Draft Study Plan

Amendment to Bradley Lake Hydroelectric Project (FERC No. 8221)

Proposed Dixon Diversion

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DEFINITIONS OF TERMS, ACRONYMS, AND ABBREVIATIONS

°C	degrees Centigrade
2D	two-dimensional

A

ACCS	Alaska Center for Conservation Science
ADCP	acoustic doppler current profiler
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AEA	Alaska Energy Authority
AHRS	Alaska Heritage Resources Survey
AKDT	Alaska Daylight Time
AKST	Alaska Standard Time
AKWAM	Alaska Wetland Assessment Method
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
APE	area of potential effect
AVCT	autonomous video counting tower

B

BCC	bird of conservation concern
BFD	bankfull depth
BFW	bankfull width
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMC	bird of management concern
Bradley Lake Project	Bradley Lake Hydroelectric Project (FERC No. 8221)

C

CFR	Code of Federal Regulations
cfs	cubic feet per second
CIK	Cook Inletkeeper
cm	centimeter
CWA	Clean Water Act

D

Dixon Diversion Project	Proposed Dixon Diversion, Amendment to the Bradley Lake Hydroelectric Project
Dixon-Bradley Alternative	water from Dixon Glacier will flow through a tunnel to Bradley Lake and subsequently to the Bradley Lake powerhouse

Dixon-Martin Alternative	water from Dixon Glacier will flow through a tunnel to a new Martin River powerhouse
DO	dissolved oxygen
DSP	Draft Study Plan

E

EA	Environmental Assessment
EIS	Environmental Impact Statement

F

FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
FSP	Final Study Plan
FWCA	Fish and Wildlife Coordination Act

G

GIS	Geographic Information System
GPS	Global Positioning System

H

HGM	hydrogeomorphic
HUC	Hydrologic Unit Code

I

ICD	Initial Consultation Document
IFIM	Instream Flow Incremental Methodology
ITU	Integrated Terrain Unit

K

Kenai Refuge	Kenai National Wildlife Refuge
kV	kilovolt

L

LWD	large woody debris

M

MBTA	Migratory Bird Treaty Act
mg/L	milligrams per liter
MOU	Memorandum of Understanding
msl	mean sea level
MW	megawatt

N

NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve

NHD	National Hydrologic Dataset
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NTU	nephelometric turbidity unit
NWI	National Wetland Inventory

O

OHA	Office of History and Archaeology

P

PP	photo point

Q

QA	quality assurance
QC	quality control

R

RM	river mile

S

SBAS	satellite based augmentation system
SHPO	State Historic Preservation Office
SOI	Secretary of the Interior

T

TB	terabyte
TBD	to be determined
TH	test hole

U

USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

1.0 INTRODUCTION

The Alaska Energy Authority (AEA) is pursuing a Federal Energy Regulatory Commission (FERC) license amendment associated with the existing 120-megawatt (MW) Bradley Lake Hydroelectric Project (Bradley Lake Project, FERC No. P-8221). The purpose of the proposed amendment is to gain authorization to divert water from the Dixon Glacier outflow to generate additional power. This Draft Study Plan (DSP) describes the studies to be conducted to collect relevant resource data associated with the proposed Dixon Diversion Amendment.

AEA owns the Bradley Lake Project, which is operated on behalf of AEA by Homer Electric Association. The Bradley Lake Project is located on the Bradley River in the Kenai Peninsula Borough northeast of the town of Homer in Southcentral Alaska. The existing Bradley Lake Project diverts water from the Middle Fork Bradley River, the Nuka River, the East Fork Upper Battle Creek, and the West Fork Upper Battle Creek into Bradley Lake. Water flows from Bradley Lake through a 3.5-mile-long power tunnel to the Bradley Lake Project powerhouse, located near upper Kachemak Bay. The Bradley Lake Project is located outside (east and north) of the Kenai National Wildlife Refuge (Kenai Refuge) and discharges into the Kachemak Bay National Estuarine Research Reserve (NERR) (Figure 1.1-1).

Figure 1.1-1 Location of Proposed Dixon Diversion Project Including Both the Dixon-Martin and Dixon-Bradley Alternatives Near Kachemak Bay, Alaska

1.1 Proposed Project Description

AEA is exploring potential alternatives to utilize the flow coming seasonally from Dixon Glacier meltwater to increase power production at the Bradley Lake Project. These alternatives include a new diversion dam constructed on state-owned land to impound sufficient water that would either 1) flow through a tunnel to Bradley Lake and subsequently to the Bradley Lake powerhouse (Dixon-Bradley Alternative); or 2) flow into a bypass tunnel to a new Martin River powerhouse (Dixon-Martin Alternative) (see project area and facilities in Figure 1.1-1). AEA anticipates that the diversion dam would be a concrete weir wall approximately 25-feet high by 75-feet long; and a crest elevation of 1,275 feet. A forebay area would act as a stilling basin for the intake. The Dixon Diversion to Bradley Lake tunnel would be approximately 4.9 miles long with a diameter of approximately 12 feet. The Martin River bypass tunnel from the Dixon Diversion would be pressurized and be approximately 2.75-miles long with a diameter of approximately 10 feet. Under the Dixon-Martin Alternative, the Martin River powerhouse would be located approximately 5 miles upstream of the mouth of the Martin River and just upstream of the confluence of the Red Lake outlet stream with the Martin River (Figure 1.1-1). The reinforced concrete powerhouse footprint would be approximately 100 feet by 60 feet and house a 55 MW vertical Pelton turbine. Under both scenarios, excess flow greater than the capacity of the tunnel would spill over the diversion weir wall to the East Fork Martin River canyon.

Regardless of which alternative is selected, AEA would request authorization to increase the maximum pool elevation of the Bradley Lake impoundment, to increase flexibility in the timing of power generation. This AEA request may proceed under a separate amendment, which AEA could pursue along a parallel path until a determination is made regarding the feasibility of the Dixon Diversion Project alternatives described above. To that end, AEA has identified three potential pool-raise alternatives for evaluation, including a 7-foot, a 14-foot, or a 28-foot increase in the normal pool elevation. The 7-foot Alternative would involve increasing the level of Bradley Lake to elevation 1,187 feet by adding 7-foot-high spillway crest gates over the fixed (concrete) spillway crest. This raise would maintain the maximum reservoir level within the existing project boundary. The 14-foot Alternative would involve increasing the level of Bradley Lake to elevation 1,194 feet, resulting in an increase in the total surface area to 4,021 surface acres and an increase in storage capacity to approximately 343,000 acre-feet. The 28-foot Alternative would involve increasing the normal full pool level of Bradley Lake to

elevation 1,208 feet through a combination of raising the concrete spillway crest elevation and adding spillway crest gates. This would result in an increase in the total surface area to 4,224 surface acres and an increase in storage capacity to approximately 389,000 acre-feet. AEA has planned this pool raise to ensure that Kenai Refuge lands would not be inundated under any of the alternatives being considered for the proposed new maximum pool elevation.

A total of approximately 7.3 or 10.1 miles of new, 16-foot-wide, gravel-surfaced access roads would be constructed to support operations and maintenance of the new project facilities, depending on the alternative selected. Under both alternatives, an approximately 6.3-mile-long road segment would extend from the existing Bradley Lake Access Road to the new Dixon Diversion: 3.8 miles of additional road would be constructed for the Dixon-Martin Alternative and an additional 1 mile would be constructed for the Dixon-Bradley Alternative. AEA would install a new, approximately 6.9 mile-long, 115-kilovolt (kV) transmission line to connect the new Martin River powerhouse to the existing substation at the Bradley Lake Project powerhouse under the Dixon-Martin Alternative.

