus, and hydropower facilities. The report will include an electronic supplement that makes the data used in this study available for the use of other studies.

7. § 5.9 (b): 7.0 Considerations of Level of Effort and Cost

This study can be completed in six months because climate projections for the region already exist. It will then be ready as input to other studies. The cost is reasonable considering the PAD estimated that $1,000,000 annually in diesel cost could be avoided once this project comes online. Correctly sizing turbine and designing them for maximum efficiency at the flows expected during the license term could change the unit efficiency by ten percent. Producing daily projected flows and temperatures, compared to monthly, will increase the cost and time required slightly, but not significantly.

Study Request 6
Ice Processes Assessment

Background

The PAD states that Nuyakuk Falls normally remains ice free. The intake upstream of the falls needs to be specifically designed to prevent icing as ice tends to adhere to any exposed surface put in the river. Tazimina Falls Hydropower Project (P-11316) is 110 miles away at a similar elevation. Icing of the intake, caused primarily by frazil ice, was a major problem during the first decade of operation. In 2018, the screen bars were retrofitted to minimize frazil ice clogs. That system is not designed for smolt exclusion. We anticipate similar issues at the Nuyakuk site especially given the expectation for exclusion screens.

Ice processes in large rivers are complex. Based on the temperatures in Dillingham during the first week of 2020 (Figure 1). Icing on the proposed structure would be expected. The Nuyakuk Falls is 280 feet higher in elevation and 40 miles farther inland than Dillingham, both of which would suggest the site was colder than Dillingham.

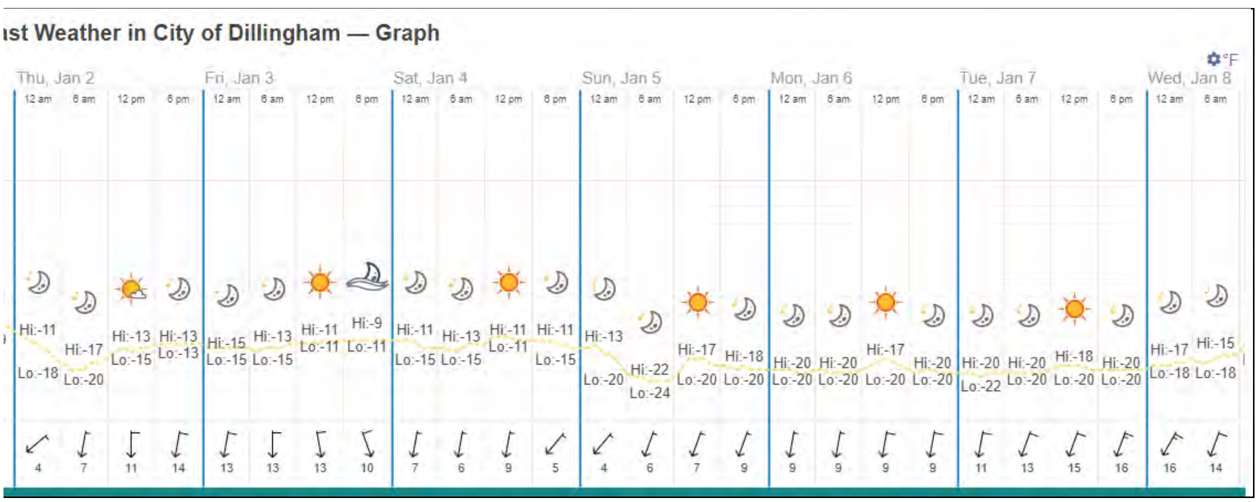

Figure 3. Weather graph for the City of Dillingham demonstrating temperatures for January 2 through 8, 2020.

Frazil ice forms when water emerges from underneath a layer of ice cover and contacts very cold air. The water becomes super cooled quickly and forms frazil ice. Cold water will emerge from under a layer of ice cover directly above the intake. Anchor ice forms on the bottom of rivers by ice crystals adhering to cobbles and gravel and then floating these particles to the surface. If small chunks of this ice get into penstock it could damage to hydropower facility.

Climates studies for Bristol Bay (Osterkamp and Gosink 1983) indicate that temperature may alternate above and below freezing perhaps all winter and through the Spring (April- May). This rising and falling of temperature around the freezing point could greatly complicate frazil ice development. Operators at existing northern facilities know that certain sets of actions need to be taken mid-winter and others during spring breakup to keep their moving mechanism ice free. A poorly designed facility combined with alternating deep freeze/thaw conditions could require an operator to be present all winter.

Content of Study Request (18 CFR § 5.9 (b))

1. **§ 5.9 (b): 1.0 Goals and Objectives of Request**

   Computational Flow Dynamic studies, intake velocities and fish exclusion devices can all become compromised and/or ineffective once frazil ice, anchor ice, shore ice or ice jams start to form. For the structures to effectively intake water and simultaneously exclude juvenile salmon, the intakes must remain clear. Salmon smolt outmigration begins just before ice melt out in and continue through June. The month the fish exclusion devices must be most effective is when the ice conditions may be most challenging. The goal of this study is to evaluate winter conditions to determine how likely frazil and other types of ice is to form at various times during the year. Three objectives are:

   a. Obtain a clearer understanding of the amount of icing that has happened above Nuyakuk Falls during the last 20 years from satellite or overflight images.

   b. Complete a literature search of other facilities and determine which climatic conditions (temperatures, relative humidity, wind) cause the most challenges. Compare this to the Future Flows and Temperature study results to determine how frequently icing problems are likely to develop.

   c. Obtain videos from remote cameras during two winters to better understand frazil ice production processes and spring breakup. Determine if lake ice eddies out in front of the proposed intake.

2. **§ 5.9 (b): 2.0 Resource Management Goals**

   The relevant resource management goals are captured in the NOAA Fisheries strategic Plan for 2019-2022 (NOAA 2019b) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in NOAA's strategic plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is also supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

3. **§ 5.9 (b): 3.0 Relevant Public Interest Considerations**

   The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. **§ 5.9 (b): 4.0 Existing Information and Need for Additional Information**

   Satellite imagery does exist for this area and periods of extreme cold usually occur during cloud free weeks. These conditions providing excellent images (https://www.sentinel-hub.com/explore/eobrowser). Studies exist on the rate of frazil ice formation based on air temperature, wind speeds and the degree of mixing in the water column (Osterkamp and Gosink 1983).

Ice studies were conducted for the Susitana-Watana project (P-14241) and may have been conducted for the Tazimina project (P-11316) and Igiugig project (P-13511). Information from these studies may inform the study plan development.

We recommend the applicant obtain additional information and follow these steps to complete the study analysis:

1. Obtain satellite imagery for the previous 20 years to quantitatively determine the extent of ice free water above the falls during different periods of cold temperature patterns. Weekly or more frequent images November through April would be useful.
2. Create a model based on this information of likely times of year and weather scenarios that would create frazil ice in the area above the falls.
3. Obtain video or frequent still images at the falls during two winters to better understand the processes of frazil ice formation and spring breakup. We would expect the first year that images would start when ice forms on Tikchik Lake and go through mid-April. The subsequent year could have a narrower time window, once a crosswalk is developed between average daily temperatures and ice formation. Additionally we recommend video from a remote camera during ice breakup to understand the size of icebergs that arrive at the falls. A remote camera, attached to a bank of batteries or solar panel could be put in place before breakup and removed after.
4. Collect frazil ice information in the Dillingham area during the two study winters. Use this information to develop a link between frazil ice near Dillingham and frazil ice at the cascade.
5. Visit Nuyakuk Falls during crucial periods to confirm the strength of the link between frazil ice formation in the Nushagak in Dillingham and frazil ice at Nuyakuk Falls.
6. Do a literature search of other hydropower facilities with fish exclusion devices in above 55 degrees north. Particularly focus on projects close to the coast where large swings in temperature mid-winter are common.

5. § 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements

The Nuyakuk River supports one of the largest sockeye salmon runs in the world. Any development creates a risk of reducing the salmon run. This study will help ensure that the designed infrastructure will function during Bristol Bay’s tough winter environment. Further, this data will support the development of license articles regarding project operations and maintenance to ensure the facility generates the power these communities need year-around; and support the development of mitigation measures to ensure the resources these communities depend on will remain sustainable.

6. **§ 5.9 (b): 6.0 Consistency with Generally Accepted Practice**

   The information gathering described above will support generally accepted practices for evaluating ice conditions at a new hydropower facility. The study should use existing scientific protocol for analyzing the collected data.

7. **§ 5.9 (b): 7.0 Considerations of Level of Effort and Cost**

   The only on the ground effort is the annual placement and removal of cameras. The level of effort/cost is small compared to the value of potentially lost energy due to iced over intake structure.

Study Request 7
Assessment of False Attraction at the Tailrace Fish Barrier

Background

Hydropower project operations can result in false attraction to project works, resulting in migration delay and loss of productivity. The Nuyakuk Cascades are approximately half way through a migration of close to 100 miles for some salmon species. Understanding how the various solutions for preventing false attraction to tailrace discharge will inform the project design and licensing process, and lead to more effective and cost efficient mitigation measures for protecting aquatic resources.

False attraction to a dead end is energetically costly for upstream migrating fish. Adult salmon have a limited window to reach natal spawning habitat, including habitat above Tikchik and Nuyakuk Lakes. Therefore, any delay has consequences for the productivity of a salmon run. Once the tailrace is constructed, fish will choose between trying to go up the tailrace or up the cascades. Fish clue into velocity, temperature, turbulence, turbidity, olfactory signals and other sensory clues when deciding which route to take up a river. In an ideal situation very few returning adults of any species would be attracted to the tailrace. If fish stay in a holding pattern below the tailrace for days or weeks, it could lower their chance of successful spawning. The assessment of false attraction will evaluate the potential for delay at the tailrace and the need for alternative design features to minimize this effect.

In addition to fish returning to an unfamiliar spatial flow patterns at the tailrace, flow volumes and flow velocities as climate change trends progress may cause flows during migration seasons to change. Hydrograph peak August flow could be lower as there is no snow melting, and mean October flows could be much higher. These study requests are interdependent.

Content of Study Request (18 CFR § 5.9 (b))

1. **§ 5.9 (b): 1.0 Goals and Objectives of Request**

   The goal of this request is to evaluate the performance of proposed tailrace location and design to demonstrate which alternatives do not attract returning adults. The study objects include:

   a. Complete a literature search of tailrace designs with and without fish barriers that mitigate the false attraction by salmon. This is focused on physical structures to keep fish out.

   b. Propose multiple project tailrace designs/locations with and without barriers based on other functioning hydropower tailraces that minimize both salmon attraction to the tailrace area and salmons ability to get through the tailrace barrier.

   c. Do a feasibility analysis and select a tailrace design/location in consultation with the resources agencies. Indicate the percentage of the flow the project will leave in the river during the months when salmon return as determined by Study Request 1.

   d. Use the two dimensional model developed in the Study Request 2 (Upstream Passage) to demonstrate why the majority of fish will be attracted to one of the three cascades at the lower end of the falls rather than to the tailrace. For each month where a significant proportion (more than 10% of the run) of a species of concern has traditionally returned, run the model at the 20% exceedance flow and the 80% exceedance flow combined with the hydropower facility:

i. operating at 100% capacity and leaving the remaining flow or 1000 cfs, whichever is greater;
ii. removing 30% of the flow and leaving 70% in the river (current state law);
iii. removing 50% of the flow and leaving 50%;
iv. removing 70% of the flow and leaving 30%.
v. This will potentially generate 20+ scenarios to model, many of which will be similar. Work with the resource agencies to agree on a set flow/diversion amounts that represent the range of river conditions and operational plans during the time adult salmon return.

e. If the model indicates a significant attraction to the tailrace, identify the conditions below the tailrace will be unfavorable to adult salmon searching for a different route upriver.

f. Demonstrate that a physical barrier will safely keep fish out of the tailrace.

2. § 5.9 (b): 2.0 Resource Management Goals

The relevant resource management goals are captured in the NOAA Fisheries Strategic Plan for 2019-2022 (NOAA 2019a) and the Strategic Conservation Action Plan for Southwest Alaska (SASHP 2017). Identified in NOAA's strategic plan is the long-term goal of healthy oceans that support healthy populations of marine species and sustainable commercial and recreational fisheries. Our involvement is supported by mandates under the Fish and Wildlife Coordination Act and Magnuson-Stevens Fishery Conservation and Management Act.

3. § 5.9 (b): 3.0 Relevant Public Interest Considerations

The requestor, the National Marine Fisheries Service, is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat.

4. § 5.9 (b): 4.0 Existing Information and Need for Additional Information

At this time, no information about velocities, depths, or turbulence exists in the vicinity of the proposed tailrace. This study request will fill this information void and allow the applicant and resource agencies to quantify the risk of a false attraction. Data are accessible to address this study request. Guidelines exist for tailrace infrastructure designs that do not allow fish to pass and where the fish do not physically injure themselves while trying to pass (NMFS 2011). Project studies and literature support an understanding of the functionally of physical barriers. This study will create a bibliography of the effectiveness of various tailrace designs, and then facilitate the Nuyakuk design for a structure that will meet project goals while protecting a regionally valuable public trust resource.

5. § 5.9 (b): 5.0 Nexus Between Project Operations and Effects on the Resource Studied, and How the Study Results would Inform the Development of License Requirements

Hydropower project operations can result in false attraction to project works, resulting in migration delay and loss of productivity. The proposed project represents a new, anthropogenic impact in an otherwise pristine salmon river. The Nuyakuk Cascades are approximately half way through a migration of close to 100 miles for some salmon species. Understanding how the various solutions for preventing false attraction to tailrace discharge will inform the project design and licensing process, and lead to more effective and cost efficient mitigation measures for protecting aquatic resources.

6. § 5.9 (b): 6.0 Consistency with Generally Accepted Practice

Ensuring that the tailrace does not create a false attractant is generally accepted practice for new hydropower projects. We anticipate all scientifically accepted practices to be implemented for the completion of this study.

7. § 5.9 (b): 7.0 Considerations of Level of Effort and Cost

The cost of completing a literature search and evaluating various tailrace designs is reasonable. The literature search should be completed before the tailrace is designed. Completing the literature search and using this information to inform design decisions should take several months to a year. The cost of this study is commensurate with a project of this size, and located in a valuable natural resource area.

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ROYAL COACHMAN
BRISTOL BAY, ALASKA

February 3, 2020

Honorable Julia Kolberg
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

RE: (P-14873-001) Pre-application document/scoping document 1, Study requests, Public comment, Request for acceptance of Regional plans as Comprehensive Management Plans

Dear Ms. Kolberg,

We've operated the Royal Coachman Lodge which is located just 3 miles from the project site for the past 16 years. We host 10 to 12 anglers per week and operate 16-18 weeks each summer from June to early October. Our guests come to our lodge for some of the best sportfishing in the world, but also to enjoy the remote untouched wilderness of the Wood Tikchik State Park. This project would significantly affect our guest's wilderness experience. Because of our close proximity to this site and all the time we spend there, we feel we are well suited to make comments on studies that should be conducted prior to installing a hydro electric system there. Following are issues that we believe should be studied or addressed prior to allowing the Nuyakuk hydro electric project to continue:

- Study the effect of the hydro turbines on not only sockeye, king and coho salmon smolt but also on pink salmon alevin and fry. It was proven by P Budy, and G Thiede, in 2002 that there is a link between delayed mortality to salmon in passing through hydrosystems during downstream migrations. Thousands of pink salmon spawn above the Nuyakuk falls and in the Tikchik river on even numbered years. As you may know, the pink salmon does not stay in the system until reaching the smolt stage. They drift/swim downstream shortly after hatching and may be more sensitive to turbines than the larger smolt sized fish. We also believe that 2 years of studies relating to salmon runs moving upstream through the falls and the salmon Smolt/Alvin downstream migration is not sufficient to fully understand the fish movement through the affected area. The salmon in this system have 2 to 5-year life cycles. Varying water conditions, size of salmon runs, and timing of salmon runs also affect how the fish move through this area. Therefore, we feel the study should be conducted over at least a 5-year period to fully understand their movements.

- Since this project has a potential effect on the salmon runs, an economic study of commercial, subsistence, and sport fishing of the Nushagak salmon runs should be done.
- Study the effect of resident fish moving upstream and downstream through the falls. We know that rainbow trout, grayling and even lake trout move up and down through the falls throughout the year.
- Study the oxygenation provided by the falls and its benefit to the fish in the system. With water temps rising (due to climate change), changing the oxygenation levels of the river could cause damage to the fishery and the ability of the anadromous fish to proceed upstream on their spawning runs. Given that warmer water carries less oxygen for the fish, oxygen levels could become more important to fish survival in the future.
- Study the effect of lower water flows through the falls on the birdlife and fish that rely on the high turbulence of the rapid to feed heavily on the smolt migration through the site. With the experience we have in the area, it's obvious to us that the smolt migrate through the falls not only in springtime but throughout all the summer months. It is also clear to us that these migratory birds and fish depend on this food source.
- We'd like to see a full archaeological study along the portage trail. This is the natural portage site for the rapid, and as a result we would assume it had historical use. We've heard of people discovering items believed to be remains of spear heads along the trail. Digging this area up could destroy a lot of evidence pertaining to the history of the people who have used this site for thousands of years.
- This project's impact on the Park User's experience and the correlating economic impact on service providers should be investigated. Our guides and guests hike through the proposed construction area to fish below the falls nearly every day June through September. This project would adversely affect their experience (visually, fishing quality, remoteness, etc.). Therefore, we believe it would definitely have a negative economic impact on our business as well as other Park User businesses in the area.
- Study the impacts on tourism in the area during studies, construction and operation. With intake tunnels, a power plant, employee housing, runway, and power lines, this area will undoubtedly lose much of its wilderness aspect and aesthetic values. We also believe the noise that will be generated during the construction of this project will impact park visitors and wildlife.
- Determine the minimum CFS needed to operate the turbine(s). SB 91 was worded to allow up to 30% of water flow to be diverted around the falls. With winter flows always going down to 3000 CFS and sometimes as low as 1000 CFS, it's safe to say this power plant may not operate year-round.

We understand that these comments do not meet the study request criteria outlined in 18 CFR section 5.9(b). We ask that the Commission utilize these comments when developing study plans pertaining to this project.

With a project of this magnitude, there's no doubt that an ecological succession will occur, as every species has environmental conditions it relies on to survive, grow and reproduce. Changing the environment with infrastructure will alter the ecological community. Because there is no turning back once the powerplant is installed, we believe a full EIS (environmental impact statement) is in order for this site. We believe this project will have a cumulative effect on the salmon runs and other local wildlife. An EA (environmental assessment) is much less suited to determining the full impact this project will have on the park and its resources.

Lastly, this is not a study request but rather a suggestion -- Put in a clause stating that if this power plant is constructed, studies of its cumulative effect on the fishery and other resources should continue. If it's found to be having an adverse effect on the resources (mainly the salmon runs), the project should be shut down and the site returned to its original state.

Thank you for your careful consideration of these matters.

Sincerely,

Pat Vermillion
Royal Coachman Lodge General Manager

Scott Schumacher
RCL Operations Manager

Alison Smith
RCL Administrative Manager

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united
TRIBES OF BRISTOL BAY

Tuesday, February 4, 2020

Julia Kolberg,
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426
Submitted via FERC online

Re: Nuyakuk River Hydroelectric Project (P-14873-001)

Nushagak Cooperative Inc. submitted a FERC Pre-Application Document for the Nuyakuk River Hydroelectric Project (P-14873) on October 7, 2019. And FERC sent out Scoping Document 1 to interested parties on November 8, 2019. Based on a review of these documents, I respectfully submit the following questions on behalf of the United Tribes of Bristol Bay.

General Design and Construction Concerns

- What is the estimated average annual generation capacity of the Project (e.g., is it 72,800 MWh or 55,300 MWh)?
- How much energy is needed for the fish processing and packaging efforts in the summer versus the heating and electricity needs in the villages?
- Will there just be a single bore tunnel arrangement for the 2 conveyance pipes to the powerhouse? How long and how far underground will it be?
- Will there be 2 or 3 Kaplan turbines in the powerhouse?
- What is the amount of flow that will be diverted to the intake structure every month of the year?
- Where will the gravel source be located for the runway and road construction?
- How will the winter ice and low flow conditions, the potential for ice dams, and high flows during Spring breakup impact the operation of the diversion structure? How will ice and debris issues be mitigated from impacting the intake on the river bank? Will antifreeze be used in winter through the intake structure to avoid ice buildup?
- What are the plans for the construction man camp and will it be used in the winter months? How many people will be needed for the construction phase? Will locals have hiring preference?
- When will construction of transmission lines occur, how many streams and acres of wetlands will need to be crossed during construction, and what environmental impacts will there be during the construction of the transmission lines?
- What will be the barging challenges on the Nuyakuk River to bring in heavy equipment and turbines to the site? In the Scoping Meeting it was stated that there are navigational issues near the project site (e.g., only a small 18' boat can reach the site).
- What is the design of and how long will it take to construct the diversion structure or groyne? Will a cofferdam be used for the construction of the groyne? How long will the cofferdam be in place? How will the construction of the groyne impact in- and out-migrating salmon?

- What are the maintenance requirements for the power plant and transmission lines? Will the power plant need to be shut down annually, if so for how long?

Miscellaneous Concerns

- What other federal and state permits will be needed for the project?
- How long will the project provide hydroelectric power to the villages (e.g., 20, 50, 100 years)?
- What are the decommissioning plans for the hydroelectric power plant?
- What are other electricity needs besides the villages along the transmission line corridors (e.g., Aleknagik landfill, Float Plane Road, and Johnny Tugatuk Road) that could benefit from the Project?
- When will an economic feasibility study be conducted and how will the Nushagak Cooperative fund this Project (e.g., through funds from the State of Alaska, federal funds and/or bank financing)?

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TRIBES OF BRISTOL BAY

Tuesday, February 4, 2020

Julia Kolberg,
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426
Submitted via FERC online

Re: Study Plan Requests for the Nuyakuk River Hydroelectric Project
(Docket # P-14873-001)
Submitted by United Tribes of Bristol Bay

ENGINEERING FEASIBILITY STUDY PLAN

GOALS AND OBJECTIVES

The goal of the engineering feasibility study is to determine the suitability of the site for the construction of the infrastructure related to the Nuyakuk River Hydroelectric Project (Project). Field surveys, bathymetric and topographic mapping will determine the feasibility of constructing the various Project infrastructure in relation to biological and physical site conditions. For example, the surveys for bathymetric data and topography are needed for the hydraulic modeling of specific tunnel designs and generator capacities. Developing the specific engineering designs of the proposed diversion and intake structures, project buildings, access roads, airstrip, and transmission lines will need site specific geotechnical data.

Objectives include the need for geologic borings to define the site bedrock unit characteristics and a soil survey for proper engineering design and construction plans of the buildings and underground tunnels (e.g., is the bedrock competent enough for the conveyance tunnel). The study objectives should also include an evaluation of the seismicity potential at the site and groundwater conditions that might be impacted during the construction and operation phases.

RELEVANT RESOURCE MANAGEMENT GOALS

The Project site is designated as a Natural Area in the Wood Tikchik State Park (WTSP) Management Plan (2002) and the purpose of this Natural Area is to provide for moderate to low impact, clustered or dispersed forms of recreation, and managed as relatively undeveloped and undisturbed areas. Therefore the Project needs to provide flow and sediment regimes that closely mimic natural flows and geomorphological processes as much as it is biologically and technically feasible, which will then optimize conditions downstream for aquatic biota life cycles.

According to the WTSP Management Plan any development in the Park shall be sited, designed, and constructed to minimize impacts upon the natural environment and the area's

scenic quality. And facilities developed in the vicinity of salmon streams and other areas of ecological importance should plan to mitigate any problem stemming from over-use or other visitor activities. The WTSP Management Plan states that developments in such areas will only be considered if there is evidence that the environment will not suffer significant adverse effects.

RELEVANT PUBLIC INTEREST CONSIDERATIONS

It is important that the Project protects and conserves the area's fish and wildlife populations; provides for the continued use of the area for traditional subsistence and recreational purposes; and to protect the area's recreational and scenic resources.

DESCRIBE EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Limited geotechnical information was collected at the site during summer 2018. Engineers were on site to look at potential infrastructure locations and collected limited bathymetric survey and water quality data. Therefore additional topographic, bathymetric, and geotechnical surveys are required at the site to properly design the diversion structure, conveyance tunnels, tailrace, the access roads, and airstrip.

EXPLAIN THE NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON THE RESOURCES TO BE STUDIED

The geotechnical information will determine the site design for the Project’s infrastructure.

EXPLAIN HOW ANY PROPOSED STUDY METHODOLOGY IS CONSISTENT WITH GENERALLY ACCEPTED PRACTICE

Methods for the geotechnical surveys should follow USGS procedures and the field results can be evaluated with GIS tools to produce site specific maps on bathymetry, topography, soil types and bedrock geology. For example, acoustic bathymetry surveys often use multi-beam sonar or acoustic device system to collect stream depth. The Acoustic Doppler Current Profiler (ADCP) are used to measure water velocity by transmitting sound waves which are reflected off sediment and other materials in the water. Data collected from ADCPs can then be used for bathymetric maps.

DESCRIBE LEVEL OF EFFORT AND COSTS

A field engineer/geologist with surveying background and a field technician will be needed for the development of the field study plan, conducting the field work, and post data-collection evaluation using GIS tools to produce site-specific maps showing the topographic and bathymetric elevations, soil and bedrock types. An estimated cost for this task is $100,000.

FLOW AND SEDIMENT STUDY PLAN

GOALS AND OBJECTIVES

The goal is to understand the flows necessary for fish passage near the Project, how the Project will alter sediment transport, and to understand the water quantity, peak flows, and design flows required for the hydroelectric power operation. This information will also determine the exact size and type of turbine/generator, switchgear, transmissions facilities and other electrical equipment.

It is important that the Project mimics the flow and sediment regimes which provide for the maintenance and enhancement of channel structure and habitat for aquatic- and riparian-dependent species near the Nuyakuk Falls. The Project needs to maintain instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment transport crucial to spawning gravels. Therefore the study needs to determine flows that would alter the route of spawning-gravel-sized sediments near the project site and that support the riparian and aquatic habitats in the anadromous habitats near the site.

The objectives are to determine how the outflows from the tailrace will alter spawning gravel size and sediment transport and what will be the effects from the groyne, or diversion structure, on sediment transport. The study will need to determine what flows would maintain floodplain characteristics, determine the area of available aquatic habitat for different species and life stages at different base flows, and determine how the Project will affect stream morphology and aquatic habitat characteristics.

RELEVANT RESOURCE MANAGEMENT GOALS

The Project should follow the WTSP Management Plan (2002) and maintain and restore the sediment regime under which aquatic ecosystems evolved. Important elements of the sediment regime include timing, volume, rate, and characteristic of sediment input, storage, and transport. Since so little of the Park has experienced habitat disturbance, management of Park resources is a matter of conserving existing habitat values and ensuring that those values are not lost or degraded. Habitat protection was a central purpose of the Alaska State Legislature when it established the Park. And according to the Nushagak River Watershed Traditional Use Area Conservation Plan (2012) any project, including this Project, should reserve adequate water flow under existing laws for in-stream flow reservations.

RELEVANT PUBLIC INTEREST CONSIDERATIONS

The State of Alaska through ADF&G holds an instream flow reservation for the Nuyakuk River that ranges between 1,600 and 2,700 cubic feet per second (cfs) during the low flow period in winter. The Project plans to remove 30% of the flow therefore there will barely be between ~500-900 cfs remaining in the river. So the amount of water diverted to the powerhouse may not be enough to efficiently produce electricity, during the critical winter months when the villages need a lot of power for the electricity and heating needs in their homes.

DESCRIBE EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

There is a long-term USGS stream gauging station approximately 4 miles upstream of the Project, but there are 4 major tributaries between the USGS gauging station and the Nuyakuk Falls that contribute additional flow to the Nuyakuk River. Therefore site specific flow measurements should be collected by setting up a gauging station upstream and downstream of the Project. Instruments at the gauging stations should include the ability to measure water height, discharge, water chemistry, and water temperature.

Conducting an on-site physical habitat assessment survey will help us to understand current gravel and substrates above and below the Project site. The study should define the substrate composition (gravel, cobbles, boulders, etc.), the riparian vegetation, channel morphology type using the Rosgen classification system, and should measure the average stream gradient above and below the Project.

EXPLAIN THE NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON THE RESOURCES TO BE STUDIED

The environmental baseline data should be analyzed for the potential impacts due to the construction, operation and maintenance phases to determine how the Project will alter flow and sediment regimes in the Nuyakuk River. The flow and sediment regime changes caused by the Project may result in changes to the physical structure and function of the aquatic and riparian ecosystems and the distribution and abundance of aquatic and riparian species. Therefore the flow studies need to determine how the diversion structure, or groyne, will alter the magnitude, frequency and timing of peak flow events, reduce base flows, and change the sediment regime. This is important because if the sediment transport processes are altered it may change the spawning gravels present near the site.

The timing, magnitude, duration, and spatial distribution of peak, high and low flows must be protected. Therefore we need multi-year water depth and flow data to better forecast the flow of the river during all seasons above and below the Project. The peak flows will be altered by the diversion structure that will be installed above the Nuyakuk Falls. The flows being discharged from the tailrace will also be different from the natural background flows below the Falls. Therefore an instream flow study is needed to understand the flow needed to maintain the seasonal migration patterns of resident and anadromous fish and the depths and velocities critical for spawning habitats near the Project.

Mean monthly flow in Table 1 of the Preliminary Permit show low flow values occurring in the months of December through April and range from 1690-3220 cfs. Therefore, it is important to determine how will these low flows impact the efficiency of the hydroelectric output because these are the coldest and darkest months and are when the villages are using the most diesel fuel for heating and electricity.

EXPLAIN HOW ANY PROPOSED STUDY METHODOLOGY IS CONSISTENT WITH GENERALLY ACCEPTED PRACTICE

A stream gage is a structure installed beside a stream or river that contains equipment that measures and records the water level (called gage height or stage) of the stream. Streamflow (also called discharge) is computed from measured water levels using a site-specific relation (called a stage-discharge rating curve) developed from onsite water level and streamflow measurements. The relation between stream stage and discharge is determined, and a stage-discharge relation (rating) is developed to calculate streamflow for each recorded stream stage (Rantz et al., 1982). These data are used to calculate the daily mean discharge for each day at a site. All measurements should be made according to standard USGS procedures (Rantz et al., 1982; Sauer and Turnipseed, 2010; and Turnipseed and Sauer, 2010).

Physical stream assessment protocols should follow the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency guidance document: Physical Stream Assessment - A Review of Selected Protocols for Use in the Clean Water Act Section 404 Program (September 2004). This document outlines procedures to define the physical (geomorphological and habitat variables) to assess stream bank erosion, a stream's hydraulics and geometry, bank stability, and the pool to riffle percentage in a stream reach.

DESCRIBE LEVEL OF EFFORT AND COSTS

A hydrologist and a field technician will be needed to develop a comprehensive flow and sediment field study plan, collect, analyze, and summarize the stream flow and physical stream assessment data. Logistical costs will include commercial airline flights to Dillingham, helicopter support to transport field crew to the Project site, room and board during field work, and monthly site visits. The estimated monthly labor requirements for on-site visits would be approximately 40 hours/month for a hydrologist and a technician. Estimated annual costs are $150,000.

FISH SURVEY STUDY PLAN

GOALS AND OBJECTIVES

The goal is to gather presence/absence information, abundance and fish habitat information, to understand the life stages, life history and distribution for all resident and anadromous species upstream and downstream of the Nuyakuk Falls Hydroelectric Project.

Objectives of the fish surveys include a biological description including physical descriptions, geographic distributions, average and record sizes, age and growth characteristics, food habits, predator and prey dynamics, and use and value to humans. The fish survey should evaluate when the different species use the Nuyakuk Falls for migration and how their migration changes relative to seasonal flows. The fish surveys should include a general description of life history phases and description of migratory behavior for each phase.

The study should identify habitat requirements for each life phase including reproductive, early life, and adult stage. The habitat assessment should map the percentage of pools versus riffles upstream and downstream of the Project. It is also important to determine the water depth, velocity, cover and substrate preferences for the different life stages particularly with respect to seasonal changes in the hydrograph, and under different climate scenarios.

The survey needs to determine what is the temporal and spatial distribution of each species and life stages. It needs to evaluate how the diversion structure, or groyne, which could change the behavior and migration patterns of fish up and down that stretch of river. This is particularly important because the groyne will change water flows, as a function of stage height. Data needs to be collected on the abundance for all the anadromous and resident fish species that migrate upstream and downstream of the Nuyakuk Falls. The study should evaluate the seasonal timing and the timing of the migration relative to the seasonal hydrograph.

RELEVANT RESOURCE MANAGEMENT GOALS

The Wood Tikchik State Park (WTSP) Management Plan (2002) goals include the protection of the fish and wildlife resources of the Park, including management of natural habitats and support systems. Objectives of the WTSP Management Plan include establishing habitat management practices through consultation and cooperative agreements with the Alaska Department of Fish and Game (ADF&G) to protect salmon spawning grounds, resident fish populations, critical habitats and distributions of wildlife populations.

According to the WTSP Management Plan there are extensive spawning grounds located along the western half of Nuyakuk Lake and the Nuyakuk River outlet. And five species of Pacific salmon [chinook (king), sockeye (red), coho (silver), pink, and chum] spawn in the Tikchik Lakes systems. ADF&G estimates that the Park's waters contribute a significant share of the Bristol Bay commercial sockeye salmon fishery. Escapement into the Wood and Nuyakuk Rivers often constitutes 20 percent or more of the total annual Bristol Bay sockeye escapement. The sockeye salmon also play a significant role in the sport and subsistence fishery in the Park.

Freshwater resident fish are generally prolific throughout the area near the Project. Rainbow trout, grayling, lake trout, Arctic char, and Dolly Varden abound. Northern pike of good size offer fishing variety in several of the lakes. According to the WTSP Management Plan the present angling pressure is estimated to be on the order of 2,000 to 3,000 angler days annually in the Tikchik River system.

RELEVANT PUBLIC INTEREST CONSIDERATIONS

The requestor of the study is the United Tribes of Bristol Bay (UTBB), which is a tribal consortium working to protect the traditional Yup'ik, Dena'ina, and Alutiiq ways of life in Bristol Bay that depend on the sustainable harvest of the watershed's renewable resources, most notably Bristol Bay's wild salmon. UTBB requests that the surveys be multi-seasonal over at least a 2 year time period. This is important because there is substantial year to year variation in the hydrograph and we know that fish passage up and down the Falls changes under different seasonality and magnitudes of the hydrograph. The analyses should also include scenarios that explore potential hydrograph variations under climate change scenarios.

The survey needs to take into account that thousands of pink salmon are known to spawn above the Falls on even numbered years; to identify the presence and abundance of both anadromous and resident fish species because of the subsistence value; and because rainbow trout, grayling and lake trout are known to move up and down the Nuyakuk Falls through out the year.

DESCRIBE EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Extensive fish surveys need to be site specific as defined in the Goals and Objectives Section of this plan since there has been no site specific fish surveys conducted at the site.

EXPLAIN THE NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON THE RESOURCES TO BE STUDIES

The Project needs to understand how diverting flow with the groyne structure will impact the aquatic habitat and the migration routes through the Falls. The Project need to estimate the direct fish mortality or injury due to turbine entrainment, impingement, or reentry into the powerhouse via the tailrace under different flow conditions, and an evaluation of the potential delayed mortality downstream (e.g., for juveniles).

The design of the intake structure and groyne needs to take into consideration how the they will change the current relationship between the seasonal flow regimes and adult fish migration (e.g., will the groyne create back eddies and potentially slow the migration of juvenile fish). Reduction of fish mortality can be accomplished by reducing the flows at the intake and by using fish screens (e.g., Pelton Round Butte Screens which can be used in flows greater than 5,000 cfs).

The Project needs to ensure that there will be no low flow migration inhibition affects or affects to adult upstream migration through bathymetric and hydrologic models. The models should estimate flow impacts on adult fish migration under current conditions and to understand the impacts of reduced flow on juvenile and adult resident and anadromous fish. The Project also needs to evaluate how the flow of the water at the tailrace channel into the river will be dissipated so that it is not going to cause a false attraction and confuse the fish to hang out in this area because of the increased flow and increased water volume.

EXPLAIN HOW ANY PROPOSED STUDY METHODOLOGY IS CONSISTENT WITH GENERALLY ACCEPTED PRACTICE

The recommended methodology to resolve the migration timings and routes through the Falls is by using a **D**ual frequency **ID**entification **SON**ar (Didson) Acoustic Camera. The Didson technology is used by ADF&G for detecting fish in rivers and was developed at the University of Washington. This method can be used to count adult fish migrating up the Falls, smolts and fry moving down the Falls, and what routes they take across different seasons and under different water stages. This methodology could be supplemented with the use of aerial drone footage and/or using an underwater video camera.

Field surveys are needed because there is very little site specific data. The surveys will define fish species composition, distribution, presence/absence, and life history by using acceptable field methods to meet the study objectives. Sampling methods must conform to the conditions of ADF&G regulations to ensure minimal risk to aquatic life. Survey methods and timing are subject to restrictions and protocol requirements identified by ADNR and ADF&G Fish Habitat Permits, or other regulatory requirements.

DESCRIBE LEVEL OF EFFORT AND COSTS

Fish biologists and field technicians will be required to develop the comprehensive field study plan, conduct the field work, evaluate the survey results, and write up a draft and final summary report. Field equipment and supplies that will need to be purchased include the Didson hydroacoustic equipment and other video equipment such as an underwater video camera and drone. The logistical costs include airline tickets to reach Dillingham, helicopter support to transport the field crew to the site, and room and board during the field work. An annual estimated cost for this survey is $300,000.

WATER QUALITY STUDY PLAN

GOALS AND OBJECTIVES

The goal is to collect baseline water quality data to identify Project effects on water temperature, turbidity, dissolved oxygen and other parameters which may have adverse effects to the function of the aquatic ecosystem and detrimental change in habitat for aquatic species.

The objectives are to collect background water quality data (e.g., water temperature, turbidity, suspended sediment, dissolved oxygen, dissolved gas, nutrients, and pH) for 2 continuous years at monitoring sites above and below the Falls. It is important that the water quality and the flow rate after the Project is operating will remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

RELEVANT RESOURCE MANAGEMENT GOALS

The Project needs to operate and mimic natural processes to the greatest extent possible because the objective of the Wood Tikchik State Park Management Plan (2002) is to protect and conserve the area's fish and wildlife populations; provide for the continued use of the area for traditional subsistence and recreational purposes; and to protect the area's recreational and scenic resources. The Nushagak River Watershed Traditional Use Area Conservation Plan (2012) states that it is important to monitor and maintain water quality standards that protect wild salmon and other fish throughout the watershed.

RELEVANT PUBLIC INTEREST CONSIDERATIONS

The Project needs to maintain water quality to a degree that provides for stable and productive ecosystems (i.e., timing and character of temperature, dissolved oxygen, sediments and nutrients) to support the current healthy aquatic ecosystem and the important wild salmon fishery in this watershed. The Project needs to mimic natural processes to the greatest extent feasible to reestablish proper function after the construction phase and during the operation phase.

DESCRIBE EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Very limited water quality has been collected and the Project may alter water temperature, dissolved oxygen concentrations, and other water quality parameters and consequently degrade aquatic habitats downstream. Therefore it is important to collect environmental baseline data for background water quality conditions. Once the plant is operational it will be important to monitor the temperature of the water after it flows through the Powerhouse and after it is discharged at the tailrace. The water discharged in the tailrace channel may also change the dissolved oxygen values and therefore should be monitored because a change in the oxygenation of the water could impact the fish.

It is important to integrate the water quality study results with the flow study and fish surveys to determine what effects on-going water temperature regimes and water quality outflows have on the aquatic habitat and fish species. This integrated study should identify the life history stage and levels in the food web most sensitive to changes in water temperature, and to identify where the movement or migration of fish is affected by project effects to temperature.

EXPLAIN THE NEXUS BETWEEN PROJECT OPERATIONS AND EFFECTS ON THE RESOURCES TO BE STUDIED

The operation of the the diversion structure, hydroelectric powerhouse, and water discharged into the Nuyakuk River at the tailrace will change the water quality and therefore water quality parameters need to be monitored before and during the construction and operation of the Project.

EXPLAIN HOW ANY PROPOSED STUDY METHODOLOGY IS CONSISTENT WITH GENERALLY ACCEPTED PRACTICE

Water quality protocols for the collection of field parameters and surface water samples should follow USGS protocols that are described in the National Field Manual for the Collection of Water Quality Data and the Water Quality Sampling by the USGS-Standard Protocols and Procedures (2010). These documents include the methods and protocols for sampling surface water, methods for processing water quality samples for analysis, and methods for measuring field parameters. The water quality parameters collected should include the 6 most important indicators of water quality (e.g., temperature, dissolved oxygen, pH, conductivity, total dissolved solids, and suspended nutrients).