1.2 ICD and Consultation to Date

AEA filed an Initial Consultation Document (ICD) with FERC on April 27, 2022 (18 Code of Federal Regulations [CFR] § 4.38). The ICD describes existing facilities and current Bradley Lake Project operation; characterizes the affected environment; describes the proposed Dixon Diversion Project; and establishes the schedule for all activities, including stakeholder participation. AEA is seeking FERC authorization for the construction, operation, and maintenance of a new diversion system at the Dixon Glacier outflow that would divert flows from the East Fork of the Martin River. As described above, the intent of the proposed action would be to increase the generation of renewable hydropower at the Bradley Lake Project and/or develop a new Martin River powerhouse. Please refer to the ICD (AEA 2022) for additional description of the Proposed Action alternatives, and additional information regarding the existing Bradley Lake Project and Project area resources.

AEA hosted a Joint Agency and Public Meeting in Homer, Alaska on June 14, 2022, and representatives from the U.S. Fish and Wildlife Service (USFWS); National Oceanic and Atmospheric Administration (NOAA); Alaska Department of Fish and Game (ADF&G); Alaska Department of Natural Resources (ADNR); and the USFWS's Kenai National

Wildlife Refuge attended. Several local media sources as well as unaffiliated individuals also attended. AEA submitted transcripts of the meeting to the FERC record on October 11, 2022. At the Joint Meeting AEA provided: a) a description of the existing project and proposed action, b) an explanation of the FERC amendment process, c) a discussion of the anticipated study program, and d) an opportunity to obtain input from the public regarding resource aspects to be addressed in the amendment application. AEA requested that agency study requests be submitted on or before August 14, 2022, within 60 days of the Joint Meeting. See Section 2.0 for a summary of the comments and requests for proposed studies that AEA received.

1.3 Study Plan and Implementation Process

1.3.1 2022 Field Season Studies

In the development of the ICD, AEA collected and summarized the reasonably available information regarding the Dixon Diversion Project and its potential effects on the human and natural environments. AEA conducted preliminary consultation with agencies and preliminary studies during 2022 field season. Section 3.0 provides a summary of the 2022 field efforts conducted to date.

1.3.2 2023-2024 Field Season Studies

AEA anticipates additional studies involving site characterization and feasibility assessment during the 2023-2024 field season to inform development of a final project description for its license amendment application. This Study Plan provides a summary of the agency and stakeholder requested studies, AEA's response to the study requests, and AEA's proposed 2023 field season studies. Any stakeholder comments on AEA's proposed studies should be provided by December 30, 2022, to Bryan Carey, Alaska Energy Authority, at bcarey@akenergyauthority.org.

AEA intends to hold a Study Plan Meeting to present information pertaining to AEA's proposed 2023 field season studies as provided in this Study Plan. AEA will conduct the Study Plan meeting on November 17, 2022, from 1:00 to 5:00 PM Alaska Standard Time (AKST) via Microsoft Teams and at the AEA office (813 W Northern Lights Blvd, Anchorage, AK 99503). To assist with meeting planning and logistics, AEA requests that all agencies or stakeholders who plan to attend the meeting RSVP by sending an email to Bryan Carey at bcarey@akenergyauthority.org or by phone at (907) 771-3065 by November 15, 2022.

After the comment period, AEA will develop a Final Study Plan (FSP) and submit to agencies in March 2023. Table 1.3-1 provides a general schedule for review and comment on the Study Plan, anticipated schedule for the FSP, study implementation and reporting, and key milestones up through filing of the amendment application. This schedule is subject to change and updates will be provided at agency and public meetings.

Table 1.3-1 Updated Dixon Diversion Amendment Process Schedule

Responsible Party	Activity	Dates
Stage 2 Study Planning and Implementation		
AEA	Draft Study Plans	October 2022
Stakeholders	Comments on Study Plans	December 2022
Stakeholders	Study Plan Meeting	January 2023
AEA	Final Study Plan	March 2023
Stakeholders	Pre-Field Season Meeting	April 2023
AEA	Conduct 2023 Season Studies	Spring/Summer 2023
Stakeholders	Field Season Debrief Meeting	November 2023
AEA	2023 Study Reports	December 2023
Stakeholders	Comments on Study Reports	February 2023
Stakeholders	Pre-Field Season Meeting	April 2024
AEA	Conduct 2024 Season Studies (as needed)	Spring/Summer 2024
Stakeholders	Field Season Debrief Meeting	November 2024
AEA	2024 Study Reports	January 2025
AEA	Draft Amendment Application	January 2025
FERC/ Stakeholders	Comments on Draft Amendment Application	March 2025
Stage 3 License Application Filing and FERC Review		
AEA	Final Amendment Application	June 2025
FERC	FERC Notice of Amendment	Anticipated August 2025
Stakeholders	Comments on Amendment Application	Anticipated November 2025
FERC	FERC EA/EIS* (subject to change)	TBD
AEA	FERC Amendment Order (subject to change)	TBD

Note: Post license Order actions, including key engineering, construction and FERC dam safety milestones will be developed once the alternative is selected.

1.3.3 Periodic Reporting and Ongoing Consultation

Stakeholders can expect three opportunities for input during each study year (Table 1.3-1). AEA will conduct a Pre-Field Season meeting each April to discuss planned

activities in the upcoming field season in accordance with the Final Study Plan. After each year of study, AEA will host a Field Season Debrief meeting in November to summarize implementation of the study methods. The 2023 Study Report will summarize study methods, results, and any recommendations for further study. Any study with 2 years of data collection will develop a final, cumulative report in 2024.

1.3.4 Field Data Quality Assurance and Quality Control

Many of the planned studies include the collection of field data. The goals of data management are to establish a data quality assurance/quality control (QA/QC) protocol to be applied at logical stages of data collection and processing and to ultimately create a database of all QC'ed data collected for the Dixon Diversion Project. Five levels of QC (QC1 to QC5) will be completed to govern data collection efforts and ensure a rigorous and high-quality product. Each QC level is tracked either within tabular datasets (Microsoft Excel and database tables), or within file path names (as for raw field data files). This allows for quick determination of the QC status of all data. A data dictionary describing the database entities and attributes will be compiled to accompany the database and to provide an understanding of data elements and their use by anyone querying or analyzing the data.

Data quality control (QC) will be ensured by implementing three levels of data quality review:

- QC1: Field data will be checked for accuracy and completeness by a team member other than the recorder prior to site departure.
- QC2: All data are checked following entry to identify entry errors.
- QC3: Before data analysis, data are inspected for completeness, outliers, or inconsistencies by field staff familiar with the sampling events and site conditions.
- QC4: Database Validation: Tabular data files are verified to meet project database standards. Data are verified for completeness, project standards (codes, field name conventions, date formats, units, etc.), calculated and derived fields, QC fields, etc.
- QC5: Technical Review: Data revision or qualification by senior professionals when analyzing data for reports. Data calculations may be stored with the data. Some data items may get corrected or qualified within the database, while others are only addressed in report text. QC5 may be iterative, as data are analyzed in multiple years.

All data quality measures will be documented with the reviewer's initials and date.

1.3.5 References

Alaska Energy Authority (AEA). 2022. Initial Consultation Document, Proposed Dixon Diversion. Amendment to Bradley Lake Hydroelectric Project (FERC No. 8221), April 27, 2022.

2.0 SUMMARY OF COMMENTS RECEIVED AND STUDY REQUESTS

2.1 Summary of Comments and Proposed Studies Received

Alaska Department of Fish and Game (ADF&G), Cook Inletkeeper (CIK), National Marine Fisheries Service (NMFS), and the U.S. Fish and Wildlife Service (USFWS) submitted comments regarding the Initial Consultation Document and study requests associated with the proposed Dixon Diversion license amendment (Table 2.1-1). A summary of the study requests and proposed studies are listed in Table 2.1-2 including AEA's approach (adopted, modified, or did not adopt). "Adopted" means the study or recommendation was incorporated in its entirety in one or more of the preliminary study plans as noted in AEA response column. "Modified" means some portion of the recommendation was incorporated into a preliminary study plan as described in the AEA response column. "Not Adopted" means the study request was not incorporated into a preliminary study plan with an explanation as to why AEA did not adopt noted in the AEA response column. Specific comments by each entity and AEA's response to the requested studies (adopted, modified, or did not adopt) are provided in Appendix A.

In addition to AEA's ten proposed studies (as provided in Section 4.0), AEA is planning two additional study efforts that would be developed outside of this study planning process. The first of these efforts is a study on Future Flows in the Martin River. Goals and objectives of the study are in development. AEA also plans for a collaborative mountain goat study with ADF&G which is anticipated to include a pre- and post-construction assessment.

Table 2.1-1 Written Comments Received in Response to the ICD

Commenting Entity	Filing Date
Alaska Department of Fish and Game	August 10, 2022
Cook Inletkeeper	August 12, 2022
National Marine Fisheries Service	August 15, 2022
U.S. Fish and Wildlife Service	August 15, 2022

Table 2.1-2 Summary of Study Requests and Proposed Studies

Requested Study	Entity[1]	Approach	AEA's Proposed Studies	Study Season
Martin River Flow Monitoring	ADF&G, NMFS, USFWS	Adopted	4.1 Streamflow Gaging	2023-2024
Water Quality Monitoring	ADF&G, NMFS, USFWS, CIK	Modified	4.2 Water Quality Monitoring	2023-2024
Aquatic Habitat Characterization	NMFS, USFWS	Modified	4.3 Aquatic Habitat Characterization	2023
Seasonal Fish Use	ADF&G, USFWS	Modified	4.4 Martin River Fish Use	2023-2024
Two-Dimensional (2D) Hydraulic Modeling, Geomorphology, and Habitat Connectivity	ADF&G, USFWS	Modified	4.5 Hydraulic Modeling, Geomorphology and Aquatic Habitat Connectivity Evaluation	2023-2024
Wetland Delineation	USFWS	Adopted	4.6 Wetland Delineation	2024
Vegetation Characterization	USFWS	Adopted	4.7 Vegetation and Wildlife Habitat Mapping	2023
Wildlife Habitat Evaluation	USFWS	Modified	4. 8 Wildlife Habitat Evaluation	2024
Bird Use	USFWS	Modified	4.9 Raptor Nesting and Migration	2023
Mountain Goat Monitoring	ADF&G, USFWS	Modified[2]	In collaboration with ADF&G	TBD (pre- and post-construction)
Future Flows in the Martin River	NMFS	Not Adopted	I---	---
Martin River Productivity	USFWS	Not Adopted	---	---
Wolverine Monitoring	USFWS	Not Adopted	---	---
Section 106 Requirement	Not Applicable	Not Applicable	4.10 Cultural Resources	2023

[1] Alaska Department of Fish and Game (ADF&G), Cook Inletkeeper (CIK), National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS).

[2] Modified – Alaska Energy Authority intends to conduct the identified studies (i.e., Mountain Goat Monitoring and Future Flows in the Martin River); however, their scope is in development and completion schedule is on a different timeline.

2.2 Summary of AEA's Proposed Studies

The general purpose of the studies for the Dixon Diversion Project is to gather resource information pertaining to potential Project-related effects of the proposed action. The studies proposed by AEA are intended to gather additional information for the development of the draft and final license amendment applications, and to provide information for consideration in FERC's environmental analysis of the AEA's proposed amendment application.

As described in Section 4, AEA is proposing 10 studies to support the proposed amendment and address resources for which sufficient information was unavailable for the ICD, or for which specific issues have been identified through stakeholder consultation and comments. AEA incorporated components of stakeholder study requests into these studies to address key requested study goals and objectives. These studies include:

1. Streamflow Gaging
2. Water Quality Monitoring
3. Aquatic Habitat Characterization
4. Martin River Fish Use
5. Hydraulic Modeling, Geomorphology and Aquatic Habitat Connectivity Evaluation
6. Wetland Delineation
7. Vegetation and Wildlife Habitat Mapping
8. Wildlife Habitat Evaluation
9. Raptor Nesting and Migration
10. Cultural Resources Study

The individual study plans are provided in Section 4 including: study goals and objectives, known resource management goals, background and existing information, project nexus, methodology, deliverables and schedule, cost and level of effort, and references.

3.0 SUMMARY OF 2022 FIELD SEASON STUDIES

3.1 Topographic Survey

A topographic survey of the glacier area was anticipated for collection in 2022 but had not yet occurred as of mid-October 2022 due to poor data collection conditions. Light Detection and Ranging (LiDAR) along the mainstem of the Martin River was collected in October 2022. Additional bathymetric data collection is anticipated for May 2023.

3.2 Streamflow Gaging

Gaging data were collected in the Dixon Diversion Project area and vicinity in 2022 by the U.S. Geological Survey (USGS) and by AEA. Both studies and available gage data are described in detail below.

Hydrologic data has been collected by USGS at five locations in the Bradley River basin and at four locations in the Battle Creek basin (Figure 3.2-1 and Table 3.2-1). USGS Gage 15238990 is located in the Upper Bradley River near the Nuka Glacier approximately 1.2 miles downstream from Nuka Glacier terminus and 3.5 miles southeast of the Bradley Lake outlet at an elevation of approximately 1,250 feet above mean sea level (msl; USGS 2021a). The other gage measuring inflow to Bradley Lake is located on the Middle Fork of the Bradley River (USGS Gage 15239050), upstream of the Middle Fork diversion dam. USGS Gage 15239001 is located approximately 1,300 feet downstream of Bradley Lake Dam (USGS 2021c). USGS Gage 15239060 is located on the Middle Fork Bradley River downstream of the North Fork Bradley River and approximately 5.5 miles downstream of the Middle Fork Bradley River diversion dam, upstream of its confluence with the mainstem Lower Bradley River (USGS 2021b). The Middle Fork of the Bradley River gage is located approximately 3.6 miles downstream of Bradley Lake Dam at an elevation of approximately 225 feet msl (USGS 2021d). A gage is also located on the lower portion of the Bradley River: the Bradley River near tidewater (USGS Gage 15239070). The tidewater gage is located 0.8 miles downstream of USGS Gage 15239060 at elevation of approximately 25 feet msl (USGS 2021e).

Figure 3.2-1 USGS and AEA Streamflow Gage Locations in the Bradley, Battle Creek, and Martin River Basins (Source: USGS [2022b])

Table 3.2-1 Active USGS Streamflow Gages in the Bradley and Martin River Basins

USGS Gage	Drainage Area (sq mi.)	Latitude (NAD27)	Longitude (NAD17)	Elevation (feet)	Available Period of Record
15239050 MF BRADLEY R NR HOMER AK	9.1	59°46'42"	150°45'15"	2,300[1]	October 1979 to current year
15239060 MF BRADLEY R BL NF BRADLEY R NR HOMER AK	Unknown	59°47'54"	150°51'48"	225[1]	August 1996 to current year
15238978 BATTLE C DIV AB BRADLEY LK NR HOMER AK	Unknown	59°44'45"	150°50'22"	1,300[1]	June 1992 to June 2016
15238982 BATTLE C BL GLACIER NR HOMER AK	10.6	59°44'19"	150°53'49"	789[1]	July 1991 to September 2013
15238985 BATTLE C NR TIDEWATER NR HOMER AK	19.8	59°45'20"	150°57'12"	90[1]	July 1991 to September 2013
15238986 BATTLE C 1.0 MI AB MOUTH NR HOMER AK	Unknown	59°45'44.4"	150°57'11.0"	32[3]	July 2010 to current year
15238990 UPPER BRADLEY R NR NUKA GLACIER NR HOMER AK	12.7	59°42'02"	150°42'09"	1,250[1]	October 1979 to current year
15239001 BRADLEY R BL DAM NR HOMER AK	66	59°45'30"	150°51'02"	1,054[2]	October 1989 to March 8, 2016, May 21, 2019 – current water year
15239070 BRADLEY R NR TIDEWATER NR HOMER, AK	82.4	59°48'06"	150°52'58"	25[1]	Water years 1986 to 1999, and October 2010 to current year
15238950 DIXON C NR HOMER AK	19.1	59°41'34.07"	150°55'6.11"		December 2021 to present

Note: [1] NGVD29, [2] Project Datum, [3] NAVD88.