DESCRIBE LEVEL OF EFFORT AND COSTS

A water quality specialist/hydrologist and a field technician will be required to develop the field study plan, to conduct the field work, to evaluate the water quality results, and write up a draft and final summary report. Field equipment and supplies needed include a multi-parameter water quality meter, sample vials, miscellaneous field and office supplies. The logistical costs include airline tickets to reach Dillingham, helicopter support to transport the field crew to the site, and room and board during the field work. An annual estimated cost for this survey is $50,000.

APPENDIX C: Nexus Between the Project and Fish Populations, by Proposed Fish Study

1. Appendix C – Nexus Between the Project and Fish Populations, by Proposed Fish Study

The potential for the Project to impact the fish community and aquatic habitats in the Project vicinity will be evaluated with the six studies proposed in Section 4. This appendix provides the foundation that was used for study development. The first section, Project Nexus Statements characterize the connections from Project-related changes to potential impacts and identifies the questions that the studies will address, as well as likely monitoring and adaptive management that may be required once the Project is operating. The second section is a list of specific hypotheses that will be addressed through implementation of the empirical and modeling studies. These will be synthesized with the Integrated Risk Assessment to provide a comprehensive assessment of potential Project impacts of the fish community and aquatic habitats in the vicinity of the Project.

2. C1. Project Nexus Statements

Primary Nexus: Project operations will divert river water through the powerhouse and return it to the river below the Falls Reach via a tailrace, so fish habitat will be affected via decreased flow through the Falls. Regional climate will determine the flow and temperature of water entering the Project Area and may affect operations (due to flow changes) or have effects on fish (due to flow and water temperature changes).

Secondary Nexus: Physical Project components (e.g., groin, intake, tailrace) will replace existing fish habitat with flow control structures upstream and downstream of the Falls thereby altering habitat characteristics at those locations.

Note: Each Nexus statement (1a through 4a) below is written with the preface of "Project structure and/or operations may have a potential effect on, e.g., 1a *Upstream passage behavior and survival of fish through the Falls Reach*", etc.

Table 1. Nuyakuk River Hydroelectric Project Nexus with Aquatic Habitats and Functions: Potential Impacts on the Timing, Distribution, and Overall Success of Fish Moving Upstream and Downstream Through the Falls Reach (defined as the river reach from the point of proposed intake to the downstream end of the pool adjacent to the proposed tailrace). This Nexus relates to downstream passage via powerhouse entrainment or the Falls Reach in Nexus #2a, and stranding/trapping in Nexus #3a.	
Project Nexus #1a	Upstream passage, behavior and survival of fish through the Falls Reach
Structural/Operational Source of Impact	River flow will be diverted above the Falls proper and through the powerhouse at a variable rate. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Upstream passage conditions and habitats within the Falls Reach of the Nuyakuk River.
Potential changes in conditions/habitats	Will reduce the quantity of river flow and distribution of flow through the Falls Reach and alter the depth/velocity distributions and the quantity and composition of habitats suitable for upstream passage.
Potential effects on fish	3. Changes in depth, velocity and habitat composition may impair or improve upstream fish passage conditions (variable by species and size) compared to baseline and affect their behavior. Reduction in pathways or passage opportunities may affect the timing and distribution of migrating fish and/or reduce numbers of fish upstream of the Project. An increase in pathways or passage opportunities may also affect temporal distribution of migrating fish and increased numbers of fish upstream of the Project. 4. Reduced total aquatic habitat available for upstream passage may increase fish density and respective density dependent ecological effects (e.g., predation, injury, stress). 5. There may be interactive effects between future climate change and flow conditions, including reduced or increased flow overall and during specific seasons. Must consider potential interactive effects between increased temperatures and passage metrics.
Metrics and criteria to evaluate the change to habitat and fish passage	1. Metric - Depth and velocity output from 2D modeling under different flow conditions, With and Without-Project. Criteria - Established depth, swimming speed and jumping criteria will be linked to outputs from 2D modeling to spatially determine areas of suitable/unsuitable passage under different flow conditions.

Will generate probability distributions of migration pathways (scale TBD; e.g., ranked according to highly likely, likely, possible, unlikely).

2. Metric - Passage success and pathways under different flows, With and Without-Project.
   Criteria - Comparisons between 2D model predictions and empirical data (measures of passage success and identification of pathways).

   Comparison between 2D model predictions for attraction and empirical staging times and locations to evaluate potential delay due to conditions in the Falls Reach.

   Potential ancillary information on fallback/dropback rate, size frequency distribution of run, temporal distribution, incidence of injury/mortality, and others (Related to Nexus 4a).

3. Metric - 2D model predictions linked with Habitat Suitability Criteria (HSC) (e.g., adult holding; adult jumping/plunge pool area), With and Without-Project.
   Criteria – Comparison of suitable upstream passage related habitat quantities under different flow conditions.

4. Metric – Fish density in pathways, With and Without-Project.
   Criteria – Comparison of modeled fish density in pathways under different flow conditions.

5. Metric – Survival to spawning for fish successfully passing the Falls Reach, With and Without-Project.
   Criteria – Compare probability distributions of latent/pre-spawn mortality.

Comparison Basis:

- With and Without-Project hydrologic conditions as predicted from 2-D model. Potential for flow field changes to affect behavior of fishes depending on the proportion of flow through the Falls Reach.
- Probability distributions of suitable passage metrics and habitat conditions. If probabilities are similar or higher between With and Without-Project operations, then likely no effect.
- Comparison of likelihood estimates of successful passage based on simulations.
- For Sockeye and Chinook salmon, probabilities can be linked to the appropriate Life Cycle model to determine upstream related Project effects on individuals and population.

Operational Considerations	Timing and quantity of flow through the Project may be adjusted to minimize risk of negative effects. Engineered manipulations of passage routes could alter flow patterns and direct flows to improve passage conditions within pathways.
Monitoring and Adaptive Management	Flow based assessments and observations. With-Project evaluation of flow pathways. Assessment of fish passage by observation or trapping in the Falls Reach (movement, jumping, aggregations, predation, pre-spawn mortalities, injuries). Assessment of habitat composition and connectiveness, incidence of fish-unfriendly conditions.
Project Nexus #1b	Downstream passage and behavior of fish through the Falls Reach
Structural/Operational Source of Impact	River flow will be diverted above the Falls proper and through the powerhouse at a variable rate. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Downstream passage conditions and habitats within the Falls Reach of the Nuyakuk River. A new downstream passage route will be available through the Project. A proposed groin upstream of the intake and a tailrace downstream of the powerhouse would change flow fields along the left bank of the river (facing downstream)
Potential changes in conditions/habitats	Will reduce the quantity of river flow and distribution of flow through the Falls Reach and alter the depth/velocity distributions within pathways used for downstream passage, and the quantity and composition of habitats suitable for downstream passage. Proposed groin adjacent to the intake and a tailrace downstream of the powerhouse could create eddy conditions or change other flow field characteristics.
Potential effects on fish	1. Changes in depth, velocity and habitat composition may impair or improve downstream fish passage conditions. Migration pathways may change and affect passage run timing (seasonally and diurnally) and distribution. 2. Reduced total aquatic habitat available for downstream passage may increase fish density and respective density dependent ecological effects (e.g., predation, injury, stress). 3. Changed hydraulic conditions (e.g., eddy) could delay small fish (e.g., salmon fry or parr) or modify their diurnal timing of passage. 4. There may be interactive effects between future climate change and flow conditions, including reduced or increased flow overall and during specific seasons. Consider interactive effect between increased

	temperatures and passage metrics.
Metrics and criteria to evaluate the change to habitat and fish passage	1. <u>Metric</u> – Depth, velocity habitat output from 2D modeling under different flow, With and Without-Project. <u>Criteria</u> – Comparison of particle travel times under different flow conditions, Without and With-Project – (assumes passive downstream migration) and compare potential injury risk areas; Assess depth/velocity matrices and drop features within the Falls Reach to identify and compare potential injury risk areas (With and Without-Project). 2. <u>Metric</u> - Estimates of downstream passage timing through the Falls Reach. <u>Criteria</u> – Compare peak number per day and trends past a location above and below the Project; 3. <u>Metric</u> - Vertical and horizontal distribution of downstream migrating fishes in the vicinity of the intake. <u>Criteria</u> – Comparison of relative distribution, Without and With-Project. Modeled flow field characterization may provide inferences to fish distribution. 4. <u>Metric</u> – Fish density in pathways, With and Without-Project. <u>Criteria</u> – Comparison of modeled fish density in pathways under different flow distribution. <u>Comparison Basis:</u> - With and Without-Project hydrologic conditions as predicted from 2-D model. Potential for flow field changes to affect behavior of fishes depending on the proportion flow through the Falls Reach. - Probability distribution of suitable downstream passage metrics and habitat conditions. If the probabilities are similar or higher between baseline and operations, then likely no effect. - Comparison of likelihood estimates of successful passage based on simulations. - For Sockeye and Chinook salmon, probabilities can be linked to Life Cycle model to determine downstream related Project effects on individuals and population.
Operational Considerations	Timing and amounts of flow through the Project may be adjusted to minimize risk of negative effects. Engineered manipulations of passage routes could alter flow patterns and direct flows to improve passage conditions within pathways. Selection of fish friendly turbines will affect passage success through the Project.
Monitoring and Adaptive Management	Flow based assessments and observations. With-Project evaluation of flow conditions and pathways. Assessment of fish passage by observation or trapping in the Falls Reach (movement, aggregations,

	predation, injuries). Assessment of habitat composition and connectiveness, incidence of fish-unfriendly conditions. Monitoring of route-specific and overall timing and passage survival. Monitoring for fish delay associated with groin eddy or tailrace. Predator distribution and abundance.
Project Nexus #1c	Rearing habitat in the Falls Reach
Structural/Operational Source of Impact	River flow will be diverted above the Falls proper and through the powerhouse at a variable rate. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Rearing habitat (areas for refuge, feeding, holding, moving) for fish within the Falls Reach of the Nuyakuk River.
Potential changes in conditions/habitats	Will reduce the quantity of river flow and distribution of flow through the Falls Reach and alter the depth/velocity distributions within rearing habitats, and the quantity and composition of habitats suitable for rearing. Channel configuration, substrate composition, and the composition and configuration of rearing habitat below the Falls proper could be modified. Anticipate seasonal changes associated with operations.
Potential effects on fish	1. Changes in depth/velocity may reduce or increase the total quantity of rearing habitat (as defined by depth/velocity suitability indices) in the Falls Reach. Reduced total aquatic habitat may increase fish density and respective density dependent ecological effects (e.g., feeding opportunity, predation, injury, stress). 2. Changes in habitat below the Falls proper may affect a prime feeding area for resident fish. 3. There may be interactive effects between future climate change and flow conditions, including reduced or increased flow overall and during specific seasons. Consider interactive effect between increased temperatures and respective metrics.
Metrics and criteria to evaluate the change to habitat and fish passage	1. <u>Metric</u> - Depth and velocity output from 2D modeling under different flow conditions, With and Without-Project. <u>Criteria</u> – Comparison of the quantity, composition, and distribution of rearing habitat (e.g., # pools, tail outs) for fish using Habitat Suitability Criteria (HSC) values derived from the 2D model to define the area of habitat under different flow conditions, by different species.

	Probability distribution of available rearing habitats, With and Without-Project. If the probabilities are similar or higher between baseline and operations, then likely no effect. For Sockeye and Chinook salmon, probabilities could be linked to Life Cycle model to determine the effect of rearing habitat changes in the Falls Reach on individuals and the population as related to Project operations. <u>Metric</u> – Distribution and relative abundance of resident fish below the Falls proper. <u>Criteria</u> – Seasonal distribution and relative abundance changes, With and Without-Project. <u>Comparison Basis:</u> - With and Without-Project hydrologic conditions as predicted from 2-D model. Potential for flow field changes to effect behavior of fishes depending on the proportion flow through the Falls Reach. - Probability distribution of suitable habitat rearing conditions. If the probabilities are similar or higher between baseline and operations, then likely no effect. - For Sockeye and Chinook salmon, probabilities can be linked to Life Cycle model to determine downstream related Project effects on individuals and population.
Operational Considerations	Timing and quantities of flow through the Project may be adjusted to minimize risk of negative effects to habitat in the Falls Reach.
Monitoring and Adaptive Management	Flow based assessments and observations. With-Project evaluation of flow conditions and pathways. Assessment of habitat use by observation or trapping in the Falls Reach (refuge, feeding, holding, moving, aggregations, predation). Assessment of habitat composition and connectiveness, incidence of fish-unfriendly conditions (e.g., trapping or stranding areas; development of predator stations).

Table 2. Nuyakuk River Hydroelectric Project Nexus with Aquatic Habitats and Functions: Potential Direct and/or Indirect Mortality of downstream moving Fish Due to passing via the powerhouse (entrainment) or the Falls Reach. Relates to stranding/trapping in Nexus 3a.	
Project Nexus 2a	Downstream passage and survival. Fish may pass downstream through the powerhouse (entrainment) or through the Falls Reach.
Structural/Operational Source of Impact	River flow will be diverted above the Falls proper and through the powerhouse at a variable rate. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Downstream passage conditions and habitats within the Falls Reach of the Nuyakuk River. A new downstream passage route will be available.
Potential changes in conditions/habitats	Will reduce the quantity of river flow and distribution through the Falls Reach and alter the depth/velocity distributions within pathways used for downstream passage, and the quantity and composition of habitats suitable for downstream passage in the Falls Reach.
Potential effects on fish	1. Changes in depth, velocity and habitat composition may impair or improve downstream fish passage conditions through the Falls Reach compared to baseline. For example, slower velocities and shallower depths may improve survival rates through the reach (less turbulence and potential abrasion, injury). In contrast, lower velocities and depths may predispose fish to lower survival due to predation. Also, an increase of rearing habitats (pools) within the Falls Reach could increase predation risk for downstream migrating salmon. 2. Migration pathways may change and total aquatic habitat available may decrease in the Falls to affect passage survival and respective density dependent ecological effects (e.g., predation, injury, stress). 3. Passage through the Project will offer novel conditions that may result in differential survival and injury as compared to the Falls Reach. Fish survival and physical condition could be affected by abrasion from concrete infrastructure, impingement on gates and screens, strikes with turbines, and predation in or adjacent to the tailrace structure. Differential injury or stress on fish between the routes may potentially cause a higher, latent mortality for route-specific fish after leaving the Project Area. 4. There may be interactive effects between future climate change and flow conditions, including reduced or increased flow overall and during specific seasons. Increased temperature from climate change and

	expansion of predator habitat could increase predation rates of small fishes/lifestages. Consider interactive effect between increased temperatures and passage metrics.
Metrics and criteria to evaluate the change to habitat and fish passage	1. <u>Metric</u> – Depth, velocity and habitat output from 2D modeling under different flow conditions, With and Without-Project. <u>Criteria</u> – Proportions of flow through the Project and the Falls Reach, pathways and areas of suitable/unsuitable passage, particle travel times; 2. <u>Metric</u> – Literature derived estimates of powerhouse passage survival effected by impingement, fish-friendly turbines, and predation in the tailrace. <u>Criteria</u> – Comparison with empirically derived estimates of survival; 3. <u>Metric</u> - Estimates of empirically derived downstream survival through the Falls Reach. <u>Criteria</u> – Comparison of rates of downstream passage survival between powerhouse and Falls Reach fish, Without and With-Project. 4. <u>Metric</u> – Proportional rate of injury for fish passing the Falls, With and Without-Project, and incidence of injury through the powerhouse. <u>Criteria</u> – Compare estimates of injury rate of fish passing through the powerhouse and Falls. <u>Comparison Basis:</u> - Probability distributions of suitable passage metrics and habitat conditions. If probabilities are similar or higher between With and Without-Project operations, then likely no effect. Comparative analysis of predicted injury and mortality between Falls, With and Without-Project, and through Project routes. - Probabilities can be linked to Life Cycle model to determine upstream related Project effects on individuals and population.
Operational Considerations	Turbine type, flow distribution across routes and timing, engineering design (gates, screens, tailrace) for higher passage survival in the Falls Reach
Monitoring and Adaptive	Flow based assessments and observations. With-Project evaluation of flow conditions and pathways.

Management	Observation of habitat use by fish in the Falls Reach (moving, aggregations). Assessment of habitat composition and connectiveness, incidence of fish-unfriendly conditions. Predator distribution and abundance.

Table 3. Nuyakuk River Hydroelectric Project Nexus with Aquatic Habitats and Functions: Potential Stranding or Trapping of Fishing the Falls proper, and potential dewatering or scouring of spawning habitat below the Falls and tailrace. Due to Rapid Flow Reductions (Down-ramping). Relates to migration pathways and total habitat in Nexus 1b, suitable conditions for rearing in Nexus 1c, and direct/indirect mortality in Nexus 2a.	
Project Nexus 3a	Pathways for movement. Potential stranding or trapping of fishes in the Falls Reach
Structural/Operational Source of Impact	River flow will be diverted above the Falls proper and through the powerhouse at a variable rate. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Rearing habitats and passage corridors within the Falls Reach of the Nuyakuk River.
Potential changes in conditions/habitats	Rapid changes in flow operations may result in rapid decreases or increases in flow through the Falls Reach. Some fringe habitats/corridors may become dewatered stranding fish, or as water recedes fish may be trapped in small, isolated pools.
Potential effects on fish	1. Rapid flow changes may render fringe habitats/corridors dewatered or partially dewatered resulting in potential stranding and/or trapping of small fish such as (e.g., salmon fry).
Metrics and criteria to evaluate the change to habitat and fish passage	1. Metric - Review of bathymetry and depth and velocity output from 2D modeling to identify areas with a high likelihood for getting disconnected from flow (e.g., perched depressions; gently sloping lateral margins; complex lateral habitats with widely variable topography). Criteria - Evaluate and compare stranding and trapping potential by running different operational ramping rate scenarios and seeing how identified risk areas respond in terms of the timing to disconnection, trapping and stranding, and the total areas affected. Quantify and characterize identified areas as high or low likelihood. High concern area is characterized as areas that are perched and highly sensitive to flow changes; low concern areas have depressions that only become

	disconnected under extremely low flow conditions. 2. Metric – modeled rate of mortality for fish stranded/trapped. Criteria - use life cycle model and a distribution of mortality rate for sensitivity analysis of stranding/trapping under flow scenarios. Comparison Basis: - Comparison of (a) total trapping/stranding area (m2) under With and Without-Project operations, and (b) modeled mortality estimates With and Without-Project based on different down-ramping rates. - Results linked to life cycle model as source of influence on juvenile/smolt/fry survival rates through the Falls Reach.
Operational Considerations	Rate of change in flow directed through the turbines. Sequence and timing of turbine start up and shut down.
Monitoring and Adaptive Management	With-Project monitoring of topography of the Falls proper to identify specific locations for fish stranding and or trapping low flow condition. Monitor program during downstream fish migration during; conduct post – flow change monitoring of areas at risk to see if any trapping or stranding has occurred.
Project Nexus #3b	Spawning habitat below Falls and tailrace. Potential for dewatering or scouring.
Structural/Operational Source of Impact	Operational changes in flow rate and distribution through the powerhouse and the Falls Reach.
Conditions/Habitats Affected	Potential spawning habitats downstream of the Falls and tailrace.
Potential changes in conditions/habitats	Changes in operations may result in decreases or increases in flow through the Falls Reach. Decreases may result in some fringe habitats used for spawning (if present) to become dewatered. Rapid increases may result in some scouring of these areas. Water flow, water elevation, river channel configuration, and distribution of substrate composition may create suitable spawning habitat in new locations.
Potential effects on fish	1. Flow reductions may render fringe spawning habitats dewatered or partially dewatered resulting in

	potential egg desiccation or reduced embryo survival (reduced intragravel velocities). 2. Rapid flow increases may scour redds and dislodge eggs/embryos. 3. Suitable habitat for spawning may be created by new hydraulic conditions of the Project. 4. There may be interactive effects between future climate change and flow conditions, including reduced or increased flow overall and during specific seasons. Consider interactive effect between increased temperatures and passage metrics.
Metrics and criteria to evaluate the change to habitat and fish passage	1. <u>Metric</u> – Evaluate2D model flow field and water elevations below the Falls and tailrace over several operational scenarios including different ramping rates, to determine whether and extent to which potential spawning areas might be affected (dewatered, scoured etc.). <u>Criteria</u> – Identify flow field and elevation changes may result in potentially erosive or dewatering conditions, or the development of new suitable spawning locations. 2. <u>Metric</u> - Observations and demarcation of spawning gravel distributions downstream of the Falls proper, including within and downstream of the proposed tailrace. If possible, collect substrate samples to verify size classes present. <u>Criteria</u> - If spawning observed, review output form 2D model to define areas where potential changes in operational flows could dewater or scour redds. Relate potential impact area to potential for fish incubation effects based on estimates of redds/square meter and embryo per redd estimates obtained from the literature. <u>Comparison Basis</u>: - Comparison of (a) area of spawning/incubation habitat under With and Without-Project operations, and (b) potential effects to embryo mortality under With and Without-Project operations. - Results linked to life cycle model as source of influence on juvenile/smolt/fry survival rates through the Falls Reach.
Operational Considerations	Timing and sequence of turbine start up and shut off. Rate of change of intake flow through the powerhouse.
Monitoring and Adaptive Management	With-Project observational monitoring for redds for the area downstream of the Falls proper to downstream of the tailrace. The area of interest may modify depending on shifts in channel in substrate because of

	Project operations.

Table 4. Nuyakuk River Hydroelectric Project Nexus with Aquatic Habitats and Functions: Potential migration delay and injury may result in the delayed passage timing and/or latent mortality of fish moving upstream due to false attraction to the tailrace or changes in habitat below the Falls proper. Relates to upstream moving fish in Nexus 1a.	
Project Nexus #4a	Timing, behavior, and passage routes of upstream moving fish entering the Falls proper.
Structural/Operational Source of Impact	Operational changes in flow rate and distribution through the powerhouse/tailrace and the Falls Reach. Some river habitat will be replaced with water conveyance structures.
Conditions/Habitats Affected	Flow field and the proportion of flow coming through the Falls Reach and tailrace. Channel configuration and habitats below the Falls proper could be modified.
Potential changes in conditions/habitats	Project operations will result in a higher proportion of flow in the tailrace compared to the Falls Reach tailout and may change the flow field, channel configuration, and water depths/velocity below the Falls proper. The composition, configuration, connectivity, and suitability of holding/staging/migration/ascension habitats downstream of the Falls proper and tailrace may change.
Potential effects on fish	1. Changes in holding/staging/migration/ascension habitats below the Falls proper may become less suitable or connected and result in delayed passage through the Falls or higher rates of injury. Anadromous migrants may have higher rate of latent mortality prior to spawning. Resident migrants may arrive later or not at all to destinations associated with their life history. 2. Upstream migrating fish may be attracted to the predominant flow of the impassible route of the tailrace and thereby be delayed in finding the migration pathway into the Falls proper or subject to higher rates of injury. 3. Adult salmon attracted to turbine discharge into the tailrace could be injured jumping at draft tubes or other structures. 4. Fish may expend additional energy related to 1) the alteration of holding /staging/migration/ascension habitat immediately below the Falls proper or 2) time and effort being falsely attracted to the tailrace and result in premature mortality.

Metrics and criteria to evaluate the change to habitat.	1. <u>Metric</u> - Depth and velocity output from 2D modeling under different flow conditions (With and Without-Project). <u>Criteria</u> - Identification and assessment of potential changes to holding/staging/migration/ascension habitats (quantity, composition and flow characteristics) and the effect on migration into the Falls proper. 2. <u>Metric</u> – Assessment of the mixing of flow fields from the tailrace and Falls Reach. May provide an indication of potential for and severity of false attraction to the tailrace. <u>Criteria</u> - Depth and velocity vector values can be compared to standards developed by NMFS for fish passage at hydropower facilities. 3. <u>Metric</u> - Observations or telemetric data of numbers and timing of fish holding/milling/searching immediately downstream of the Falls proper and tailrace compared to numbers successfully passing the Falls Reach (i.e., above the Project). <u>Criteria</u> – A relative increase in the number of fish below the Falls proper compared to the number passing the Falls proper may indicate a delay in passage timing. Fish holding/milling for extended time at locations further downstream With-Project. 4. <u>Metric</u> - Ratio of number migrants upstream versus downstream of the Falls Reach, With and Without-Project. <u>Criteria</u> – A decrease in ratio would indicate fewer migrants are successfully passing the Falls Reach. 5. <u>Metric</u> – Observed rate of injury or mortality of fish below the Falls proper and tailrace. Observation of migration jumping at unpassable structures. <u>Criteria</u> – Observed higher incidence of injury or mortality With-Project may indicate unsuitable habitat conditions. Information gleaned from analysis can be parameterized into Life cycle model as a mortality factor. 6. <u>Metric</u> – use life cycle model analyses to address the potential energy expenditure effect (#4). <u>Criteria</u> – Assess the potential quantity of delay time that would cause latent pre-spawn mortality in migrating salmon due the additional energy used during the delay. <u>Comparison Basis</u>: - Rates of injury, delay, milling compared to expected values.

Operational Considerations	Engineered modifications to tailrace outflow, rerouting of flow from turbines, physical methods to prevent fish from entering the tailrace
Monitoring and Adaptive Management	Monitoring of fish behavior at tailrace and in the holding pool downstream of the Falls. Estimates of injury and mortality in the tailrace. Monitoring of passage success.

3. C2. Hypothesis Statements

Null Hypothesis	Alternative Hypothesis	Example Values	Example Metric
Comparative metrics for pre- and With-Project conditions, given natural variability. The metrics for Hypotheses 2,3,4,5,7 are intended for sensitivity analysis with the Life Cycle Model to ascertain the magnitude to which these relations may be important in the risk analysis. However, this does not exclude the potential need for validation of the relationships that are demonstrated to be sensitive to change and form the basis of collecting the necessary empirical data for the Nuyakuk (e.g., tower counts of adults and hydroacoustic counts of juveniles for salmon). Blue shade indicates a sequence which potentially leads to reduced long term production and sustainability of the population.			
DIRECT Effect - H1N. The probability of upstream passage success through the Falls will be similar. Life Cycle Transition 1. Metric(s) 1a2	H1A1. The probability of upstream passage success through the Falls will be significantly lower under With-Project conditions relative to Without-Project.	Without-Project = 0.90 With-Project = 0.80	Probability of upstream passage success through the Falls (from a calibrated fish passage model). A lower probability can result in a decreased population.
	H1A2. The probability of upstream passage success through the Falls will be significantly higher under With-Project conditions relative to Without-Project.	Without-Project = 0.90 With-Project = 1.0	
DIRECT Effect - H2N. The ratio of upstream-Project to downstream-Project adult migrants will be similar. Life Cycle Transition 1. Metric(s) 4a4	H2A1. The ratio of upstream-Project to downstream-Project adult migrants will be significantly lower (i.e., relative decrease in spawners upstream the Project) under With-Project conditions relative to Without-Project.	Without-Project = 0.90 (9:10) With-Project = 0.80 (8:10)	Number of adult migrants upstream-Project and downstream-Project. A lower ratio can indicate a lower passage success and can result in a decreased population.
	H2A2. The ratio of upstream-Project to downstream-Project adult migrants will be significantly higher (i.e., relative increase in spawners upstream the Project) under With-Project conditions relative to Without-Project.	Without-Project = 0.90 (9:10) With-Project = 1.0 (10:10)	

INDIRECT Effect - H3N. The ratio of upstream-Project juvenile migrants to upstream-Project adult migrants will be similar. Life Cycle Transition 2. Metric(s) 1b2, 4a4	H3A1. The ratio of upstream-Project juvenile migrants to upstream-Project adult migrants will be significantly lower (i.e., relative increase in adult delayed mortality through the Project) under With-Project conditions relative to Without-Project.	Without-Project = 100.0 (100:1) With-Project = 50.0 (50:1)	Number of juvenile migrants upstream-Project and number of adult migrants upstream-Project. A lower ratio can indicate fewer successful spawners and result in a decreased population.
	H3A2. The ratio of upstream-Project juvenile migrants to upstream-Project adult migrants will be significantly higher (i.e., relative decrease in adult delayed mortality through the Project) under With-Project conditions relative to Without-Project.	Without-Project = 100.0 (100:1) With-Project = 150.0 (150:1)	
DIRECT Effect - H4N. The ratio of downstream-Project juvenile migrants to upstream-Project juvenile migrants will be similar. Life Cycle Transition 3. Metric(s) 1b2	H4A1. Ratio of downstream-Project juvenile migrants to upstream-Project juvenile migrants will be significantly lower (i.e., relative decrease in juvenile outmigrants downstream the Project).	Without-Project = 0.90 (9:10) With-Project = 0.80 (8:10)	Number of juvenile migrants downstream-Project and upstream-Project. A lower ratio indicates lower survival and can result in a decreased population.
	H4A2. Ratio of downstream-Project juvenile migrants to upstream-Project juvenile migrants will be significantly higher (i.e., relative increase in juvenile outmigrants downstream the Project).	Without-Project = 0.90 (9:10) With-Project = 1.0 (10:10)	

INDIRECT Effect - H5N. The ratio of downstream-Project juvenile migrants by brood year to downstream-Project returning adult migrants by brood year, compared to ratios observed in other systems, will be similar. Life Cycle Transition 4. Metric(s) 1b2, 4a4	H5A1. The ratio of downstream-Project returning adult migrants by brood year to downstream-Project juvenile migrants by brood year, compared to ratios observed in other systems, will be significantly higher (relative increase of juvenile delayed mortality passing through the Project).	Without-Project = 0.10 (1:10) With-Project = 0.05 (1:20)	Number of adult migrants downstream-Project and juvenile migrants downstream-Project and (brood analysis). Higher ratio indicates fewer adult returns per juvenile and may result in a decreased population.
	H5A2. The ratio of downstream-Project returning adult migrants by brood year to downstream-Project juvenile migrants by brood year, compared to ratios observed in other systems, will be significantly lower (i.e., relative decrease of juvenile delayed mortality passing through the Project).	Without-Project = 0.10 (1:10) With-Project = 0.15 (1:7)	
Direct Effect - H6N. The quantity of suitable rearing habitat in the Falls Reach will be similar. Life Cycle Transition 3. Metric(s) 1c1	H6A1. The quantity of suitable rearing habitat in the Falls Reach will be significantly lower under With-Project conditions relative to Without-Project.	Without-Project = 1 ha With-Project = 0.5 ha	Quantity (hectare) of suitable rearing habitat in the Falls Reach as defined by depth and velocity as index of effect on survival. A lower survival can result in a decreased population.
	H6A2. The quantity of suitable rearing habitat in the Falls Reach will be significantly higher under With-Project conditions relative to Without-Project.	Without-Project = 1 ha With-Project = 1.5 ha	

Direct Effect - H7N. The survival of downstream migrants through the Falls Reach and the powerhouse will be similar. Life Cycle Transition 3. Metric(s) 2a2, 2a3, 2a4	H7A1. Survival of downstream migrants through the powerhouse (literature) will be significantly lower than Without-Project through the Falls Reach (empirical).	Falls Reach = 95% powerhouse = 85%	Proportion of downstream migrants surviving through the powerhouse and Falls Reach. A lower survival can result in a decreased population. With-Project survival through the powerhouse may be empirical.
	H7A2. Survival of downstream migrants through the powerhouse (literature) will be significantly higher than Without-Project conditions through the Falls Reach (empirical).	Falls Reach = 95% powerhouse = 99%	
Direct Effect - H8N. The survival of downstream migrants through the Falls Reach *and* tail out will be similar. Life Cycle Transition 3. Metric(s) 2a3, 2a4	H8A1. Survival of downstream migrants through the Falls Reach and tail out under With-Project conditions will be significantly lower than Without-Project.	Without-Project = 95% With-Project = 85%	Empirical proportion of downstream migrants surviving through the Falls Reach *and* tail out. A lower survival can result in a decreased population. This comparison is conducted if the Project is built.
	H8A2. Survival of downstream migrants through the Falls Reach and tail out under With-Project conditions will be significantly higher than Without-Project.	Without-Project = 95% With-Project = 99%	

Direct Effect - H9N. The risk of stranding/trapping of small fish in the Falls Reach will be similar Pre- vs - Post Project. Life Cycle Transition 3. Metric(s) 3a1, 3a2	H9A1. The risk of stranding/trapping of small fish With-Project will be significantly higher than Without-Project.	Without-Project = 0.5 With-Project = >0.6	Estimated risk will be determined by channel bathymetry/topography in relation to flow reduction associated With-Project operations. Will then look at range of typical flow changes over different time periods Pre- and Post-Project operations to see to what extent stranding/trapping may occur within those areas.
	H9A2. The risk of stranding/trapping of small fish With-Project will be significantly lower than Without-Project.	Without-Project = 0.5 With-Project = <0.4	
Direct Effect - H10N. The modeled total area of potential dewatering or erosion of spawning habitat *in* the powerhouse tailrace and Falls Reach tail out will be similar. Life Cycle Transition 3. Metric(s) 3b1, 3b2	H10A1. The total area of potential dewatering or erosion of spawning habitat will be significantly higher With- versus Without-Project conditions.	Without-Project = 1 ha With-Project = 1.5 ha	Modeled area of potential dewatering or erosion of spawning habitat (defined by suitability criteria) as an index of effect on juvenile production *in* the powerhouse tailrace and Falls Reach tail out. Decreased spawning habitat can result in decreased production and population.
	H10A2. The total area of potential dewatering or erosion of spawning habitat will be significantly lower With- versus Without-Project conditions.	Without-Project = 1 ha With-Project = 0.5 ha	

Direct and Indirect Effect - H11N. The modeled flow field (velocity vectors and depth) in the Falls Reach tail out will provide similar upstream migration attraction cues to current conditions in the Falls Reach. Life Cycle Transition 1. Metric(s) 4a1, 4a2, 4a5	H11A1. With-Project water velocity vectors and depth in the Falls Reach tail out will be significantly different and result in poor upstream migration attraction cues into the Falls Reach relative to Without-Project conditions.	Without-Project = within criteria With-Project = out of criteria	Modeled water velocity vectors and depth in the Falls Reach tail out as an indicator of passage attraction flow. Pre- and With-Project suitability of water velocity and depth in ascension pathways based on physical ability and NMFS attraction flow criteria compared to tailrace flows. Delayed migration can result in increased injury, pre-spawn mortality, and a decreased population.
	H11A2. With-Project water velocity vectors and depth in the Falls Reach tail out will be significantly different and will result in better upstream migration attraction cues into the Falls Reach relative to Without-Project conditions.	Without-Project = within criteria With-Project = out of criteria	

Direct and Indirect Effect - H12N. Residence times (empirical) of upstream migrants below the Falls Reach will be similar. Life Cycle Transition 1. Metric(s) 4a3, 4a5	H12A1. Residence times of upstream migrants below the Falls Reach will be significantly higher under Without- versus With-Project conditions.	Without-Project = T With-Project = 2T	Residence times (empirical) below the Falls Reach as an indicator of false attraction. Delayed migration can result in increased injury and pre-spawn mortality, and a decreased population. Baseline residence times to be compared with With-Project times during monitoring period. This comparison is conducted if the Project is built.
	H12A2. Residence times of upstream migrants below the Falls Reach With-Project will be similar to Without-Project.	Without-Project = T With-Project = 0.5T	

APPENDIX D: Proposed Study Plan Comment Responses (7/23/2021 Aquatics Resources Work Group Technical Subcommittee Distribution)

Table 1. Comments received on the Proposed Study Plan (PSP) for the Nuyakuk River Hydroelectric Project (P-14873) distributed to the Aquatics Resources Technical Workgroup (ARWG) on July 23, 2021 and Nushagak Cooperative's responses.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
1	ADFG (Tim Sands)	4.1.1.7 Methodology – Adult Salmon Migratory Behavior Observation	I'm concerned that they think they can accomplish this by surveys every five days weather depending. I'm also concerned that they are married to these 3 zones. It may be much easier and safer to sample or monitor migrations further away from the high flow areas adjacent to the falls. I understand that they want to monitor activity in that area but to accomplish the stated goal of estimating timing and number of fish they should consider finding the place where that is easiest even if that is outside of their defined zones. I suspect that closer to the lake it may be easier. That is not to say they shouldn't still do surveys and try and determine the migratory paths and all that.	The intention of visual observation surveys is to gain some understanding of how the fish move through the falls and what paths they are using: right, left or middle so subsampling is an appropriate approach. However, to capture the variable nature of the flows and subsequent passage at this site, we have revised the study plan to indicate that observations would occur every two to five days weather and method depending. With respect to sampling locations, our intent is to focus on Zones 1-3 as the data collected there would be site-specific and representative of the existing condition in the proposed bypass reach. That said, we acknowledge that additional site evaluation is necessary to determine appropriate methods for this area, safety considerations and whether collecting data a bit further upstream and/or downstream of the Project area is necessary.
2	ADFG (Tim Sands)	4.1.1.7 Methodology – Downstream Migrant Trapping/Migration Pattern Observations	I'm concerned that they will only run this sampling for 72 hours during each survey week. I can't quite figure out when the survey weeks are. Are they once a month? Once in the spring, summer, fall and winter. I read through this whole section and can't figure it out. I'm not sure what the timing is for the various species that will outmigrate but it sure seems like a 72 hour window a week a month will not categorize the migratory timing by species very well.	Text was added to clarify the intent of operating migrant traps throughout the salmon outmigration window and to indicate that the 72 hour minimum could be achieved through a combination of a number days a week and block of hours each trap day.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
3	BBSRI (Bryan Nass)	2.0 Project Location and Description	I recall that an economic feasibility assessment of undetermined scope was proposed or considered at some point. Am I missing something or is there a separate document or source of information on this aspect so that stakeholders can review the numbers and assumptions? The only reference I found on the website was a bullet in the FAQ doc.	An economic feasibility assessment will be ongoing during the entirety of the study program process and a financial assessment (benefits, impacts, plan for development, etc.) will be incorporated into draft and final license applications. As natural resource study results come in and design elements are refined accordingly, the financial assessment will evolve.
4	BBSRI (Bryan Nass)	2.3 Project Facilities	[regarding sentence: "The powerhouse is conceptualized to contain two Kaplan-style reaction turbine generating units to accommodate a combined maximum design flow of approximately 6,000 cfs divided evenly among the units."] Fig 4-4 and 4-7 indicate diversions up to 7,551 as based on the PAD. Likely not critical since it says approximately, but recognize that some analyses (like % diversion) are based on the 7,551 value.	The flow amount in the caption for Figure 4-4 is intended to define the amount of flow in the river on the date the aerial image was taken. Regardless and as the comment recognizes, a substantial amount of design and analysis will take place in the coming years to ultimately define the amount of water that may be able to be diverted for power production.
5	BBSRI (Bryan Nass)	2.3 Project Facilities	[regarding sentence: "This combined maximum design flow <u>between 55% and 80% of</u> the average flow rate for the months of June, July and August, less <u>a design specification of</u> 1,000 cfs for instream uses."] I am assuming this is not a regulatory specification.	As noted in the prior comment response and the sentence preceding the reference in the PSP, operational and flow values are "conceptual" at this point. A substantial amount of design and analysis will take place in the coming years to ultimately define the amount of water that may be able to be diverted for power production.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
6	BBSRI (Bryan Nass)	2.3.2 Nuyakuk Falls Diversion & Intake	[“regarding sentence: The intake diversion would move water from the southern portion of the river above the falls into a drop shaft-type structure connected with two 18-foot diameter tunnels.”] Has modeling already been completed to substantiate this statement? Otherwise, it is not known what the flow field looks like.	At this point, all design elements are conceptualized and based upon baseline surveying, site visits, historic hydrology, etc. Substantia site-specific analysis will occur in parallel with the natural resource study program and ultimately define the specifics of the Project infrastructure.
7	BBSRI (Bryan Nass)	4.1 Aquatics/Fisheries Resources	It would be good to decide when “falls” and “reach” are capitalized, as in Falls reach, and make it consistent throughout. Also, need consistency for with and without Project (used as a condition. With-Project, without-Project?), as in pre-Project and post-Project (which I think are used in a timeframe context). For some reason my find tool is not finding them…	Thank you for this comment. The document has been revised to have consistent conventions in these regards.
8	BBSRI (Bryan Nass)	4.1 Aquatics/Fisheries Resources	“Water diversion would reduce flow and may change habitat conditions through the approximately 0.7 mile falls reach,” As per Section 2.1 The stat from 2.1 may not be appropriate bc it apparently starts at the physical intake and ends at the physical tailrace. Therefore, I’ve changed this according to the potential extent of hydraulic influence as indicated in 4.1.1.2. Based on the fish passage study area, the “falls” area is approx. 1930 ft or 0.36 mi	The reach length issue has been resolved and the PSP updated accordingly