Current flow data are unavailable for the Martin River and its tributaries. USGS Gage 15238950 Dixon Creek near Homer, AK was installed by the USGS in the fall of 2021 for the collection of water temperature data and was updated in late July 2022 to include gage height (USGS 2022a). Gage height is currently available for July 26, 2022 through present. The intent was for the USGS to collect streamflow measurements at this site in order to prepare a discharge rating curve by Summer 2022. However, field measurements of discharge have proved difficult at this location and no measurements have been collected as of yet. There are safety concerns with installing a cable system across the creek and the velocity and turbulence conditions are not conducive to measuring the velocity using this type of method since it is very fast and steep (USGS email communication). Other approaches under consideration include wading under very low flows and dye dilution methods under higher flow levels (USGS email communication).

AEA has installed streamflow gages at two locations including one at the Red Lake outlet and one on RM4.0R OCH outlet which drains to the Martin River (Figure 3.2-1). Gaging was attempted at the East Fork Martin River canyon but was unsuccessful due to high stream velocities and moving bedload that damaged equipment. The two successful stream gage sites use a non-vented logger (Onset HOBO MX 2001) that is secured to a protective casing and either anchored to the stream bed and attached with a cable to the bank or adhered to bedrock using self-tapping rock bolts. Loggers were installed to the riverbed at a depth of at least three feet. A barologger was installed in both locations using a modified ammunition can bolted to the bedrock approximately five to eight feet above the ordinary high water. Loggers were set to record in 15-minute increments. Calibration certificates were provided by the manufacturer and loggers were calibrated after installation by recording and entering the depth of water above the pressure transducer into the HOBOware software.

The installation and data download schedules are outlined in Table 3.2-2. Units will be removed in October 2022. Streamflow measurements were conducted using a Sontek RS5 acoustic doppler current profiler (ADCP). A minimum of six transects were collected to record the discharge. A rating curve will be established between the water level predicted from the pressure readings and the measured flow for the three sites and a daily flow record will be prepared. Data records will be available by October 2023.

Table 3.2-2 2022 Stream Gage Installation and Download Schedule

Date	Sites	Data Collection
May 24, 2022	Red Lake outlet, EF Martin Canyon, RM4.0R OCH outlet	Site Reconnaissance
June 15, 2022	Red Lake outlet, EF Martin Canyon	Equipment installation and discharge survey
August 4, 2022	Red Lake outlet, EF Martin Canyon, RM4.0R OCH outlet	Maintenance or installation and discharge survey
Scheduled September 22, 2022	Red Lake outlet, EF Martin Canyon, RM4.0R OCH outlet	Maintenance and discharge survey
Scheduled October 27, 2022	Red Lake outlet, EF Martin Canyon, RM4.0R OCH outlet	Equipment retrieval and discharge survey

3.3 Red Lake Autonomous Video Counting Tower

Run timing for Pacific salmon entering Red Lake was evaluated in 2022 using an autonomous video counting tower (AVCT) that employed above-stream remote video cameras and digital time-lapse recording equipment. The Red Lake AVCT was located along the outlet stream joining Red Lake to the Martin River. This methodology is proposed to be repeated in 2023 and 2024 as a component of the Martin River Fish Use Study described below (see Section 4.4).

The AVCT system was comprised of several off-the-shelf electronic and video components attached to a pole located streamside at a site conducive for counting fish and generating sufficient solar power to operate the system. The camera was enclosed in a weatherproof camera housing affixed to the 3.1-meter pole extension atop the tower with a field of view that encompassed the entire cross section of the creek, from bank to bank. A high-contrast substrate panel comprised of a 4.6-millimeter (3/16 inch) mesh beach seine was stretched across the stream bottom perpendicular to the channel to make it easier to see fish swimming past the AVCT.

Installation of the Red Lake tower occurred on June 8, 2022 and will be operated through late October. There are approximately 4 hours each night (00:00-04:00) when it is too dark to see fish in the AVCT in June/July with daylight shortening throughout the

monitoring period. Although disk space required for a day's video varies with the complexity of the images (e.g., varying light conditions, cloud shadows, etc.), the 2 terabyte (TB) hard drives used typically accommodate about 28 days of recorded video. As currently configured, up to approximately 50 days of video can be recorded on a single hard drive. A time-lapse recording rate of 3 frames per second was used to optimize hard drive space without compromising the reviewer's ability to track individual fish transiting the video site. During the season, staff periodically swapped out the hard drives during regularly scheduled site visits when they were approaching maximum storage capacity (approximately every 4 weeks).

Fish counts and other noteworthy observations (e.g., weather, dawn/dusk, video quality, and sightings of bears, moose, or other wildlife captured on video) were recorded. Daily fish counts have been stratified by species into 6-hour time blocks (e.g., 00:01-06:00, 06:01-12:00, 12:01-18:00, and 18:01-24:00). Staff also recorded any periods of video loss or other technical difficulties. Daily counts will be used to describe run timing and escapement indices for Red Lake by species during the study period.

The most recent hard drive was retrieved on September 22, 2022 and it has been reviewed, but Figure 3.3-1 only contains Sockeye Salmon (*Oncorhynchus nerka*) counts through July 8. Since then, a few additional Sockeye Salmon have passed the video station (total count through Sept 21: 681), along with 5 Pink Salmon (*O. gorbuscha*) and 53 Dolly Varden (*Salvelinus malma*) (see Appendix B). No Coho Salmon (*O. kisutch*) have been observed to date, but interestingly, 6 colored-up Sockeye Salmon ascended past the video site in September after no Sockeye Salmon were observed the whole month of August. Given the timing and their bright red coloration, it seems likely these were fish that had previously been counted back in June but had recently drifted downstream past the video site at night when it was not operating, only to move back upstream again during daylight hours. The video counting tower will be maintained through the third week of October to look for Coho Salmon before significant ice formation occurs.