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
9	BBSRI (Bryan Nass)	4.1 Aquatics/Fisheries Resources	The 2D model extents do not cover the entirety of the hydraulic extents of the Project (approx. 0.5 mi up and dn of the falls as per the fish community study). We think it should cover that whole area to be able to understand the conditions that upstream and downstream migrating salmon will encounter as they approach the physical Project. The hydraulics may provide cues migrating fish that will influence where those fish arrive with respect to the Project and the falls, and thereby affect their interaction with the Project. I updated the distances for the 2D model according to the information in the Fish Pass Study 4.1.2.2 updated by Dudley. However, if the hydraulic extent is actually 1.36 mi (as in 4.1.1.2), then it would be appropriate for the 2D model to cover that. Note that the lidar covers 1.86 mi of river.	The reach length issue has been resolved and the PSP updated accordingly

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
10	BBSRI (Bryan Nass)	4.1.1 Characterization of the Fish Community and Behavior Near the Project Area 4.1.1.2 Geographic Scope	["regarding sentence: approximately 0.5 miles upstream of the Nuyakuk Falls (the Falls) to an area approximately 0.5 miles downstream of the Falls, which includes the proposed tailrace area of the Project (Figure 4-2). Based on current design, this one-1.36 mile study area would account for the entire area of potential flow alteration associated with Project operations."] According to 4.1.2.2, the falls is 0.36 mi in length. The extents of potential flow operation are important to determining what the zone of influence is for the Project as habitats may change within it (i.e., the overall study area), and needs to be consistent throughout the document.	The reach length issue has been resolved and the PSP updated accordingly

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
11	BBSRI (Bryan Nass)	4.1.1 Characterization of the Fish Community and Behavior Near the Project Area 4.1.1.3 Study Goals and Objectives	Potentially "new" predation in the form of increased effort and new locations could arise as a result of the Project. It would be prudent to include some directed effort as part of this study to determine the whereabouts of piscivores and the extent to which they are eating smolts in the spring. Are piscivores presently in the vicinity of the intake and tailrace? Is the falls tailout a location of relatively high abundance of piscivores? Important locations: near-field of intake, near-field of tailrace, in the falls, falls tailouts. Also see comment in the Mortality section of the entrainment study. There may be other forms of predation that this study could document (avian, mammals)	This fish sampling study will be designed to evaluate presence of piscivores in the study area under baseline conditions through this study area and with a primary focus on the intake, tailrace and the reach immediately downstream of the falls. We do not anticipate being able to documents predator abundance throughout the Falls proper due to depth and velocity conditions but will conduct sampling along the channel margins where it is safe. In addition, the 2-D model results will give us information on potential habitat conditions throughout the project area related to different flows. We can then review these conditions and habitat suitability characteristics for key piscivorous fishes to evaluate the potential of creating or eliminating habitat for piscivores. In addition, we can collect incidental observations of avian or mammalian piscivores in the area. The text has been edited to clarify these points.
12	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.1 General Description of Proposed Study	This is salmon centric, so should residents be mentioned as this is a general description for the study?	Text revised to note other fish species will be considered as well.
13	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.1 General Description of Proposed Study	[regarding a new figure provided by Bryan Nass] I recommend using this figure rather than the original as it provides the metric of % diverted.	Agreed, figure modified accordingly.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
14	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.1 General Description of Proposed Study	[regarding title for Figure 4-4 which was edited by Bryan Nass] This data was analyzed on a daily basis	The figure caption has been revised to state "daily".
15	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.2 Geographic Scope	[regarding sentence: "The geographic focus of the Fish Passage Evaluation will be from the upstream hydraulic control of the Nuyakuk Falls downstream approximately 0.35 miles to the base of the falls."] Section 2.1 says it is 0.7 miles (?).	The reach length of the hydraulic modeling has been resolved and the PSP updated accordingly. Text reads-*The geographic focus of the Fish Passage Evaluation will extend from approximately 1,000 ft (0.19) above the upper end of the Nuyakuk Falls to approximately 1,400 ft (0.27 mi) be from below the lower end of the falls; total length of the study area is approximately 4,310 ft (0.82 mi.). (Figure 46???)* Two figures have been added, one that depicts the Falls reach and extent of 2D modeling, the second the extent of the LiDAR coverage with the Falls reach (focus of hydraulic modeling) highlighted and superimposed on that coverage.
16	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.2 Geographic Scope	This is where it might be beneficial to include the extents of the LiDAR data.	The extent of the LiDAR data was intentionally in excess of the bypass reach for the proposed Project. The goal here was to be certain that we acquired all necessary topographic and bathymetric data during the survey so the need for additional LiDAR in the future would not be required. A new figure has been inserted into the PSP under the 2D Modeling section that displays the extent of LiDAR coverage and the Falls reach that encompasses the hydraulic modeling.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
17	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.6 Project Nexus	[regarding statement: "Diverted water would then be discharged back into the natural channel immediately below the falls resulting in a 0.34 mile bypass section that comprises the Nuyakuk Falls reach."] Correct?	As noted above, the length of the bypass section has been adjusted to 0.82 mi.
18	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	May 2020 indicated above [regarding bathymetric survey date]	Date adjusted here to May 2020 to correspond with other date
19	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	[regarding a new figure provided by Bryan Nass] I recommend using this figure rather than the original as it provides the metric of % diverted. I added general periodicities for salmon to the figure	Agreed, figure modified accordingly.
20	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	[regarding Figures 4-9 and 4-10] These are the exact same figure, so either we only need one of them, or one scenario needs a new figure.	Replaced second figure with proper one for downstream migration
21	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	Not critical, but, migration, operations, and reduction are misspelled. On 4-12, the expected change associated with climate is supposed to indicate "downstream".	Changes made to figure

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
22	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	I must be missing something as I don't see how the figure illustrates habitat change, other than the diversion…	Agree – figure deleted
23	BBSRI (Bryan Nass)	4.1 Aquatics/Fisheries Resources	"Water diversion would reduce flow and may change habitat conditions through the approximately 0.7 mile falls reach," As per Section 2.1	The length was changed from 0.7 mi to 0.82 mi per the Fish Passage Study. This was computed via GIS from the top of the falls to below the tailrace and is therefore the most accurate estimate. All length numbers are now consistent between sections.
24	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	Windows can only be validated by collection of empirical data on individual fish passage events over a range of flows. Without it, there is an indeterminant level of risk that the modeling does not characterize fish passage through the falls.	True, but doesn't forego the estimation of probabilities of successful passage based on published swimming and jumping capabilities compared with model generated values within the Falls reach under different flow characteristics. Telemetered data would serve as a validation step to see if probability estimates were realistic.
25	BBSRI (Bryan Nass)	4.1.2 Nuyakuk Falls Fish Passage Study 4.1.2.7 Methodology	This characterization of the evaluation is too ambiguous for a reviewer to ascertain what the steps are. Seems this should be a bit more specific regarding what constitutes this evaluation in the last step. How is the modeling going to provide an evaluation? Probabilities of occurrence for a qualitative range of dewatering? Please identify specific data that can be used in the LCM and IRA where risk will be classified.	Additional text was added to this section to more fully explain the modeling process including the assessment of potential stranding and trapping.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
26	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	[regarding sentence: "A two-dimensional hydraulic model of Zones 1, 2, and 3 of the Nuyakuk River will be developed under the Fish Passage Study."] This statement conflicts with the shaded areas representing the modeled area for this study, the passage study, and the false attraction study. It seems the modeled area does not equal all of zones 1,2,3. But we would like to see all of the zones modeled in their entirety for reasons indicated elsewhere.	As described in the Geographic Scope of the Nuyakuk Falls Fish Passage Study (4.1.2.2), the 2D model will encompass all three zones within the project area. Additional text clarifications were added in the description of the 2D model to affirm this coverage.
27	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	[regarding sentence: evaluate approach velocities and approach angles in relation to primary fish species swimming ability and behavior for various intake designs and orientations. Similar to the attraction study, this description does not provide adequate information for the reader to understand what the steps and criteria are. As an example, what range in velocities and angles would most certainly entrain and not entrain a juvenile sockeye? 3 m/s at 45deg ? Is this the concept or am I conceptualizing this incorrectly?	The approach and sweeping velocity criteria will be species-specific and will use NMFS criteria as guidelines for protection. The velocities and approach angles that result in sweeping velocity will likely vary with different intake design configurations. These values will need to be determined during the study once flow patterns, species and design options are known.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
28	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	[regarding statement: "The overarching goal of the literature review and hydraulic model evaluation is to refine the preliminary design for the Nuyakuk Project intake that minimizes potential fish mortality and injury due to entrainment, and impingement, and related fish mortality and injury."] Minimizing the interaction that leads to lower mortality and injury	We appreciate the comment but want to leave the focus on finding the design that reduces mortality and injury through the project. A focus on minimizing interaction with the Project implies that we expect that turbine passage has more potential for injury and mortality then reduced flow conditions over the falls and I am not sure we can assume that. By focusing on reduced mortality and injury associated with passage through the Project we are going to find a better design regardless of which route is safer.
29	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	As discussed, I could not detect in the first two references [EPRI 2997; FERC 1995] anything that substantiates the statement – I took detailed notes of content during my review. Specifically, I did not see anything about using a modeled flow field and hypothetical fish density to estimate entrainment (but I would be intrigued to see a paper that does). I was not able to obtain the Winchell doc and would appreciate a copy to see if it provides supporting information. The credibility of this approach would be elevated if you could cite actual FERC license documentation for a Project that could be used as an example.	The text has been revised to clarify intent of citations. In addition, a copy of the Winchell et al. document was provided to Bryan Nass and can be made available to others. The following projects included FERC approved desk top entrainment studies: Mason Dam Hydroelectric Project (P-12686), Uniontown Hydroelectric Project (P-12958), Overton Hydroelectric Project (P-13160), Emsworth Back Channel Hydroelectric Project (P-13761), Montgomery Locks and Dam Hydroelectric Project (P-13768), Evelyn Hydroelectric Project (P-14799), Braddock Locks and Dam hydroelectric project (P-13739), Allegheny Lock and Dam 2 Hydroelectric Project (P-13755), and the Emsworth Locks and Dam Hydroelectric Project (P-13757).
30	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	I could not obtain this document and would appreciate a copy. [regarding: Coutant and Whitney 2000]	A copy of the Coutant and Whitney document was provided to Bryan Nass and can be made available to others.

31	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	For discussion with MLK. Turbine intake and outfall flow fields have been shown to be energetically beneficial locations for predators to take other passing fish, especially juveniles, that get concentrated in water diversion scenarios. For example, consider a juvenile salmon that makes it past the gauntlet at the intake, survives passage through a turbine, and then is preyed upon by a waiting Dolly Varden at the tailrace. Regardless of the location in that route, the Project would have indirectly increased vulnerability, increased mortality, and thereby potentially decrease survival of the population (short and longterm). This relationship needs to be recognized and/or incorporated into the assessment of Project mortality. Similarly, changes in flow through the falls reach could increase (or decrease) predation on juvenile salmon in the falls proper and in the falls tailouts. Perhaps the quantitative predation is for the LCM, but it seems the fish community study should be addressing the distribution of predators, pre and post Project, and provide the rationale. This study may research how this phenomenon has developed at other Projects. Similarly, changes in flow through the falls reach could increase (or decrease) predation on juvenile salmon in the falls proper and in the falls tailouts. Perhaps the quantitative aspect of this is for the LCM, but it seems the fish community study should be addressing the distribution of predators, pre and post Project	We appreciate the comment. As stated in response to comment 10, Fish sampling during the Fish Community study will be designed to evaluate presence of piscivores in the study area under baseline conditions through this study area and with a primary focus on the intake, tailrace and the reach immediately downstream of the falls. The relationship between the Project and indirectly mortality cannot be empirically determined before the project is built. Once we have conducted the pilot testing we may be able to evaluate mortality over the falls, depending on our ability to collect fish above an capture a substantial portion below. Given interannual variability of outmigrant size and condition, the best empirical data on this issue will come post-project through monitoring that can inform adaptive management. Additionally, the LCM will be able to incorporate sensitivity of losses to predation on overall populations.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
32	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	For discussion with MLK. Relates to the prior comment. This assumes that flow is proportionate to entrainment, but it may be that smolts disproportionately follow flow. It may be more conservative to assume that any smolt that enters the flow field (the draw of the intake) will be entrained. A thorough sensitivity analysis will evaluate this and other assumptions.	The text was modified to add behavior to the factors that influence entrainment, I think this take us away from the assumption that entrainment will be expected to be proportional to flow.
33	BBSRI (Bryan Nass)	4.1.3 Fish Entrainment and Impingement Study 4.1.3.7 Methodology	For discussion with MLK. Relates to the prior two comments. This assumes that smolts/fry normally migrating at 5-17 kcfs survive at the same rate as if they migrated at 1-10 kcfs (according to the base case flow regime and timing). This relationship might be evaluated with sensitivity analysis as smolts tend to migrate with the freshet to be fast and covert (and avoid predation).	We appreciate this comment and note that the entrainment study is focused on first evaluating the potential to minimize direct injury and mortality from the turbine and project infrastructure design features. If estimates/predictions of direct injury prove to be of concern, collaborative study planning discussions associated with year 2 efforts would take this into account and a supplemental study to assess/predict indirect mortality over the falls and through the project may be deemed justified.
34	BBSRI (Bryan Nass)	4.1.4 Assessment of False Attraction at the Tailrace Fish Barrier 4.1.4.2 Geographic Scope	[Regarding Figure 4-16, which shows the study area] Hatching should go up to/into the chutes to the extent that habitat could change with respect to attraction.	The figure has been modified to show the study area up to the falls downstream chutes.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
35	BBSRI (Bryan Nass)	4.1.4 Assessment of False Attraction at the Tailrace Fish Barrier 4.1.4.7 Methodology	This characterization of the evaluation is too ambiguous for a reviewer to ascertain what the steps are. There are three metrics identified but no indication of what or how comparisons are made, and by what criteria. What constitutes potential effectiveness? What are the conditions that enhance attraction? As in the fish passage study, perhaps provide an example. There are no cited references provided to support the proposed approach. Is this a newly conceived approach, or has it been applied in a similar situation previously? I suspect the former given the general description provided, but if there is precedence, it would be good to know.	Text has been added to help clarify the intent of the comparative model approach and its acceptance by regulatory agencies on another FERC project. Criteria that are used to define effectiveness have not yet been determined but will be built into the model in collaboration with the ARWG.
36	BBSRI (Bryan Nass)	4.1.4 Assessment of False Attraction at the Tailrace Fish Barrier 4.1.4.7 Methodology	[regarding: "ecological, physical and operational criteria"] For example ?	Text was edited replacing "criteria" with characteristics and several examples of the types of data are provided.
37	BBSRI (Bryan Nass)	6.0 References	It has been my experience in FERC hydro processes that the references are made available to the public should they wish to research particular aspects. For my review, I was not able to obtain several documents through public channels (some require membership or to purchase). I won't advocate for establishing a repository bc I know it is extra effort, but I will appreciate being provided elusive docs. Thx.	We are happy to share reference documents cited in our study plans and report at the request of reviewers.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
38	BBSRI (Bryan Nass)	Appendix C, H3N	Please keep the alternative hypotheses (A1, A2) together (i.e., no orphans)	The Cooperative appreciates the comment. This formatting was corrected during document revision.
39	BBSRI (Bryan Nass)	Appendix C, H11N	Please keep the alternative hypotheses (A1, A2) together (i.e., no orphans)	The Cooperative appreciates the comment. This formatting was corrected during document revision.
40	NMFS (Sean Eagan)	Section 2.4.1 Proposed Project Operations	Sean Eagan wrote an email as follows: "The five most recent hydrographs do not resemble that 60-year average or even each other very well. I think the PSP should have a diagram with the 10 most recent hydrographs as 10 different color lines. We need to help everyone understand how different the flow is each year." Sean provided a series of 5 hydrographs for our use or as an example in his email. The scales on these are all over the board, but I'm sure Chuck could display on one scale and make it pretty. For the general public, I'm not a fan of log scale.	Per our conversation with NMFS, we have added this chart to the specified section.
41	UTBB (Molly Welker)	Introduction	An Executive Summary should be included to give readers an overview of the entire document so that the stakeholders do not have to read the entire document to understand its purpose.	An email will accompany any draft distribution to the stakeholders outlining the intent of every document throughout the licensing process.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
42	UTBB (Molly Welker)	Section 4	Additional monitoring should be included during the 6-7 months of winter to collect data on winter base flows, winter water temperatures and ice conditions, and to determine overwintering habitat for juvenile salmon and resident fish near the Project.	A stream gage will be installed on site with temperature sensing equipment to document flow and water temperatures throughout the winter. Further, remote cameras will be installed to document ice conditions throughout the winter.
43	UTBB (Molly Welker)	Section 4	More information should be included from other projects in Alaskan or similar northern regions on impacts to fish from concrete gravity diversion structures (e.g., groin) and tailraces, and problems with frazil ice on infrastructure (e.g., water intake structure).	Per Section 4.2.3.7, "a literature review of existing hydropower facilities in Alaska and other cold weather environments to evaluate their methods for continued winter operation in harsh environments" will be conducted.
44	UTBB (Molly Welker)	Section 4	Thank you for including this appendix that discusses the relationship between the Project and fish behavior and habitat.	We appreciate the comment.
45	UTBB (Molly Welker)	Appendix C	The ADFG protocols for out-migration studies should be considered in the PSP. I agree with ADFG (i.e., Sands and Borden) comments on the need for more than the minimum 72-hours for the out-migration studies to accomplish the goals of the PSP.	Unlike ADFG population or smolt abundance studies, this study is not focused on estimating abundance. It is focused on understanding the migratory patterns over time and distribution of fish across the river channel so that we can refine the design of the intake to minimize impacts to these downstream migrants. Still, collecting sufficient numbers of fish to be representative of the population will be important, thus multiple methods may be used together to best characterize fish distributions. Text was added to clarify the intent of operating migrant traps throughout the salmon outmigration window and to indicate that the 72-hour minimum could be achieved through a combination of a number days a week and block of hours each trap day.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
46	NMFS (Sean Eagan)	2.3 Project Facilities Page-9	Leave open the option of installing one Kaplan turbine and one more modern fish friendly turbine. During the peak of smolt out-migration, the Kaplan turbine could be turned off (if smolt mortality is unacceptable) and only the fish-friendly turbine left generating power. The rest of the year, they could run in tandem or only the Kaplan turbine could spin if there is insufficient flow for both. The text should reflect flexibility in the turbine choice.	Design parameters for the facility will be evolving throughout the study implementation and conceptual design process.
47	NMFS (Sean Eagan)	2.3.2 Intake Page-12	Consider heating a portion of the trash racks as the groin could slow the water down and exacerbate the icing on the metal bars. With climate change, this may not be a problem, but it is simpler to add heating elements at the start then to retrofit later. Only a section of the trash rack would need to be heated, as when de-icing is required, there will not be much water being routed to the penstock.	Design parameters for the facility will be evolving throughout the study implementation and conceptual design process.
48	NMFS (Sean Eagan)	Figure 2-6	This figure leads the public to envision an overly simplified hydrograph. A similar graph with 10 colored lines: one for each of the last 10 annual hydrographs (2012-2021) would be more informative. Everyone should be aware that sometime the October hump is larger than the June-July hump.	Per our conversation with NMFS, we have added this chart to the specified section.
49	NMFS (Sean Eagan)	4.1.1.2 Geographic Scope	NMFS is Okay with the ½ mile above and below for the 2-d hydraulic model geographic scope. Tagging of fish could happen outside of this short section if necessary for logistics or safety. Clarify the text so people understand some activities could happen outside the 1.5 mile long modeled section.	Text added to clarify study related activities may occur outside of the study area.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
50	NMFS (Sean Eagan)	4.1.1.3 Study goals	We should know if fish are being delayed below the falls at some flows under natural conditions. If the pre-project delays at 10,000 cfs are 36 hours for the average fish, Nushagak Utility should not be asked to keep that under 24 hours.	We appreciate the comment and agree baseline passage behavior is important to understand. Because of the uncertainty associated with methods for tracking fish immediately downstream and through the falls study question 3 was written broadly to address salmon upstream passage migratory patterns and behavior. Text was added to indicate what pattens/behaviors may be assessed.
51	NMFS (Sean Eagan)	4.1.1.5 Existing Info Fig 4-7	Anadromous waters catalog says five species of salmon above the falls. Are there a substantial number of pinks above the falls? Fig 4-7 suggest you do not plan to look at pink passage - NMFS is fine with this, but include some information as to why. Such as "99% of pink never approach the falls so this project is unlikely to affect the pink population."	We appreciate the comment and we agree that very few pink salmon are likely to pass the falls under baseline conditions, However, there is the possibility the with-project flow conditions enhance Pink Salmon passage. Thus, we would like to keep Pink Salmon on the list for now. This can be revised if appropriate, based on discussions with the AWRG prior to filing the Revised Study Plan.
52	NMFS (Sean Eagan)	4.? Literature review Fisheries Resources Studies	This list is missing the University of Washington - Alaska Salmon Program (the exact name has changed a few times). This group has been looking at Bristol Bay salmon life histories for 60+ years. Using as much salmon information collected in the Bristol Bay region as possible, and not rely on Oregon/Washington or even SE Alaska salmon data, will be important if stakeholder groups challenge the study results.	University of Washington-Alaska Salmon Program has been added to the list.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
53	NMFS (Sean Eagan)	Candidate Fish Sampling Page 38	Is it important to sample fish during the large October flow? This could coincide with a significant Coho run.	The May to September schedule is specific to fish collection, not adult observations. Further and per collaboration/agreement amongst the ARWG, Coho were not one of the target salmon species we are focusing on for the LCM. The value of adult observation efforts would be to understand baseline migration trends, and that would depend on how long the Coho run goes, ice-in timing, and whether or not we can collect information that would be representative of the run. This will be discussed with ADFG after the opportunity for a more detailed literature review and if warranted, additional text may be incorporated prior to filing of the RSP.
54	NMFS (Sean Eagan)	Adult Migratory Behavior Page 42	On page 38 it suggest only sampling the edges of zone 2 for safety reasons. Here it suggest we will understand adult routes through the middle of the cascade. Once site visits have occurred, NMFS would appreciate more details. Spatial telemetry tracking of fish might work. Could several receiver antennae be suspended on cables across the cascade? This should be in the Fish Passage study 4.1.2.	We appreciate the comment and will provide further detail in the RSP once site visits have taken place.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
55	NMFS (Sean Eagan)	4.1.1.7	"Vertical and horizontal distribution of juveniles could be evaluated and monitored in the intake vicinity" This is very important and should be stated as "will" happen.	Agreed, but that particular "could" is referring to the method of evaluation that is at the end of that phrase quoted. The study plan does indicate a focus on the intake area as indicated with quote below, taken from the *Downstream Migrant Trapping/Migration Pattern Observations section.* "Downstream migrant trapping may occur at several locations in the Project area to account for spatial variability; however, survey efforts will be focused in Zone 1 near the proposed Project intake (Figure 4-3)."
56	NMFS (Sean Eagan)	Fish Passage study Figure 4-5	How will we verify if our human guesses of where fish hold are correct? These ovals are basketball court or larger sized areas. What if the most critical rest areas are actually much smaller, like 2 - 10 m2 triangles downstream of boulders?	To the best of our ability, holding areas will be identified during baseline conditions regardless of size. For the 2D model we will look for habitats of specific depth and velocity that are consistent with salmon holding suitability. The zones on Figure 4-5 will not define where we look for holding. This figure is intended to demonstrate that a number of different pathways and holding areas may be present in the Falls reach.
57	NMFS (Sean Eagan)	4.1.2.3 Goals	The water is flowing through the cascade fast enough that juvenile fish and fry primarily go with the flow. Juvenile max swim speed of 0.6 m/sec seems to be no match for the current 3-5 m/sec. The text should indicate that unlike adults, juveniles do not pick a route through the cascade.	We agree with your comment under baseline conditions, but are uncertain how the velocities will change under with-Project conditions. Thus, we would like to reserve making that judgement at this time.

58	NMFS (Sean Eagan)	4.1.2.3 Page 49	Salmon are adept at finding tiny pockets of slower velocity to move upstream and reverse hydraulics to propel their jumps up cascades/falls. It seems a HEC-RAS 2-D model may be too coarse to capture these micro areas that salmon rely on to move up cascades. Please provide an example of where a similar 2-D model has successfully modeled salmon passage through a similarly complex cascade.	The application of 2D modeling to assess passage conditions for fish has been applied as early as 2006, in Australia (Haeusler, T and Bevitt, R. (2007). Hydraulic modelling of a fish barrier – Pinch Falls, Snowy River. Snowy River Recovery: Snowy River Flow Response Monitoring, NSW Department of Water and Energy) and is currently being applied to the Skagit River as part of relicensing studies being conducted by Seattle City Light. The Australia study was completed in 2006 and employed River2D modeling but was constrained by limited bathymetric mapping due to dangerous conditions in field surveys (LiDAR was not yet available). The SCL studies are focused on the Gorge Bypass Reach of the Skagit River and are using a 2D HEC-RAS model. The reach is high gradient and contains large boulders and a number of falls and cascades. There is some question as to whether anadromous fish ever passed through this reach and the modeling studies are one of the tools being used to assess potential pathways under different flow conditions. The study is relying on LiDAR coupled with some field surveys to develop an initial topographic model. Pressure transducers have been installed at key falls locations to allow more detailed evaluation of localized hydraulic features which will aid in model calibration. While the results of this analysis are not complete, the application of a 2D HEC-RAS model to assist in evaluating flow-passage conditions in this very complex reach of the Skagit River has been generally accepted by state and federal resource agencies. For more information visit Relicensing the Skagit Hydroelectric Project - City Light | seattle.gov. You are correct that salmon rely on multiple velocity cues that can be quite complex. The extent to which the 2D HEC-RAS model will be able to capture and accurately represent these areas will depend on the mesh used and overall model calibration.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
59	NMFS (Sean Eagan)	4.1.2.5	All models should be calibrated and validated with two different sets of data prior to being used for predictions. Elaborate on the data that will be used to calibrate and validate this 2D hydraulics model. NMFS may be fine with one of the other five proposed models, but they all need to be calibrated and validated.	The 2D model will be calibrated using three sets of field data as described in Section 4.1.2.7, Conduct Bathymetric Mapping of Reach. The first set was collected coincident with the LiDAR surveys. The second and third surveys will be collected during high and medium flows, tentatively scheduled for late June and mid-July. The July survey will also be used to collect data useful for hydraulic model calibration. For this, floating tracers (a variety of objects can be used) will be deployed from a boat in Zone 1 and monitored via drone-based videography. These data will be post-processed to determine the magnitude and direction of surface velocities under a given flow condition. The model will be calibrated using the water surface elevations surveyed near each benchmark during the field surveys, and using the direction and surface velocity information measured using floating tracers. The calibrated model will then be used to model passage conditions under different flows.
60	NMFS (Sean Eagan)	Table 4-2	Please obtain leaping and jumping capability and body sizes from similar Bristol Bay sockeye and Chinook populations. The sockeye that usually seek a lake only 100 meters or so above sea level may have lower jumping limits then other populations.	As noted in Study 2.1, under Establish Species Swimming and Leaping Criteria, "As part of this study, a combined literature and internet search will be completed to compile relevant information related to both swimming and leaping capabilities of salmon. From this, a set of criteria will be developed in collaboration with the stakeholders that will be used in the modeling and passage evaluation. Observational data on fish leaping behavior at the Nuyakuk Falls area during the Characterization of the Fish Community and Behavior Near the Project Area study and anecdotal information (including videography) will be included for consideration."

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
61	NMFS (Sean Eagan)	Table 4-3	The PSP should not describe flying a helicopter low over a cascade as safe.	Any designation of "safe" or "unsafe" has an implicit level of relativity incorporated into it. Relative to foot-based and/or any type of boat surveys, aerial imagery of the falls area is a much safer option.
62	NMFS (Sean Eagan)	Fish Passage Study page 59	Please describe the known accuracy of the LiDAR data and how that was verified. The fact that it cannot penetrate deeper than 20 feet is not a problem. What is the accuracy on water less than 3 feet deep? How do bubbles or froth in a rapid figure into that depth? What size boulder, or bedrock outcrop, will be identified versus just being missed?	Thanks for the comment. As described in Section 4.1.2.7, "The survey and LiDAR acquisition occurred on May 14, 2020 using a Riegl VQ-880-GII mounted on a Cessna Caravan (Quantum Spatial 2020). The survey consisted of consecutive overlapping flight paths of a reach of the Nuyakuk River that extended approximately 3,000 ft (0.57 mi)1 km upstream and 2,500 ft (0.47 mi)1 km downstream from the upper and lower ends of the Fish Passsage Study Area Falls reach, respectively (total of 9,810 ft or 1.86 mi). Aerial imagery was co-acquired using a PhaseOne iXU-RS1000 digital camera that collected imagery in three spectral bands (Red, Green and Blue). The LiDAR allowed for laser penetration through the water column up to a nominal depth of 20 ft (depending on water clarity, bed surface reflectivity and turbulence) and in those areas can accurately depict the bed topography of the channel below the water surface. However, the Falls reach contains substantial areas of highly turbulent water, and mapping in those areas can be problematic and will require post-processing of data using interpolative, nearest neighbor computations. The extent to which these void areas exist will be determined as part of the model development process. These void areas and solutions for addressing them will be discussed with the ARWG.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
63	NMFS (Sean Eagan)	Page 61 - use of the model	For flows that actually occur during 2022 and 2023 it would be much more accurate to track a dozen marked fish's path through the cascade then trust the model. The model should only be used for low flows that did not happen in the July - September adult migration window of 2022 nor of 2023. Would tracking the routes coho take through the falls during low November flows be an analog for the sockeye and Chinook? Most salmon take the path of least resistance. I trust the sum logic of several cohos' routes up the cascade at 2,000 cfs much more than a models route.	Thanks for the comment although we respectfully disagree on two counts. First, assuming a dozen fish could be successfully tracked through the reach for a given flow, absent a hydraulic model you would have no or little information on the hydraulic conditions that they experienced (what caused them to select that pathway and not others?), or how those conditions would change under different flows, only that they made it The Project will alter both the magnitude and timing of flows in the Falls reach and without the development of a 2D hydraulic model, it will be virtually impossible to evaluate and render in a probabilistic manner what changes in the hydraulics that will accompany those flow alterations will have on upstream and downstream passage. Second, the entire purpose of developing the model is so that passage conditions can be reasonably defined over a wide range of flows, not just low flows. The tracking of fish through the Falls reach will be valuable in documenting whether model predictions are valid and of course as part of project monitoring, but it does not replace model development.
64	NMFS (Sean Eagan)	Fig 4-10 - mislabeled	This PSP labels this "Upstream Migration" (top left) but seems to talk about downstream migration. Also if the fish moved in the opposite direction across the page to the upstream Fig 4-9 that would help the reader understand one was up and the other down.	The figure has been modified to correctly display downstream migration.
65	NMFS (Sean Eagan)	Fig 4-11	"Similar analysis would be applied under a Climate Change scenario as a function of flow changes". This is hard for me to envision because climate change is not one thing or one scenario. The diversity of annual hydrographs under climate change is likely to increase.	In general, we agree with your statement. This is the primary reason we are so on board with conducting the NMFS requested Future Flows Study.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
66	NMFS (Sean Eagan)	Fig 4-14	The Tennant Method should not be mentioned even for comparison. This is the most productive sockeye run on the planet. Tennant Method may be appropriate for an urban stream with a dozen coho, but it is too blunt a tool for this location and this amazing resource.	The Tennant method is not being considered nor mentioned for any of the Nuyakuk fish passage analysis. The figure presented that shows the Tennant method was for illustrative purposes only as referenced to a study completed on Ward Creek, Alaska by Reiser et. al. 2006.
67	NMFS (Sean Eagan)	Page 65	"Likewise, fry occupying flat shallow water areas may suddenly become stranded." Please clarify whether fry hanging out in shallow areas of a cascade is common and if so at what times a day. Some data suggest fry stay in the main current to move downstream as quickly as possible.	Because we do not yet know the bathymetry and velocities of the Falls reach under with-Project conditions, and because we are assuming the substrate is largely bedrock, we are being conservative in thinking that there may be slow, shallow water areas where fry enter and are trapped.
68	NMFS (Sean Eagan)	Table 4-4	Hunter 1992 is 30+ year old information collected primarily in the lower 48. The study should get a newer reference for ramping. Secondly, different day and night ramping rates do not make sense in the Nuyakuk when smolt are out migrating in 21+ hours of clear daylight.	Based on recent interaction with Alaska agencies on other existing and proposed hydropower projects, Hunter 1992 is the standard typically utilized for setting ramping rates. Moreover, the reference to Hunter (1992) was cited as an "example" of ramping rate criteria that have been applied elsewhere and does not negate consideration of other, more local criteria if they exist. The Hunter (1992) report compiled information from a number of studies specifically designed to evaluate and test ramping rate effects due to hydroelectric operations on salmonids. The results of those studies are as germane today as they were then.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
69	NMFS (Sean Eagan)	4.1.3.2 Entrainment Study	The entire width of the channel is important.	We agree that is will be important to understand the distribution of downstream migrating fishes across the channel, that is why data collection in Zone 1 is proposed across a channel spanning transect. In addition, we are very interested in fish and flow patterns and pathways around the intake in comparison to what is and may be happening on the far bank away from the intake.
70	NMFS (Sean Eagan)	4.1.3.3 Entrainment Goals	How can anyone estimate the potential for entrainment without knowing the details of the intake and trash rack design?	As stated in the study goals and objectives, this study is being conducted to inform design and placement of the intake. The Cooperative will continue to advance the conceptual design during the entirety of the study planning process and utilize the most updated version of the intake design for the purposes of analysis. Further, multiple options will be looked at corresponding to potential alterations to intake design. We are striving to develop a design that minimizes downstream mortality and injury to migrants. Thus, the approach includes look at potential effects of alternatives as well passage for fish bypassed through the Falls reach.
71	NMFS (Sean Eagan)	4.1.3.5 Existing info	Projected future flows would be useful, if they are available in sufficient time.	Depending on the status of our Future Flows Study, we will incorporate relevant data into this analysis.
72	NMFS (Sean Eagan)	Flow routing and hydraulic modeling Page 72	The 2-D model will be useful for investigating the effects of various groin length/angles. The studies should also investigate if the groin may increase ice cover and icing on the intake structure.	The groin will be considered as a part of this and other assessments to inform its ultimate design and longevity.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
73	NMFS (Sean Eagan)	Entrainment page 72	We will not really know entrainment or mortality until after the project has been constructed and we do tagging studies on fry. The intake structure and turbines should be designed with flexible features so adaptive management can happen if entrainment and mortality are too high.	We appreciate the comment.
74	NMFS (Sean Eagan)	False Attraction Page 77	"residual risk" should be explained.	The text has been reworked to clarify the objective of looking for latent affect that results as a consequence of false attraction.
75	NMFS (Sean Eagan)	Feasibility Evaluation Page 79	"Specifically, for each month during which more than 10% of the run of a species of concern has traditionally returned, the model will be run at the 20% exceedance flow and the 80% exceedance flow." This is a good concept, however, only use the last 10 years of salmon return data.	We appreciate this comment and the intent which we interpret to be 'to use the best existing data to inform predictions re future conditions.' To do so, we would want to reserve our ability to review the existing data and then consider the variation evident in flow record and pick the period of record that captures the greatest variation to improve our ability to make predictions,
76	NMFS (Sean Eagan)	4.1.5 Life Cycle models	Do you have all agency/stake holder buy in on only completing lifecycle models for two species (Chinook and Sockeye)? Forty years from now another species might be the economic driver of the Bristol Bay fishery.	Through discussions with the ARWG, Sockeye Salmon and Chinook Salmon were selected as the target species for life cycle model development. This was in a large part due to the existing data that can support model development. We anticipate that these models will help inform assessment of other species to some extent, for example when migrations overlap. Further, as part of the Integrated Risk Analysis qualitative models will be developed for all five species of salmon present in the basin. This will give us the ability to compare both approaches and further assess potential effects for species without life cycle models.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
77	NMFS (Sean Eagan)	4.1.5.3 Study goals Page 81	"Quantify the risks" - This seems very similar to the Integrated Risk Assessment study.	We appreciate the comment.
78	NMFS (Sean Eagan)	4.1.5.3 LCM Question 3c & 3e & 6	3c- If these lifecycle models focus on Chinook and Sockeye, why are we discussing rearing habitat in the falls? 3e - Stranding will be more effected by how the project is operated then how it is constructed. Will the license specify how it will be operated 40 years from now? 6 - Great question. Can a lifecycle model tell us the amount of change in population dynamics under future climates? Is it going to take into account prey availability and predator abundance in the Bering Sea?	3c- This concern is about potential for enhancing rearing habitat for species that might prey on downstream migrating salmon. 3e- The license will define operation with respect to fish impacts through the term of the license, which likely will be 40 years. 6- With future flow conditions incorporated into the 2D model the LCM can predict population dynamics associated with the Project. It will not be able to predict changes outside of the Project effects described in this PSP.
79	NMFS (Sean Eagan)	General LCM question	How will the LCM deal with ocean conditions that are more/less favorable for salmon growth? How about more/less intense fishing pressure? How about new warmer water prey species that eat juvenile salmon and become more prevalent in the new climate? Are these questions that a completed LCM will be able to answer?	Similar to above the LCM will be able to predict population level effects that are related to future modeled flow conditions and Project-related effects only.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
80	NMFS (Sean Eagan)	4.2.2.3 Flow Duration Curve - Goals	"Use data from existing general circulation models in the region to inform the development of climate resilient license articles". This should NOT be a goal of Flow Duration Curve Study. It should be a goal of Future Flows Study or just a general part of license development. If non-stationarity is determined to be the case during Flow Duration Curve Study, maybe a third goal is to state the direction of change in each season during the last two decades. If the work can be completed in an office in 2 - 4 months with existing data, why is the price tag so high?	Agreed. Goals of the Flow Duration Curve Study will be updated. At a minimum, a tertiary goal will be to assess stationarity vs. non-stationarity of the existing, historical flow record over the last two decades. The cost to execute the Flow Duration Curve Study will be re-assessed and updated if necessary
81	NMFS (Sean Eagan)	4.2.3.7 Ice processes Page 99	The PSP says 2021 and 2022, but I think you mean 2022 and 2023. Do a global search as failing to update the year happens in several places.	Agreed. All study dates will be updated to accurately reflect the study seasons in which they will occur.
82	NMFS (Sean Eagan)	Integrated Risk Assessment Page 1	Objective one - What is the difference between a fish population and a fish community?	A population is used to define a group of fish within the same species, fish that can interbreed. A community is an ecological term to describe the assemblage of different fish species that live in the same waterbody/area.
83	NMFS (Sean Eagan)	Integrated Risk Assessment- Objective 2 -risk sources	There are many risk sources out there for fish populations especially in the ocean and they will change as the climate changes. Are we just looking a risk directly created by the project?	Yes.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
84	NMFS (Sean Eagan)	Integrated Risk Assessment	Unlike the LCM study, will this be for a much wider suite of target species? If that is correct, state it up front.	The goal statement has been revised accordingly.
85	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Section 4.1.1.3 "Study Goals and Objectives" lists 8 specific questions to be addressed. These are all excellent questions, and answers to these questions would go a long ways towards assessing risks to aquatic resources associated with the project. However, the methods proposed are mostly insufficient to answer these questions. Details in following comments.	We appreciate the comment.
86	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Specific questions #1 and #2 in Section 4.1.1.3 are "What fish species use the aquatic habitats in the Project Area across seasons?" and "What is the relative abundance of fishes in the Project Area seasonally?" The Proposed Study Plan is unclear about how often sampling will take place, but states that, "each transect will be surveyed at least once for each season." It is unlikely that a single sampling event per season will provide sufficient information to confidently answer either of these questions.	Additional detail was added to the fish collection methods. This indicates that within Zones 1 and 3 a total of 10, 50m-wide transects will be sampled during each of three sampling events and that given the deployment of multiple methods it is expected that each sampling event will take 10 days to complete. In addition, opportunistic sampling will occur in Zone 2 edge habitat during each event. This will equate to more than 36 days of sampling throughout the open water period. In addition, to fish collection, downstream migrant traps will be operated throughout the salmon outmigration period and observational data will be collected on fish moving upstream through the project throughout the salmon migration window. We are confident that, in combination, these activities will allow us to characterize fish use of habitats and relative fish abundance in the Project Area well in excess of a more simplistic fish occupancy type assessment.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
87	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Specific question #4 in Section 4.1.1.3 is "What is the proportion of adult salmon that successfully pass through the Falls Reach under baseline conditions?" Neither the transect sampling, nor the visual surveys for adult salmon (whether by drone, or helicopter) are likely to answer this question. A fairly substantial radio-tagging project is one possible method to address this question. Biotelemetry IS mentioned as a possible method, but there are no specifics as to what the biotelemetry study would look like.	Additional on-site evaluation of the specific effort needed to adequately conduct a telemetry study will ultimately define the specifics of this effort. It is anticipated that the site visits needed will take place between PSP and RSP filing and as such, further detail will be available for review/comment in the RSP.
88	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Specific question #6 in Section 4.1.1.3 is "What is the baseline migration pattern for Sockeye and Chinook Salmon passing downstream through the Project Area?" I have two concerns with the downstream migrant trapping. 1) Trapping only near the proposed project intake would yield a very incomplete assessment of outmigration. 2) Trapping a minimum of 72 hours each week will not provide any confidence in the assessment of a baseline migration pattern; as ADF&G biologist Lee Borden pointed out at our meeting (7/29/21) smolt outmigration can be extremely concentrated with the possibility of a majority of the migration occurring in just a few days.	Text was added to clarify the intent of operating migrant traps throughout the salmon outmigration window and to indicate that the 72-hour minimum could be achieved through a combination of a number days a week and block of hours each trap. In addition, as described in the PSP, once an on-site evaluation is appropriate, we will be able to assess the potential use of fixed sonar (DIDSON, ARIS) to support the assessment of run timing and migratory patterns.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
89	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Specific question #7 in Section 4.1.1.3 is "What is the proportion of juvenile salmon that successfully pass through the Falls Reach under baseline conditions?" It does not appear that anything proposed in the methods for downstream migrant trapping will shed light on this question.	We agree with the intent and concept behind this comment and will very likely add specific language to this section upon conducting a site visit to evaluate appropriate methods. The Cooperative intends to conduct these site visits prior to the filing of the RSP which will allow additional specifics to be incorporated into the study plan. As ADFG is aware, there will be a similar opportunity to review and comment on the RSP prior to FERC issuing its Study Plan Determination. This type of iterative process related to the development of specific methodologies is consistent with the "typical" ILP and the collaborative nature that we have established with the ARWG. We will evaluate the potential for telemetry and/or mark-recapture with juvenile outmigrants once access to the site is appropriate. If these baseline data cannot be obtained at this time the LCM can use a sensitivity analysis to evaluation the critical nature of this parameters. The potential Project impacts would be informed by the LCM.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
90	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	Specific question #8 in Section 4.1.1.3 is "What is the baseline condition of injury/mortality in juvenile salmon passing the Falls proper?" This seems like a very difficult question to answer, and it is not clear how any of the proposed methods would address it.	We agree with the intent and concept behind this comment and will very likely add specific language to this section upon conducting a site visit to evaluate appropriate methods. The Cooperative intends to conduct these site visits prior to the filing of the RSP which will allow additional specifics to be incorporated into the study plan. As ADFG is aware, there will be a similar opportunity to review and comment on the RSP prior to FERC issuing its Study Plan Determination. This type of iterative process related to the development of specific methodologies is consistent with the "typical" ILP and the collaborative nature that we have established with the ARWG. We will evaluate the potential for telemetry and/or mark-recapture with juvenile outmigrants once access to the site is appropriate. If these baseline data cannot be obtained at this time the LCM can use a sensitivity analysis to evaluation the critical nature of this parameters. The potential Project impacts would be informed by the LCM.