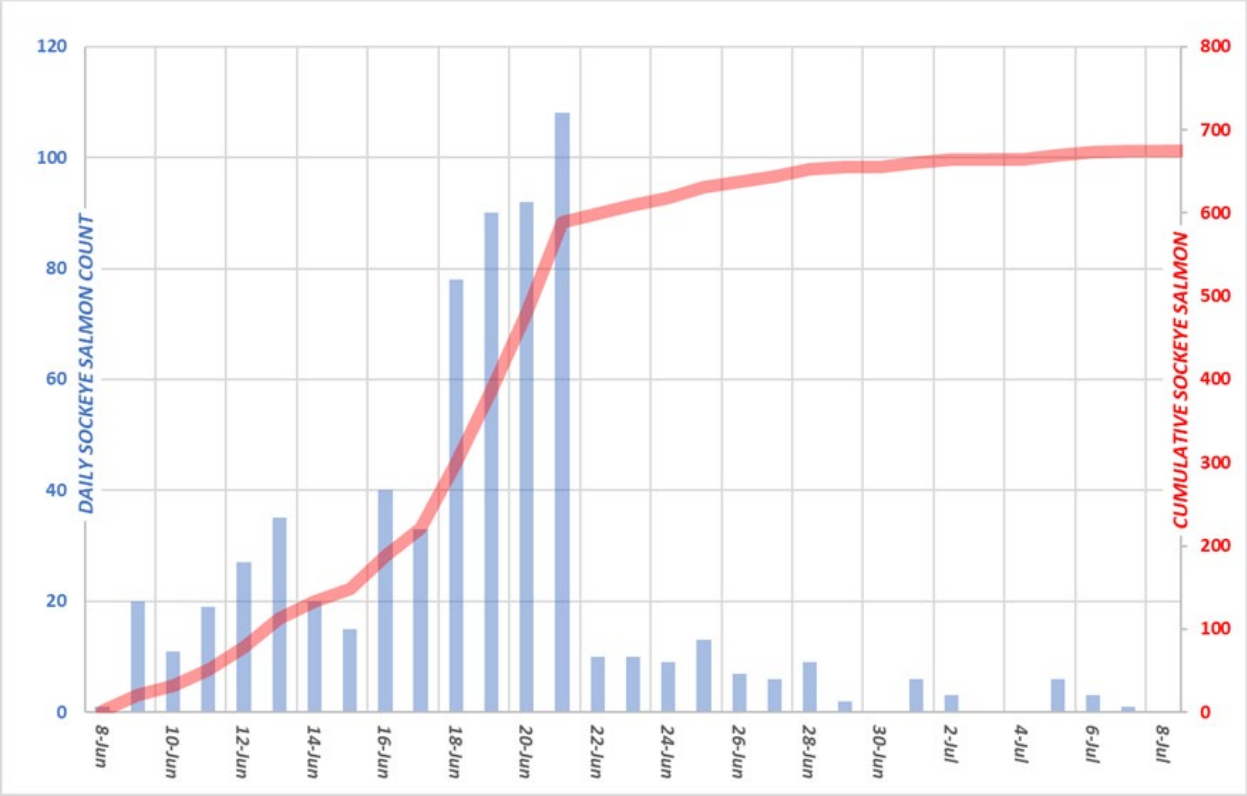

Figure 3.3-1 Daily and Accumulative Passage of Sockeye Salmon at the Red Lake Video Site (8 June – 8 July, 2022)

3.4 References

United States Geological Survey (USGS). 2021a. USGS 15238990 UPPER BRADLEY R NR NUKA GLACIER NR HOMER AK. [Online] URL: https://waterdata.usgs.gov/nwis/uv?site_no=15238990. Accessed December 2021.

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USGS. 2021d. USGS 15239050 MF BRADLEY R NR HOMER AK. [Online] URL: https://waterdata.usgs.gov/nwis/uv?site_no=15239050. Accessed December 2021.

USGS. 2021e. USGS 15239070 BRADLEY R NR TIDEWATER NR HOMER AK. [Online] URL: https://waterdata.usgs.gov/nwis/uv?site_no=15239070. Accessed December 2021.

USGS. 2022a. USGS 15238950 DIXON C NR HOMER AK. [Online] URL: https://waterdata.usgs.gov/ak/nwis/inventory/?site_no=15238950. Accessed January 2022.

USGS. 2022b. National Water Information System: Mapper. [Online] URL: https://maps.waterdata.usgs.gov/mapper/index.html?state=ak. Accessed January 2022.

4.0 AEA PROPOSED STUDY PLANS (2023 AND 2024 FIELD SEASONS)

4.1 Streamflow Gaging

4.1.1 Goals and Objectives

The goal of this study is to characterize the existing flow regime of the Martin River and its tributaries by quantifying the volume of flow at strategic locations.

The objectives are to:

- Install and maintain two continuous streamflow gaging stations on tributaries to the Martin River at Red Lake outlet and RM4.0R OCH.
- Install and maintain one continuous streamflow gaging station at the Martin River river mile (RM) 1.5 at the downstream constriction.
- Quantify the volume of water from the Dixon Glacier outflow using AEA and USGS gage data within the Martin River Basin and nearby Battle Creek and Bradley Lake Basins.

The Martin River Basin is a complex glacial river system with braided channels and side channels that receives high stream velocities and depths. Given the dynamic nature of the river and its tributaries and the high velocities experienced, continuous gaging may not be feasible due to unpredictable and variable conditions that can damage equipment and affect data collection and field crew safety. Field crew safety will remain paramount under all circumstances. If continuous streamflow records cannot be developed from collected data, alternate methods to characterize the existing flow regime and quantify the volume of flow at strategic locations will be implemented using collected spot measurement data and continuous records from streamflow gages in nearby basins.

This study will be used in conjunction with data currently being collected by the USGS at Gage 15238950 Dixon Creek near Homer, AK and assumes at a minimum, stage data will be available from the USGS in 2023. If the USGS is unable to develop a continuous streamflow record for this site, characterization at this location will instead rely on any field measurements they have collected, gage records from nearby basins (i.e., Battle Creek and Bradley Lake Basins) and estimates calculated by taking the measurements at

the Martin River RM 1.5 at the Downstream Constriction and subtracting off the upstream tributary gages at RM4.0R OCH and Red Lake outlet.

4.1.2 Known Resource Management Goals

The goal of this study is to understand the current flow regime of water within the Martin River and its tributaries. Dixon Diversion Project construction and operation will have the potential to impact the flows downstream of the diversion structure, the degree of which will depend on the final design and operating characteristics. The Dixon Diversion Project has the potential to change the timing and magnitude of flows in the river below the diversion structure which can influence downstream resources/riverine processes, including fish and aquatic biota and their habitats, channel form and function including sediment transport, water quality, ice dynamics, and riparian and wildlife communities. The data collected under this study would be used in evaluating Dixon Diversion Project impacts and in the development of protection, mitigation, and enhancement (PM&E) measures. The ADF&G, NMFS, and the USFWS have resource management goals directly related to the potentially affected resource.

The Fish and Game Act requires the ADF&G to "...manage, protect, maintain, improve, and extend the fish, game and aquatic plan resources of the state in the interest of the economy and general well-being of the state." The NMFS's Alaska Geographic Strategic Plan for 2020-2023 (NOAA 2022) identifies 1) ensuring healthy, sustainable fisheries and mariculture over the long term with ecological, economic, and socio-cultural benefits for the nation, and 2) supporting the socio-economic well-being of fisheries, and fishing communities through science-based decision-making and compliance with regulations. The overarching resource management goal of the USFWS as described in their mission is to "conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." The USFWS has this authority under Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (33 U.S.C. 1344), National Environmental Policy Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d), and Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964 (Public Law 88-577), Alaska National Interest Lands Conservation Act (Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd –668ee).

4.1.3 Background and Existing Information

All the streams in the Kachemak Bay watershed have two annual peak periods of streamflow (Field and Walker 2003). The highest occurs in the fall (late August through November) when most precipitation falls, and the next peak occurs in the spring and early summer when the snow melts (Savard and Scully 1984). Low flow occurs at the end of winter, mid-February through mid-April, after which glaciers and snowmelt are the primary source of flow (Freethey and Scully 1980). The volume of flow from glacial rivers can be 10 times as much as that from clearwater rivers (Freethey and Scully 1980). Monthly flow for the Upper Bradley River (USGS Gage 15238990) during the 2005 to 2020 period ranged from 0.3 cubic feet per second (cfs) in March to 478.7 cfs in August. Average annual flow predicted for the ungaged East Fork Martin River as estimated from a 42-year record of gaged flow from the Nuka Glacier ranged from a minimum of 79 cfs in 1996 to a maximum of 358 cfs in 2013. Additional hydrologic details specific to the Bradley River and Martin River can be found in Section 5.3.1 Hydrology of the Initial Consultation Document (AEA 2022).

Flow data are available from the Nuka Glacier from USGS Gage 15238990 which is approximately 6 miles to the east. The Nuka Glacier data may be useful in understanding flows from the Dixon Glacier but may be limited due to the southern exposure potentially receiving different amounts of precipitation and temperatures. Stream gage data are currently available for seven locations within the Bradley Lake Project vicinity. USGS Gage 15238950 Dixon Creek near Homer, AK is measuring the melt from the Dixon Glacier (see Section 3.2.1). This gage site is identified as Dixon Creek by the USGS which is the same stream as the East Fork Martin River. The USGS also collected four field measurements on the mainstem Martin River (USGS Gage 15238960 Martin River near Homer, Alaska) in 1986. Measurements were conducted in September and October 2022 and were 209 cfs, 572 cfs, 590 cfs and 1,150 cfs.