APPENDIX E:
Proposed Study Plan Comment Responses (9/24/2021 Project Contact List Distribution)

Table 1. Comments received on the Proposed Study Plan (PSP) for the Nuyakuk River Hydroelectric Project (P-14873) distributed to the Project Contact List on September 24, 2021 and Nushagak Cooperative's responses.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
1	ADF&G (Kevin Keith)	4.1.1 – Characterization of the Fish Community and Behavior Near the Project Area	ADF&G continues to be concerned with the lack of specifics for this study. Area Management Biologist Lee Borden sent you an e-mail earlier today; instead of repeating his concerns, many of which I share, I will include his e-mail below (see Comment Nos. 3-4).	Per conversations during PSP development and during the scheduling process for re-initiation of the ILP, site visits with technical specialists in 2022 will assist greatly in defining the specific methodologies to be employed. The goal of the PSP was to comprehensively list the methods that may be used depending determinations made during the aforementioned site visits. The recent decision to re-initiate the ILP in March of 2022 will allow for the remainder of the year to be devoted to these site visits and refinements to the methodologies. Those refinements will be incorporated into the RSP, distributed for comment and filed with FERC well in advance of the studies commencing in 2023.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
2	ADF&G (Kevin Keith)	4.4.1 – Subsistence Study	ADF&G fully supports the study plan to conduct subsistence surveys for the communities of Koliganek, New Stuyahok, Ekwok, and Aleknagik using the same methodologies that ADF&G has used in the past and uses throughout the State so that data collected will be comparable to previous subsistence surveys in the Project Area. The text in the Proposed Study Plan seems to imply that ADF&G will be sharing the cost of this study. We would like to clarify that ADF&G does not have any funds available for this study. We look forward to working out an agreement with the Cooperative to fund this study.	The Cooperative appreciates the comment. The intent of the text was to convey our willingness to work with ADF&G on this study and realize synergies related to data collection efforts, where possible. We did not mean to imply that any funding for this project-specific assessment would come from ADF&G. We apologize for any confusion and will review the text and modify accordingly.
3	ADF&G (Lee Borden)	4.1 Aquatics/Fisheries Resources Proposed Studies	I am still unsure on what the "methods" of any of the proposed studies would entail on the ground. Without such methods outlined and detailed, there is nothing to go on when determining the adequacy of the proposed studies to answer questions and fulfill the data collection objectives outlined in the project nexus document. The concerns brought forth from myself, and others on the ARWG regarding lack of adequate field time have not been addressed. A more specific "methods" section with detailed sampling schedules and proposed means of capture etc. would provide for a starting point to base our analysis of the adequacy of the proposed field work in meeting stated project objectives.	Per conversations during PSP development and during the scheduling process for re-initiation of the ILP, site visits with technical specialists in 2022 will assist greatly in defining the specific methodologies to be employed. The goal of the PSP was to comprehensively list the methods that may be used depending determinations made during the aforementioned site visits. The recent decision to re-initiate the ILP in March of 2022 will allow for the remainder of the year to be devoted to these site visits and refinements to the methodologies. Those refinements will be incorporated into the RSP, distributed for comment and filed with FERC well in advance of the studies commencing in 2023.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
4	ADF&G (Lee Borden)	4.1 Aquatics/Fisheries Resources Proposed Studies	From a Sport Fish Division perspective, the lack of attention given to resident species and their use of the bypass area as more than simply an area to be passed through by anadromous species is a bit of a concern. The falls themselves are a unique habitat feature that likely influences all life stages of resident/anadromous species present in the upper Nuyakuk. The Nuyakuk system is somewhat ecologically distinct from the other tributaries of the Nushagak and the falls play a big part in why. Thinking of the falls as an area that functions solely as a corridor for anadromous passage overlooks its importance as a geographical feature that effects the ecology of the drainage by providing many other functions including but not limited to winter/spring foraging, juvenile rearing, and spawning habitat.	Per the previous comment, we are confident that the site visits and associated additional dialogue that will take place in 2022 will assist in supplementing the study program with additional resident fish species information. The Cooperative open to that dialogue and the potential for additional resident fish species investigation, if it is agreed that the site warrants it.
5	ADF&G (Lee Borden)	General Comment	I'm looking forward to continuing to work with the ARWG in further refining the PSP. Let me know if there is any clarification needed for any of my comments or if you'd like to discuss anything in more detail. Much progress has been made, and I am optimistic that we can get to a place where all stakeholders are satisfied with the proposed studies.	We appreciate the comment and look forward to continued consistent collaboration throughout the process.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
6	Dan Dunaway (Stakeholder)	Water Quality/Project Design	I am concerned for gas entrainment / supersaturation that can be terribly detrimental to fish - causing gas bubble disease. Basically it creates a "bends" type situation. I believe turbines and operation of them has improved. But I'd like reassurances.	If cavitation of the turbines is not an issue, then TDG will generally not be an issue. In fact, the TDG exiting a powerhouse has been found to be slightly less than the TDG entering the powerhouse. However, if cavitation is an issue, it can be minimized by venting or injecting air into the turbines. Air introduced into turbines becomes dissolved in the water under high pressure, and can increase TDG levels in tailrace waters. There are other approaches to minimize cavitation, however, that doesn't involve venting (e.g., lowering the turbine centerline relative to the tailwater; welding overlays of cavitation resistant materials). And finally, dissipation of TDG levels through shallow water turbulence is also a possibility, given the somewhat long tailrace.
7	Dan Dunaway (Stakeholder)	2.3 Project Facilities	Groin: This structure really concerns me. Depending on design and construction it could become a barrier to migrating adults finally topping the falls. Further it may act as a trap to out-migrating smolt or other species holding them or herding them to the penstock intakes. From the beginning, one of my greatest concerns has been the potential effects on out-migrating smolt. The earliest concepts had water drawn from well out into Tikchik Lake where it was hoped smolts would not be congregated. This current concept may require very careful design and operation of the intakes as well.	We appreciate this concern. As part of the study program and design evaluation, we will assess the hydraulics near the intake to fully assess the value/impact of a groin.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
8	Dan Dunaway (Stakeholder)	4.1 Aquatics/Fisheries Resources Proposed Studies	Pink Salmon: I have long heard from Jeff Skrade, former ADFG, Area Biologist for the Nushagak Commercial Fishery, that the Nushagak / Nyuakuk pink salmon have an unusually high fat content due to their unusually long (for pinks) spawning migration and hence are a premium among Alaskan pinks. I did not know until this evening that some pinks spawn above the falls. I suggest the following: 1) assess the number of pinks spawning above the falls to evaluation the potential level of concern; 2) if there are significant above falls spawners, seriously conduct an LCM for pinks as well. Typically pinks are not nearly as strong swimmers as sockeye or chinook and may require design and operation considerations. Given that these pinks go so far and climb the falls they may be uniquely stronger too.	As part of our aforementioned site visits and refinement process (PSP to RSP) in 2022, we plan on having additional dialogue with the ARWG regarding pink salmon utilization (access and numbers) of areas above the falls.
9	Dan Dunaway (Stakeholder)	4.0 Proposed Studies	There was a comment from Mr Vermillion about how to value the area as it is now: I believe there are methods for establishing such values. I know some of the Federal conservation units have discussed such concepts extensively. Very likely someone with McMillan Jacobs can knows of this or can find folks who do. It is my hope that in final form (if built) will be of very moderate impact to the area. Large cascades / falls like these are naturally special places.	The Cooperative appreciates and shares this perspective. While we are currently in the phase of determining the project's overall feasibility, if the project is deemed feasible, licensed and ultimately constructed, the Cooperative will make every effort to blend the project with the existing landscape and make it as low-profile as possible. In addition and based on precedent, it is likely that a series of mandates (via the FERC license) will require these types of design elements to minimize the impact to the visual elements of the falls area.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
10	Dan Dunaway (Stakeholder)	4.4 Cultural Resources Studies	I didn't mention this at the meeting but providing for the on-going traditional portage opportunity at this site will be important. I think this has been recognized before too.	The Cooperative agrees and is committed to maintaining a portage trail through the area if the project is constructed.
11	BBSRDA (Andy Wink)	General Comment	Bristol Bay Regional Seafood Development Association ("BBRSDA") represents 1,862 salmon driftnet permit holders that harvest roughly 80 percent of the salmon caught in Bristol Bay. Bristol Bay is the most productive and most valuable salmon fishery in the world, typically yielding over $250 million in ex-vessel value. As you probably know, the commercial salmon industry is by far the largest economic sector in the region. The livelihood of these fishermen, their crew members, and many other local residents depends on abundant and sustainable salmon runs, which in turn depends upon preserving critical salmon habitats.	A stance which the Cooperative has never challenged, as our Board is composed of the community members that have strong ties to fishing as well as our employees. The sustainability and ex-vessel value of the fishery should also take into account the changing landscape of power generation costs and carbon production during processing to be more resilient and future-proof.
12	BBSRDA (Andy Wink)	General Comment	Lack of a Comprehensive, Independent Cost/Benefit Study: The Nushagak Electric & Telephone Cooperative (NETC) and McMillen Jacobs have provided some cursory details of what may be gained by replacing diesel with hydro power, but there needs to be a comprehensive analysis of potential costs and risks. It is also critical that this report be independent or at least peer reviewed to assure the data and assumptions made are accurate and objective.	All of the independent review processes you refer to in this comment are explicit in the FERC licensing process. Not only will FERC have consistent opportunity to review and assess the viability of the project from natural resource, design and economic perspectives, all agencies, interested technical experts and the public are mandated the same opportunities throughout the process. In short, the type of review you refer to will happen multiple times throughout the study planning, data collection/analysis and feasibility assessment processes.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
13	BBSRDA (Andy Wink)	General Comment	Lack of a Comprehensive, Independent Cost/Benefit Study: The Nushagak district, which is comprised of three main river systems (Nushagak, Wood, and Igushik rivers), has been the most productive river in Bristol Bay in recent years. Harvests of sockeye salmon in the Nushagak district averaged 15.5 million fish per year over the past five years, worth an annual average of $23.0 million in ex-vessel value. A brief review of available data provided by Bristol Bay Science and Research Institute (BBSRI) suggests that during the mid-2000s the Nuyakuk river accounted for approximately 24 percent of the Nushagak river's sockeye salmon run and BBSRI believes that older data may indicate an even higher percentage. It is imperative that stakeholders know how many salmon are migrating through the proposed project area.	We appreciate the comment and believe that the combination of the existing PSP and the supplemental dialogue planned for 2022 will facilitate the implementation of the appropriate fisheries studies to assess impacts (positive and negative) from potential project development and operations.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
14	BBSRDA (Andy Wink)	General Comment	Lack of a Comprehensive, Independent Cost/Benefit Study: This hydro project could also create additional stress on Chinook salmon runs in the Nushagak river. Although relatively few Chinook salmon are caught by commercial fishermen in the Nushagak district, as compared to sockeye, the health of local Chinook stocks has a direct impact on fishing opportunities for (and harvest volume of) sockeye salmon. It has already been a challenge for fishery managers to a) accurately count incoming Nushagak Chinook salmon and b) allow enough Chinook to get up-river without limiting sockeye harvests too much, but the Bristol Bay management plan requires protection for Chinook runs. If the hydro project were to depress already struggling (or inadequately counted) Chinook runs, commercial (and recreational) sockeye fishing opportunities in the entire Nushagak district may be significantly restricted. The economic losses from such a scenario would be very large and we believe this worst-case scenario, as well as the potential impact on Nuyakuk river salmon stocks, needs to be thoroughly understood and communicated to stakeholders.	We appreciate the comment and believe that the combination of the existing PSP and the supplemental dialogue planned for 2022 will facilitate the implementation of the appropriate fisheries studies to assess impacts (positive and negative) from potential project development and operations.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
15	BBSRDA (Andy Wink)	General Comment	Lack of an Alternative Options Study: Hydro power is just one of several options to replace diesel-generated power in Bristol Bay. Where is the analysis of other alternatives? Wind, tidal, or even solar power may prove to be competitive with a hydro project, if not even more beneficial. Further, these options would likely create less economic risk. Such a study should also include a cost/benefit analysis of what might be gained by reducing the need for power generation.	From a cost/benefit analysis perspective, that type of evaluation is explicitly required in the FERC licensing process so that analysis would be part of any Final License Application and FERC will assess that C/B as part of their NEPA process. We would be happy to have a discussion with BBSRDA regarding other options considered to date, which include both hydropower and wind projects. No other renewable energy projects have appeared as feasible for development as the Nuyakuk Project.
16	BBSRDA (Andy Wink)	General Comment	Lack of an Alternative Options Study: We are aware that previous research has been done on alternative power options; however, it was not clear why this hydro project had been selected as the best alternative. We would recommend that previous studies of alternatives be reviewed and communicated to stakeholders, as well as updated where necessary.	As has been conveyed at multiple public forums, the Cooperative has explored a variety of other potential renewable generation options over the past 10 years. We believe that this project represents the most likely long-term solution to our energy needs in the region. That said, we would be more than happy to further describe the other alternatives that have been evaluated in the past at upcoming public meetings.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
17	BBSRDA (Andy Wink)	General Comment	Lack of an Alternative Options Study: Finally on this point, stakeholders must recognize that we will probably see continued advances in power generation technologies in coming years. A stress-test ought to be performed on this hydro project, in the event that better technologies become available in the next 20 years or beyond. Can the project be profitable within a shorter time horizon?	We appreciate the comment. Based on our assessments over the past few years of other generation options, we believe hydro in general and this project specifically represents a potential opportunity (based on the feasibility assessment) to develop a long-term operational mechanism for the region that will substantially (if not wholly) remove the need for fossil fuel generation. It cannot be overstated that substantial precedent now exists for these type of hydro facilities to last well over 100 years. That type of longevity and reliability has to be accounted for in any sort of cost/benefit analysis.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
18	BBSRDA (Andy Wink)	General Comment	Concerns about Assumptions and Ability to Meet the "First-First" Resolution: In our discussions with several people who have tracked this proposed project closely, we have heard some concerns about assumptions related to how much water will need to be diverted to achieve the necessary power generation targets. This assumption and others need independent vetting before the project advances too far and consumes any more funding. If more water needs to be diverted to achieve project goals, what impact might that have on assumptions about fish mortality?	The fundamental intent of the aquatics study program is to define what level of water withdrawal can be utilized without substantial negative impact to the aquatic environment. The Cooperative would again like to alleviate any concerns related to an assumption that once the study plan is finalized, dialogue with stakeholders will cease. Nothing could be further from the truth. Once data is collected, a collaborative and comprehensive assessment of all data results will ultimately lead to conclusions on the feasibility of the project. This is a lengthy process and to put any statement related to the feasibility of the project in advance of data collection and assessment would be presumptuous. It is the Cooperative's genuine intent to carry out the feasibility assessment transparently and in the order necessary to make quality conclusions.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
19	BBSRDA (Andy Wink)	General Comment	Concerns about Assumptions and Ability to Meet the "First-First" Resolution: Also, while we greatly appreciate NETC's "Fish First" resolution (No. 2017-30) that prioritizes fish resources, the reality is that it can be very difficult to know if there's a problem until it is too late. We would request further research into how such a goal will be achieved (as well as funded); and to what extent other projects have been successful in similar efforts. More commonly, it would seem to us that monitoring efforts are not successful in predicting negative impacts until they become apparent, by which time it's often too late to mitigate the damage.	There is extensive precedent for both the success of the process the Cooperative has entered into here as well as the adaptive management monitoring protocol that would likely result if this project is constructed. We would be happy to provide you examples upon request.
20	BBSRDA (Andy Wink)	General Comment	Finally, we would like to recommend that NETC wait to file the proposed study plan with the Federal Energy Regulatory Commission (FERC) until at least March 2022. As we have explained in this letter, many important questions remain unanswered at this time. Despite our concerns at this point, we believe that if prudent steps are taken and stakeholders remain committed to reducing the high cost of power generation in Bristol Bay, such a goal can be achieved without creating negative impacts to the local economy. Please feel free to reach out to BBRSDA if there is a desire to discuss the issues raised in this letter in greater detail.	Per our recent communication and based on stakeholder input, the Cooperative will be filing the PSP and re-entering the formal FERC Integrated Licensing Process (ILP) on March 1, 2022.
21	NMFS (Sean Eagan)	Pg 5, Section 2.1	1,544 square miles is the contributing watershed at the USGS gaging station and the lake outlet. Since the proposed site is four miles downriver, the contributing watershed should be slightly larger. This incorrect watershed boundary is also graphically represented in Fig 2-2. (This repeats a NMFS 1/3/2020 comment)	The Cooperative has re-calculated the watershed area and modified this information in the PSP.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
22	NMFS (Sean Eagan)	Pg 14 Section 2.3.4 Project Design	NMFS encourages the utility to consider having one of the turbines be more smolt friendly than a Kaplan turbine (Hogan 2014). This unit could be used during the peak of smolt outmigration. 100% juvenile exclusion at the intake of out-migrating juveniles is a worthy goal; however, screen systems almost never achieve it. (This repeats a NMFS 1/3/2020 comment)	We appreciate the comment. As NMFS is aware, the design of the project will evolve throughout the feasibility assessment phase with ultimate determinations related to certain infrastructural components being made during the final license application phase (assuming the feasibility assessment is favorable to project development). The Cooperative is committed to continuing collaboration with the stakeholders throughout this process.
23	NMFS (Sean Eagan)	Pg 14 Section 2.3 - Groin	The groin has the potential to exacerbate ice buildup on both the intake and the groin itself. It is generally a poor idea to extend concrete into a river with discharges exceeding 20,000 cfs. (This repeats a NMFS 1/3/2020 comment)	We appreciate the comment. As NMFS is aware, the design of the project will evolve throughout the feasibility assessment phase with ultimate determinations related to certain infrastructural components being made during the final license application phase (assuming the feasibility assessment is favorable to project development). The Cooperative is committed to continuing collaboration with the stakeholders throughout this process.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