Streamflow data were collected in the Dixon Diversion Project area and vicinity in 2022 by AEA. These data are summarized in Section 3.1.2.

4.1.4 Project Nexus

Dixon Diversion Project construction and operation have the potential to impact Martin River streamflows and downstream riverine processes. The Dixon Diversion Project has the potential to change streamflow timing, magnitude, duration, and rate of change.

Study results would provide information needed to evaluate these potential impacts and develop PM&E measures.

4.1.5 Methodology

Field Methods

Continuous stream gages will be installed at three locations during ice-out periods in 2023 and 2024 as shown in Figure 3.2-1 and provided in Table 4.1-1. Installation will occur in May and removal will occur in October each year. Sites will be monitored with a non-vented pressure transducer (Onset HOBO MX 2001 or similar) that is secured to a protective casing and either anchored to the stream bed and attached with a cable to the bank or adhered to bedrock using self-taping rock bolts. Loggers will be installed during low flow conditions or to a sufficient depth such that dewatering is not anticipated. Loggers will be set to record in 15-minute increments on the hour, 15-minute, 30-minute, and 45-minute time and will record pressure and water temperature. A barologger will be installed at a minimum of two locations – one in the upper basin at the Red Lake outlet and one in the lower basin at RM4.0R OCH outlet or the Martin River RM 1.5 at Downstream Constriction.

Table 4.1-1 2023-2024 Proposed Stream Gage Locations*

Site Name	Latitude (WSG84)	Longitude (WSG84)
Red Lake Outlet	59.696514	-151.003133
RM4.0R OCH Outlet	59.711111	-150.988056
Martin River RM 1.5 at Downstream Constriction	59.741016	-151.002134

*Specific site locations subject to move based observed conditions in 2023 and 2024.

Datalogger data collection and maintenance will occur approximately monthly between May through October in both 2023 and 2024. During maintenance field efforts, the sensor elevation and water surface elevation will be surveyed in reference to a local benchmark.

Discharge measurements will be collected monthly at each of the three locations during scheduled maintenance field efforts. Discharge will be collected with an ADCP, but other methods (i.e., acoustic doppler velocimeter/other velocity meter, or dye tracer) will be considered under low flow or unsafe field conditions. If evaluation of data collected in 2022 at the two tributary sites suggests preparation of a rating curve is favorable from existing data, the frequency of field measurements may be evaluated and reduced, but a

minimum of four field efforts will be conducted during the May to October timeframe in both 2023 and 2024. Monthly data will be collected at the Martin River RM 1.5 at the Downstream Constriction in 2023 and the frequency may be reevaluated in 2024 depending on the favorability of preparing a rating curve and continuous record from existing data.

Cross sectional profile data will be collected at the sensor location or downstream hydraulic control during low flow conditions to compare potential channel change during the study period. These data will target collection twice per year, once in the early spring (i.e., May) and once in the fall (i.e., October), but actual data collection will be flow dependent and may only occur once per year. A longitudinal profile will also be collected annually during low flow conditions.

Field data and stage records will be reviewed after each data collection effort to determine if any changes are required for the next field effort.

Analytical Methods

Water level and discharge measurements will be used to prepare a rating curve for each of the three locations assuming channel change does not impact the ability to do so. These rating curves will be used in conjunction with the pressure transducer data to develop daily flow records between installation and removal field dates (estimated for May and October) for 2023 and 2024. Available daily flow records will be used in conjunction with daily flow records from the USGS 15238950 Dixon Creek near Homer, AK to characterize the current flow regime at the identified locations and estimate accretion between them. Flow data from the Martin River RM 1.5 at the Downstream Constriction, the Red Lake outlet, RM4.0R OCH, and USGS measurements in nearby basins (i.e., Battle Creek and Bradley Lake basins) will be used to estimate daily flow at the Dixon Glacier outflow when direct measurements are not available. An annual study report will be prepared in the fourth quarter in both years which outlines the data collection methods, available results, and any conditions which made data collection or analysis unfeasible.

As stated above in Section 4.1.1, if continuous gaging proves to be infeasible due to unpredictable and variable conditions that affect data reliability and field crew safety, alternate methods to characterize the existing flow regime and quantify the volume of flow at strategic locations will be implemented using collected spot measurement data and continuous records from streamflow gages in nearby basins.

4.1.6 Deliverables and Schedule

AEA will conduct the Stream Gaging Study within the 2023 and 2024 study seasons. Data collection is expected to occur during 2023 and 2024 field seasons. A report summarizing 2023 study activities will be included in the 2023 Study Report. A final, cumulative report will be developed for the 2024 Study Report.

4.1.7 Cost and Level of Effort

The Martin River is a complex glacial river system with braided channels and side channels that receives high stream velocities and depths. Most of the watershed is remote, making access difficult. Severe weather and wildlife issues throughout all seasons can hamper or delay field activities. Weather and environmental conditions may necessitate study modifications which can affect costs. Study costs are estimated to be approximately $488,000.

4.1.8 References

Alaska Energy Authority (AEA). 2022. Initial Consultation Document, Proposed Dixon Diversion Amendment to the Bradley Lake Hydroelectric Project (FERC No. 8221), April 27, 2022.

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4.2 Water Quality Monitoring

4.2.1 Goals and Objectives

The goal of this study is to characterize water quality in the Martin River. Waters potentially affected by the proposed Dixon Diversion Project are identified as Class C waters by the State of Alaska intended to protect the designated use of growth and propagation of fish, shellfish, other aquatic life, and wildlife. Characterization of current water quality conditions will support the evaluation of compliance with water quality criteria under current conditions and under the proposed project operation.

Study objectives include collection of water temperature, dissolved oxygen (DO), turbidity, conductivity, and pH data within the East Fork Martin River, in the outlet of Red Lake and in the Martin River downstream of Red Lake to characterize current water quality conditions.

4.2.2 Known Resource Management Goals

Characterizing water quality in the Martin River Basin will support resource management goals related to water quality and fish and wildlife habitat protection. Both the construction of the proposed Dixon Diversion Project features and operation would have the potential to impact water quality conditions of downstream waters which in turn could impact aquatic resources. The ADF&G, NMFS, and USFWS have resource management goals directly related to the potentially affected resources.

The Fish and Game Act requires the ADF&G to "...manage, protect, maintain, improve, and extend the fish, game and aquatic plan resources of the state in the interest of the economy and general well-being of the state." The NMFS's Alaska Geographic Strategic Plan for 2020-2023 (NOAA 2020) identifies 1) ensuring healthy, sustainable fisheries and mariculture over the long term with ecological, economic, and socio-cultural benefits for the nation, and 2) supporting the socio-economic well-being of fisheries, and fishing communities through science-based decision-making and compliance with regulations. The overarching resource management goal of the USFWS as described in their mission is to "conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." The USFWS has this authority under Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (33 U.S.C. 1344), National Environmental Policy Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), Bald and

Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a-d), and Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964 (Public Law 88-577), Alaska National Interest Lands Conservation Act (Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd–668ee).

4.2.3 Background and Existing Information

As summarized in the ICD, AEA is aware of only very limited water quality information for the Martin River Basin. The current understanding of general conditions within the Martin River Basin is based on data from Bradley River and limited data presented in the licensing documents from the Bradley Lake Project that described the Martin River as having higher turbidity and summer water temperatures approximately 5°C cooler than in the Bradley River (FERC 1985). This difference would be expected given the higher proportion of glacial cover in the Martin River watershed as compared to Bradley River.

Summer water temperatures at the mouth of the Bradley River (USGS Gage 15239070) have historically remained at or below 14°C (AEA 2022). Data from water years 2011-2021 documented an annual peak of daily maxima in July and August ranging between 11.1°C in 2012 and 14.0°C in 2019. These peak temperatures comply with state standards of 15°C for salmon rearing and migration year-round. The Bradley River temperatures consistently meet the criteria of 13°C for suitable salmon spawning and incubation temperatures September through June.

Water temperature data collection at the USGS gage at the proposed diversion location (USGS Gage 15238950 Dixon Creek near Homer, AK) began on November 9, 2021 and is ongoing (USGS 2022). During 2022 monitoring, the maximum daily water temperature was 0.7°C on June 5, 2022 and was observed between 14:45 and 16:15 Alaska Daylight Time (AKDT). Criteria for relevant water quality parameters are summarized in Table 4.2-1.

Table 4.2-1 Water Quality Standards for Alaska Fresh Water Uses

Pollutant	Criteria*
Dissolved Gas	Dissolved oxygen (DO) must be greater than 7 milligrams per liter (mg/L) in waters used by anadromous or resident fish. In no case may DO be less than 5 mg/L to a depth of 20 centimeters (cm) in the interstitial waters of gravel used by anadromous or resident fish for spawning. For waters not used by anadromous or resident fish, DO must be greater than or equal to 5 mg/L. In no case may DO be greater than 17 mg/L. The concentration of total dissolved gas may not exceed 110 percent of saturation at any point of sample collection.
pH	May not be less than 6.5 or greater than 8.5. May not vary more than 0.5 pH unit from natural conditions.
Temperature	May not exceed 20°C at any time. The following maximum temperatures may not be exceeded where applicable: Migration routes 15°C Spawning areas 13°C Rearing areas 15°C Egg & fry incubation 13°C For all other waters, the weekly average temperature may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.
Turbidity	May not exceed 25 nephelometric turbidity units (NTUs) above natural conditions. For all lake waters, may not exceed 5 NTUs above natural conditions.

*The water quality standards listed in this table include the criteria for the growth and propagation of fish, shellfish, other aquatic life, and wildlife.
Source: ADEC (2020).

4.2.4 Project Nexus

This study will provide data to support evaluation of the potential effects of the Dixon Diversion Project on water quality with respect to state standards and habitat for fishes and aquatic life. The proposed Dixon Diversion Project would divert water from the Dixon Glacier outflow from May through October (AEA 2022). The proposed study will characterize existing water quality conditions for parameters that may be impacted by the construction and operation of the proposed project.

4.2.5 Methodology

Study activities will include the collection of field data and summary and presentation with respect to state water quality standards. Field and analytical methods are summarized below.

Schedule

Water quality monitoring will be conducted throughout the period of proposed water diversion, May through October, in both 2023 and 2024. Temperature will be monitored continuously during this period. Other parameters including DO, turbidity, conductivity, and pH will be measured monthly, with no less than 3 weeks and no more than 6 weeks between sampling events.

The Martin River Basin is a complex glacial river system that experiences periods of high stream discharge and velocities. Given the dynamic nature of the river and its tributaries, water quality monitoring may not be feasible at all proposed locations during each sampling event due to unpredictable and variable conditions that can damage equipment and affect data collection and field crew safety. Field crew safety will remain paramount under all circumstances.

Monitoring Locations

Water quality monitoring will be conducted at active stream flow monitoring locations including the three AEA flow monitoring locations described in Study 4.1 (Figure 3.2-1; Table 4.2-2). This configuration of monitoring locations will characterize Martin River reaches potentially affected by the proposed Dixon Diversion Project.

Table 4.2-2 Martin River Basin Stream Monitoring Locations

Proposed Flow Monitoring Site Name	Latitude (WSG84)	Longitude (WSG84)
Red Lake Outlet	59.696514	-151.003133
RM4.0R OCH Outlet	59.711111	-150.988056
Martin River RM 1.5 at the Downstream Constriction	59.741016	-151.002134

*Specific site locations subject to move based observed conditions in 2023 and 2024.

Monitoring Equipment and Procedures

Continuous temperature monitoring will be conducted at 30-minute intervals following the data standards outlined in Mauger et al. (2015) using calibrated, continuous temperature loggers at the flow monitoring locations described in Study 4.1. Temperature loggers will be capable of accuracy ±0.25°C and a range of −4°C to 37°C; an Onset Hobo U22-001 or similar logger is proposed. Pre- and post-deployment accuracy checks will be used to screen for defective equipment and qualify data reporting if measurement drift occurs. Accuracy checks will be conducted at a minimum of two temperatures (0°C and 20°C).

During monthly monitoring, the continuous temperature logger will be audited by taking an independent measure of water temperature using a multi-parameter probe. A calibrated multi-parameter probe, a YSI ProDSS or similar, will be used to collect temperature, conductivity, DO, pH, and turbidity during monthly field data collection efforts. Given the prevalence of glacial inputs and high turbidity levels expected during the monitoring period, a transparency tube will also be used to estimate turbidity in nephelometric turbidity units (NTUs) when probe readings exceed 5 NTUs. Transparency tubes, also called turbidity tubes, use a small secchi disk symbol at the bottom of a clear, narrow plastic tube to allow an observer to estimate the depth of water sufficient to obscure the secchi symbol; this measurement quantifies water transparency and can be used to estimate NTUs (Dahlgren et al. 2004).

Field data will be recorded on datasheets or in pre-formatted waterproof survey field books. Records of accuracy checks and calibration events will be maintained. Metadata for field water quality measurements will include a unique site identifier, datum, latitude and longitude, date, and time. Data will be entered and managed in Microsoft Excel. Field data collection will follow the Dixon Diversion Project data quality assurance/quality control (QA/QC) protocol (see Section 1.3.4).

Analytical Methods

For continuous temperature sampling, data summaries will include daily summaries of minimum, maximum, and mean stream temperatures for days within the monitoring period that contain at least 90 percent of the 30-minute data for that day (i.e., 44 of the 48 30-minute measurements).

Monthly data meeting QC review will be reported in summary tables. Transparency tube readings will be converted to NTUs using the conversion in Table 4.2-3. Water quality data will be evaluated with respect to state water quality criteria.

Table 4.2-3 Turbidity Conversion Chart from Centimeters to NTUs

Distance from Bottom of Tube (cm)	NTUs	Distance from Bottom of Tube (cm)	NTUs
<6.25	>240	31.25-33.75	21
6.25-7	240	33.75-36.25	19
7-8	185	36.25-38.75	17
8-9.5	150	38.75-41.25	15
9.5-10.5	120	41.25-43.75	14
10.5-12	100	43.75-46.25	13
12-13.75	84	46.25-48.75	12
13.75-16.25	60	48.75-51.25	11
16.25-18.75	48	51.25-53.75	10
18.75-21.25	40	53.75-57.5	9
21.25-23.75	35	57.5-60	8
23.75-26.25	30	60-70	7
26.25-28.75	27	70-85	6
28.75-31.25	24	>85	<5

Source: USU (2022).

4.2.6 Deliverables and Schedule

AEA will conduct the Water Quality Monitoring Study within the 2023 and 2024 study seasons. A report summarizing 2023 study activities will be included in the 2023 Study Report. A final, cumulative report will be developed for the 2024 Study Report.

4.2.7 Cost and Level of Effort

Study costs are estimated to be approximately $275,000.

4.2.8 References

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Alaska Energy Authority (AEA). 2022. Initial Consultation Document, Proposed Dixon Diversion. Amendment to Bradley Lake Hydroelectric Project (FERC No. 8221), April 27, 2022.

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4.3 Aquatic Habitat Characterization

4.3.1 Goals and Objectives

The goal of this study is to characterize the aquatic habitat in the Martin River Basin that has the potential to be affected by the proposed Dixon Diversion Project.

Specific objectives are to:

- Provide baseline data for the purpose of evaluating the potential loss or gain in accessible fluvial habitat that may result from flow diversion, and
- Inform other studies including Martin River Fish Use (see Study 4.4) and the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Study (see Study 4.5).