24	NMFS (Sean Eagan)	Pg 16 Section 2.4.1	"river diverted to the powerhouse ranges between 43% and 87% of average river discharge" This new text is a large deviation from Alaska Statutes (AS§ 41.21.167(e). Whether or not this will allow the utility to still protect anadromous fish has to do with how the fish are using the falls reach during that time period of high withdrawal. Eighty-five percent water diversion during juvenile outmigration is very unlikely to allow enough smolt to pass without injury to sustain the population.	As mentioned throughout the initial ARWG meetings, the feasibility studies that will be conducted 2022-2024 will provide the capability to assess/model the impact to priority fish species and life stages. Assuming the project proves feasible, this will allow for the necessary collaborative dialogue to determine appropriate diversion rates that limit the impact to fisheries species.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
25	NMFS (Sean Eagan)	Pg 17 Figure 2-6	It would be more informative to additionally display the hydrographs from each of the last 10 years. That 65-year average is based on more USGS "estimated" daily averages than ture measurements and is misleading to the public, the agencies, and the utility itself. Focusing on more recent and precise data is actually likely to make the project appear more likely to meet demand year around. (This repeats a NMFS 1/3/2020 comment)	We will be using a 25-year period of record rather than a 10-year period or the entire period of record for the following reasons: • The USGS recommends using a minimum period of record of 25-years to develop annual exceedance probability flood events such as the 100-year flood where such data is available (Guidelines for Determining Flood Flow Frequency, Bulletin #17B); and • A nonstationarity analysis of the period of record has not yet be completed, so the extent to which nonstationarities occur within the hydrologic record is not yet known. For this reason, using a maximum period of record of 25 years will help ensure that only those years that are most reflective of today's hydrologic regime are used to develop pea flow statistics. NOTE: The Cooperative utilized Figure 2-6 to display publicly available, site specific data from a government agency (USGS) that has a rigorous QA/QC publishing protocol. It was never the intention to mislead any of the stakeholders.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
26	NMFS (Sean Eagan)	Pg 31 Section 4.1 Aquatics/Fisheries Resources	NMFS fully supports #4 that speaks to delayed juvenile mortality. Pracheil 2016 illustrates the effects of blade strick or near blade strike to smolts of passing through a turbine. The smolt can still be swimming just below the tailrace, however, they may have sustained internal injuries that will cause them to die in the next few days.	The Cooperative appreciates the comment.
27	NMFS (Sean Eagan)	Pg 32 Section 4.1.1 Characterize Fish Community	Question 1a. Is this focused on just fish piscivores or does it also refer to birds and mammal (such as bears and gulls) that eat fish.	The intent of 1a. in this section is referring to piscivorous fish.
28	NMFS (Sean Eagan)	Pg 38 Table 4-1	NMFS appreciates this new table on life stage periodicity. The table states that all juveniles from all five salmon species start out migrating on April 1. That date is very important to operational considerations and keeping smolt away from the turbines. There is research that protecting the leading edge of the outmigration cohort is more important than protecting the tail and may be starting earlier due to climate change(Sparks 2018). ● How accurate is that outmigration date for the five species? ● With more sockeye going to sea after only 1 year in fresh water will that push their fresh water departure date to later? Will climate change move all dates to earlier? What clues do juveniles use to decide to out migrate?	The initial periodicity table incorporated into the PSP is based on existing drainage-specific and regional data. A substantial portion of the 2022-2024 aquatic feasibility studies will be devoted to further specifying the site-specific periodicities associated with priority species and associated potential behavior modifications that may occur as a result of both climate change and potential project implementation.
29	NMFS (Sean Eagan)	Pg 39 Section 4.1.1.7	Will sampling only the two 50 edge meters of the 180-meter wide river quantify out migrating juveniles? Juvenile salmon tend to go down the middle river where the current is fastest. In the reach below the falls, why not sample all the way across? Is a human carriageway similar to what USGS uses impossible to construct?	Site visits in 2022 will assist in any necessary refinements to the study program. It is notable with respect to this specific topic, safety near the falls is a key consideration near the falls area.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
30	NMFS (Sean Eagan)	Pg 40	NMFS preference would be for the consultants to try multiple fish sampling techniques and locations in 2022 and determine which methods are most effective in consultation with the agencies. Then use just one or two fish sampling methods in a repeatable scientific process in 2023 and 2024. This would avoid the mismatch of difficult to compare datasets that were produced during the Susitna studies. Some of the 2022 data would be useable in the analysis; however, the 2022 data would primarily be used to determine the most effect methods.	With our now established plan for conducting robust study seasons in 2023 and 2024, the Cooperative intends on utilizing 2022 for a series of site visits with technical consultants to determine the appropriate methods to utilize during the subsequent years. These additional assessments will take place over the summer of 2022 and we will then utilize the fall/winter to collaborate with the ARWG on methodologies for the comprehensive studies in 2023 and 2024.
31	NMFS (Sean Eagan)	Section 4.1.1.7 general	Achievable goals should be written down for fish habitat use in Nuyakuk Falls zone 2. If it simply is not possible to characterize habitat in this zone while ensuring human safety, maybe this work should be discontinued after the first season. Alternatively, perhaps it is possible in some seasons but not others.	We appreciate the comment and share the primary concern for safety. As mentioned in the prior response, a focus of 2022 will be to determine what methods in the falls area are achievable.
32	NMFS (Sean Eagan)	Pg 43 Adult Salmon Migratory Behavior	The field-testing of biotelemetry described as an activity for 2022 is exactly the same trial period concept that NMFS is suggesting for the plethora of net types and fish traps. Work out the best methods in 2022.	We appreciate the comment. See previous two responses.
33	NMFS (Sean Eagan)	Pg 45	It is possible that juveniles begin out migrate during ice breakup periods. The applicant needs to find some method to quantify juvenile outmigration during this time period even if the data is less precise then after breakup.	We appreciate the comment and intend on utilizing both site specific data and existing regional data to determine what amount (if any) juvenile outmigration is occurring prior to break-up.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
34	NMFS (Sean Eagan)	Pg 46	"Hydro-acoustics and telemetry may be used for juveniles …". "These technologies will be evaluated during field testing prior to study implementation." NMFS agree; the spring of 2022 should be a trial study season, rather than year 1 of the two official years. Deng 2017 discusses using tiny acoustic transmitters.	Per previous comment, our plan is to utilize 2022 as a field testing year for certain aquatic methods.
35	NMFS (Sean Eagan)	Pg 46	How will you determine if avian predation will increase with project implementation?	Utilization of existing data from similar projects along with the site-specific data collected on site related to current avian predation and flow patterns will be utilized to assess potential impacts.
36	NMFS (Sean Eagan)	Pg 47 Section 4.1.2. Fish Passage Study Fig 4-4	This new figure does graphically represent the utilities intentions in terms of water withdrawal. 1) Presenting the 70-year average hydrograph is misleading. Present the average hydrograph from the last decade. Eighty-five percent diversion at the height of juvenile outmigration is unlikely to be acceptable to NMFS.	The Cooperative utilized publicly available, site-specific data from a government agency (USGS) that has a rigorous QA/QC publishing protocol. Our intent was not to be misleading. The PSP has been supplemented to include an average hydrograph from the past 25 years of mean daily flow data (see response to Comment #25 for further detail regarding the rationale for using 25 years rather than 10 years).
37	NMFS (Sean Eagan)	Section 4.1.2 Fish Passage Study	NMFS remains suspicious that a model of these complex hydraulics will not do an adequate job of modeling the future routes fish will use to pass through the falls. Fish utilize micro hydraulic features to get through cascades that will be smaller than the smallest modeling unit in the 2-D model. Fish also use 3-D hydraulics and the model will not capture this. This is not to advocate for a 3-D model; that could potentially be less accurate still.	Per substantial consultation with the ARWG and genuine commitment from the Cooperative, we plan on consistent technical dialogue with the ARWG throughout the remainder of the study planning process and all of the data collection, analysis and reporting phases.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
38	NMFS (Sean Eagan)	Section 4.1.2 Fish Passage Study	Once the model is constructed, how will it be calibrated and verified? 2,000 c.f.s. does happen at times during the year. (with drones) and perhaps find a remote method to assess water depth and velocity during a wide variety of flows?	On site data collection will assist in calibrating/verifying the model's integrity. On-site data collection will take place in 2023 and 2024. Additional remote data collection may include supplemental LiDAR during this period.
39	NMFS (Sean Eagan)	Section 4.1.2.3	Telemetry is a more robust way to decipher the often-used routes fish take through the falls. While more difficult than the model, it would likely be more accurate.	We appreciate the comment.
40	NMFS (Sean Eagan)	Page 50 Section 4.1.2.3 Objective 3, 4 also Question 8	NMFS encourages the applicant to use a large battery for peaking rather than drastic flow alterations especially during smolt outmigration. Cordova, Kodiak and Homer utilities have all recently installed larger batteries.	We appreciate the comment.
41	NMFS (Sean Eagan)	Pg 50 Question 6	The groin could delay downstream passage and keep fish milling near the intakes, which is another reason to try to avoid building groin.	We appreciate the comment. As NMFS is aware, the design of the project will evolve throughout the feasibility assessment phase with ultimate determinations related to certain infrastructural components being made during the final license application phase (assuming the feasibility assessment is favorable to project development). The Cooperative is committed to continuing collaboration with the stakeholders throughout this process
42	NMFS (Sean Eagan)	Pg 50 Question 9	While a valid question, NMFS will not support a tailrace design with sufficient velocities to scour out redds. Such velocity would be a fish attractant. Scour at the base of the falls should be less than current, as this project does not add water.	We appreciate the comment.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
43	NMFS (Sean Eagan)	Section 4.1.2.7 Methodology Table 4.2	Use jumping and swimming speed data collected from fish stocks in Alaska, and preferably on the West coast of Alaska where the rivers are comparatively flat. (This repeats a NMFS 1/3/2020 comment) Where was the data in Fig 4-2 collected?	We appreciate the comment and will collaborate with the ARWG to ensure that the jumping and swimming speed criteria we use are acceptable.
44	NMFS (Sean Eagan)	Pg 58 Figure 4-10	While the science and mathematical calculations supporting Figure 4-10 are likely correct, a half-mile long cascade is very different. There will not likely be any true vertical leap barriers, but the lack of areas for rest may be problematic.	We appreciate the comment.
45	NMFS (Sean Eagan)	Pg 60	"However, the Falls Reach contains substantial areas of highly turbulent water, and mapping in those areas can be problematic". NMFS appreciate this acknowledgment, however, these area with turbulence are the most critical. Where there is laminar flow, it is highly likely the fish can burst through it. Clearly identify areas of the Falls reach where nearest neighbor computations were used.	The green LiDAR data collected in 2020 was a great first step in mapping the falls area. Not only did it allow us to identify the depth/contour characteristics of a significant portion of the falls, it also allowed us to identify those turbulent areas you refer to in your comment. The Cooperative intends on focusing on additional site-specific mapping of these areas either on the ground or by supplemental LiDAR efforts at different flows.
46	NMFS (Sean Eagan)	Pg 61	NMFS supports the three pass method at different rive stages for LIDAR. This should help identify areas where the LIDAR is leading the modeler to incorrect conclusions.	We appreciate the comment.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
47	NMFS (Sean Eagan)	Pg 62	Assess the 2-D hydraulics models capabilities in each of these four area. ● water extent ● water depth ● water velocity ● metric of turbulence NMFS is skeptical of the accuracy in the last two bullets.	We appreciate the comment and plan on continuing to work with the ARWG throughout the model development process.
48	NMFS (Sean Eagan)	Pg 64 Figure 4-13	Even though it is just an example, NMFS does not support the Tennant Method. It is not based on the swimming ability of fish. (This repeats an earlier NMFS comment)	We appreciate the comment.
49	NMFS (Sean Eagan)	Pg 69 Section 4.1.3 Fish Entrainment and Impingement	A 3D model could work in the 1,000 feet upstream of the falls and should be considered. Juveniles out migrate at different water depths, and correctly understanding this could lead to substantially less entrainment. Hydropower intakes on the Columbia are put at specific depths to avoid entrainment. I believe any of the hydraulic models will work in this reach.	We appreciate the comment and plan on continuing to work with the ARWG throughout the model development process.
50	NMFS (Sean Eagan)	Fish Entrainment and Impingement	Hydraulic models have a high probability of being highly useful in reach 1 and reach 3. There is a slight chicken and egg conflict, in that the model will be more informative once the designs of several intakes have been proposed. Without a basic intake design, this cannot work.	As has been communicated and consistent with other licensing processes, refinements to the project design will utilize study results and will take place in parallel with study reporting. Biological data will be used to inform both design modifications and dialogue with stakeholders so accurate conclusions related to impacts (positive and negative) can be assessed during the feasibility studies process.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
51	NMFS (Sean Eagan)	Pg 70 Point 4	With a higher percentage of sockeye salmon out migrating after only 1 year in freshwater, make sure this is factored into the swimming ability calculation and screen size determination.	We appreciate the comment and will include this in swimming ability calculations and considerations.
52	NMFS (Sean Eagan)	Pg 70 question 3	Juvenile mortality is closely tied to turbine selection and rotation speed. Please show indirect and delayed mortality rates based on recent data from some of the newer fish friendly turbines in addition to Kaplan turbines. The size, blade configuration and rotational speed of a Kaplan turbine could change mortality.	Our project engineer has substantial experience in evaluating and selecting the appropriate turbine types for the site-specific environmental and biological considerations in place. A portion of the feasibility study process will consist of substantive dialogue between the ARWG and the Cooperative related to biological, hydrologic and hydraulic data and the implications as it relates to project design. As has been mentioned, refinements to the project design will utilize study results and will take place in parallel with study reporting. Biological data will be used to inform both design modifications and dialogue with stakeholders so accurate conclusions related to impacts (positive and negative) can be assessed during the feasibility studies process.
53	NMFS (Sean Eagan)	Pg 74	Juvenile mortality through the falls should be determined through telemetry or mark recapture studies. Although flows will be lower once the project starts this method is far superior to desktop methods evaluation of juvenile death.	We appreciate the comment.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
54	NMFS (Sean Eagan)	Pg 74	While desktop entrainment studies have been approved in the past, NMFS questions the accuracy of many of these studies. NMFS would like a full list of studies used to reach the conclusions about entrainment mortality and we will read them.	We have revised the PSP to include a list of relevant entrainment studies.
55	NMFS (Sean Eagan)	Section 4.1.4 False Attraction Pg 82	Determine the 20% and 80% monthly exceedances either using the most recent 10 years of flow data, or use the flow rates determined by the Future Flows Study. Do not use pre 2000 flow data.	While we understand the desire to utilized only post-2000 data, we have a lengthy hydrologic record for this site. We believe there is likely some merit incorporating it into the overall hydrologic assessment and look forward to reaching collaborative conclusions with the ARWG on how much of that record to utilize for exceedance values.
56	NMFS (Sean Eagan)	Pg 83	NMFS supports modeling the four operating scenarios at the top of page 83 (nice range of impacts). If you want NMFS to consider allowing the project to remove 87% of the flow, model that 87% removal.	We appreciate the comment.
57	NMFS (Sean Eagan)	Pg 86 Section 4.1.5 Life Cycle Models	• Give an example of a "management relevant threshold for the metric that constitute "risk" to help readers understand. Does "current condition without project" = "baseline condition".	The current condition without the project would be the "baseline condition".
58	NMFS (Sean Eagan)	PG 86 Section 4.1.5	How does 3b differ from 3d? How is "Impact populations projections" different from "Impact the population?" Is "downstream passage" different from "downstream survival"? Remember 98% of your audience is not familiar with these models.	We appreciate the feedback on technical detail; we agree it is important to reach the entire audience and will revise text to be more specific before filing with FERC.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
59	NMFS (Sean Eagan)	Pg 87 Question 5	"How will climate change alter the Nuyakuk River flow and temperature regime?" The Future Flows and Temperatures Study will answer this question. It is confusing to list it here also.	We appreciate the comment and have removed the referenced text from this section.
60	NMFS (Sean Eagan)	Pg 88	I know stages can be divided lots of ways, but it seems surviving/growing at sea is a stage, and "escaping" the fishermen's nets is a stage. How does the model project the fishing effort say 30 years in the future, which will be a stressor? Will there be a process based model to look at fish survival in the Pacific Ocean environment of the future?	We can build the model to be more or less refined as to what level of detail we use for the life stage inputs. This will be largely determined by what data we have and project nexus. If fishing pressure was thought to be potentially significant to understanding Project Impacts, then in the absence of data, the model could address potential future losses to fishing by incorporating some scaling factor or sensitivity type iterations. Model development and data inputs is expected to be a collaborative effort with the Aquatic Resources Working Group. That said, we do not anticipate building a model capable of predicting fish survival in a future Pacific Ocean condition.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
61	NMFS (Sean Eagan)	Pg 91	Is a "population level impact" and impact to Nuyakuk Chinook population and a "Fishery level impact" mean the fishermen catch fewer Chinook? Please give examples to help those without fisheries degrees.	We appreciate the feedback on technical detail; we agree it is important to reach the entire audience and revise to be more specific before filing with FERC. For clarification a "fishery level impact" would be an impact significant enough to prevent the fishery from attaining their goals and would also be a population level impact. However, there are other population level impacts that, for example, may operate on a smaller or more local scale and may not rise to the level of fishery impact.
62	NMFS (Sean Eagan)	Pg 94	If the project exits abeyance in Nov of 2021 future flows and temperature information will not be available in Q1 and Q2. If we reinitiate in May of 2022 future flows info may be available. If we can delay needing the future flow data until fall of 2022, we will have it.	We appreciate the comment and as communicated, the Cooperative intends to exit FERC abeyance in March of 2022.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
63	NMFS (Sean Eagan)	Pg 95 Section 4.1.6 Integrated risk Assessment Study	How do you keep this from expanding into hundreds of tables on 20+ species? At some point, your "expert" panel gets tired and just starts throwing numbers in the grid that are not based on much.	The comment is correct, it will not be efficient or effective to conduct a risk assessment for every species. We have identified two alternatives that will allow us to maintain an informative risk assessment for all priority species. 1. Assess risk for species guilds, groups of fish species/lifestages that use similar habitat. 2. Using representative species to cover a variety of habitat uses as evidenced from the baseline fish community study.
64	NMFS (Sean Eagan)	Pg 95 Section 4.1.6	How do you get the right people in the room to make all these qualitative judgements? Some "experts" may have a lot of knowledge, but little credibility in the Dillingham Borough. Others might be highly respected in Dillingham and know three species inside and out, but have a lower level of understanding of other species.	We have been very pleased with the amount of combined site-specific and regional technical knowledge that exists with our ARWG. We are confident in their knowledge base and ability to make quality collaborative decisions.
65	NMFS (Sean Eagan)	Pg 103 Section 4.1	In table 4-7 Why is Maximum Risk value more important than summing the risk across the row?	Risks are not additive and can't offset each other. For example, the impact to 10 percent of the spawning population cannot be offset by a benefit to 10 percent of the juvenile outmigrants. During study development we will work with the AWRG to determine what ranking system is appropriate.

Comment No.	Agency	PSP Section	PSP Comment	Cooperative's Response
66	NMFS (Sean Eagan)	Pg 103	If you retain an expert panel with some members with Traditional Ecological Knowledge (TEK), will you compensate all panel members? As a society, we tend to compensate people with knowledge from universities and neglect to compensate the people with TEK knowledge. Agency employees are more often compensated by their respective agency and therefore the project should not compensate them.	If the TEK is instituted, some form of compensation for their time may be considered.