4.3.2 Known Resource Management Goals

Characterizing aquatic habitat in the Martin River Basin will support resource management goals related to fish and wildlife habitat protection. Both the construction of the proposed Dixon Diversion Project features and operation will have the potential to impact aquatic habitat conditions of downstream waters which in turn can impact aquatic resources. The ADF&G, NMFS, and USFWS have resource management goals directly related to the potentially affected resource.

The Fish and Game Act requires the ADF&G to "...manage, protect, maintain, improve, and extend the fish, game and aquatic plan resources of the state in the interest of the economy and general well-being of the state." The NMFS's Alaska Geographic Strategic Plan for 2020-2023 (NOAA 2020) identifies 1) ensuring healthy, sustainable fisheries and mariculture over the long term with ecological, economic, and socio-cultural benefits for the nation, and 2) supporting the socio-economic well-being of fisheries, and fishing communities through science-based decision-making and compliance with regulations. The overarching resource management goal of the USFWS as described in their mission is to "conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." The USFWS has this authority under Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (33 U.S.C. 1344), National Environmental Policy Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), Bald and Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a–d), and Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964

(Public Law 88-577), Alaska National Interest Lands Conservation Act (Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd–668ee).

4.3.3 Background and Existing Information

A typical channel form of many glacial rivers is braided main channel reaches (interlacing network of branching and recombining channels separated by branch islands and channel bars) where the river flows through a glacial outwash plain comprised of relatively coarse grain deposits (Brittain and Milner 2001). High turbidity (typically >30 NTUs) as a result of large loads of suspended sediment (typically above 20 mg/L with peaks over 2,000 mg/L) in glacial rivers limits instream primary productivity and has important implications for salmonids. Many glacier-fed rivers in Alaska also possess a complexity of habitats adjacent to the main channel including side channels, sloughs, backwaters, and channel edges of the active river channel as well as terrace tributaries, tributary mouths, beaver ponds, and upland sloughs of the glacial outwash plain (Wheaton 2002). In addition to this spatial diversity of habitats, when the glacial component of river flows is reduced in the spring and autumn, improved water clarity and channel stability allow for some algal growth and benthic macroinvertebrate production assuming physical conditions are suitable. Thus, refugia may exist in space and time for aquatic organisms to avoid the harsher conditions of summer when glacier melt is at its maximum and both water temperatures and channel stability are low (Milner 2013). Preliminary results from imaging the Martin River in 2022 documented complex glacial outwash channels along with several off-channel habitats that contained clear water during the low flow conditions that occurred when the imagery was collected (Figure 4.3-1).

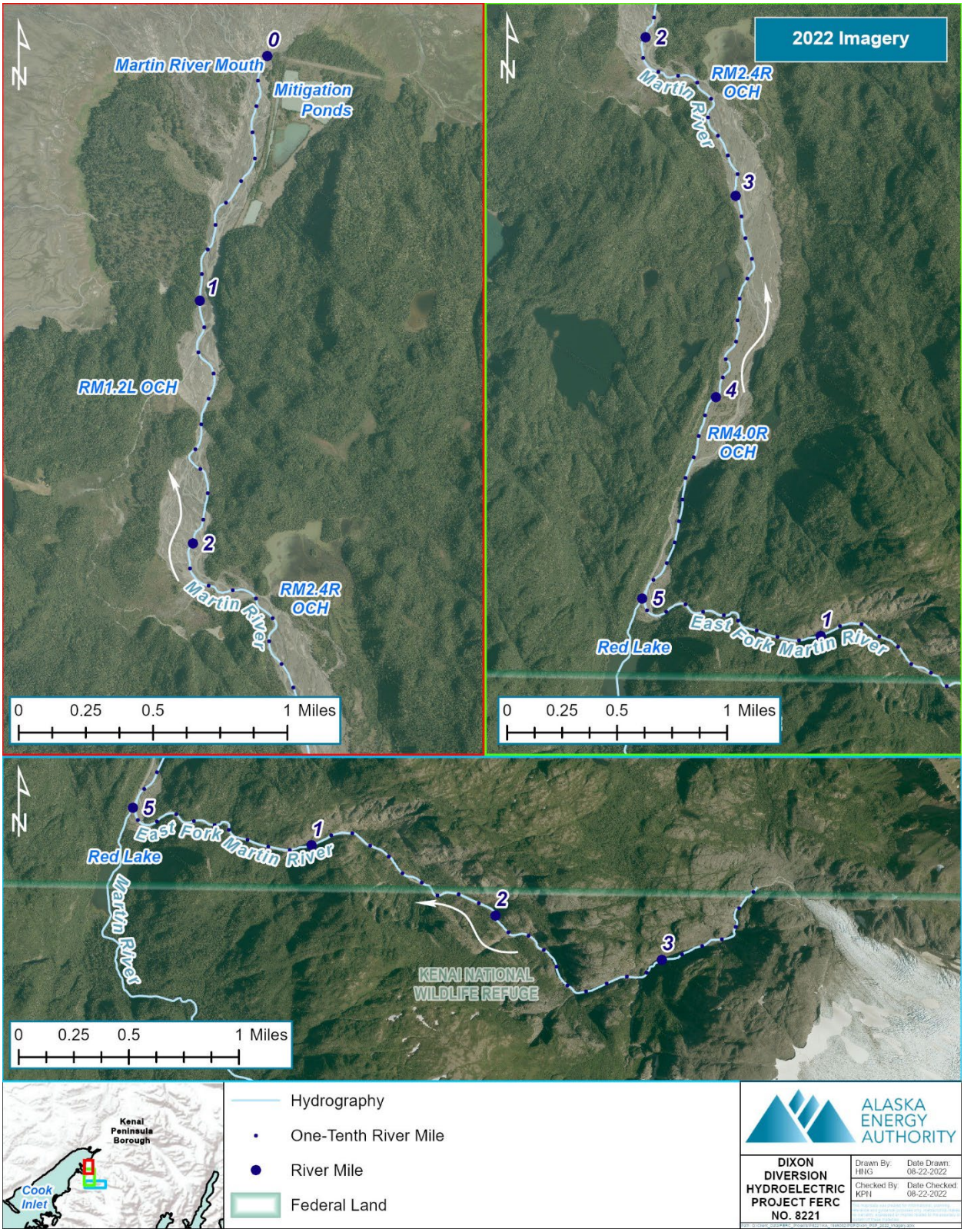


Figure 4.3-1 2022 Imagery of Martin River Upstream from the Mouth (Upper Left Image), Downstream of Red Lake (Upper Right Image), and the East Fork Martin River to the Dixon Glacier Outflow (Lower Image)

4.3.4 Project Nexus

The proposed Dixon Diversion Project may impact aquatic habitat in the Martin River by diverting flows from the Dixon Glacier outflow out of the East Fork Martin River. Under the Dixon-Martin Alternative, flows downstream of the proposed powerhouse would be unaltered. Under the Dixon-Bradley Alternative, flows would not be returned to the Martin River at the confluence with Red Lake outflows. Aquatic habitat has the potential to be impacted by the proposed reduction in Martin River flows.

4.3.5 Methodology

Ground-based habitat data collection along the entire river is impractical due to the complexity of channel plan form, the remoteness, and the flashy, high gradient and turbulent nature of the river. Thus, this study proposes an analysis of aerial imagery or LiDAR in combination with ground-based habitat data collection in off-channel, clearwater habitats that may be of particular importance to fish. Ground-based habitat surveys will target lower flow conditions in spring and fall to capture the maximal extent of low-turbidity conditions in off-channel habitats. No winter surveys are proposed as the Dixon Diversion Project would not operate during winter and Bradley Lake Project operations would not impact existing winter conditions. Both the remote mapping analysis and ground mapping data collection are described in the sections below.

Remote Line Mapping

Data derived from aerial imagery or LiDAR will be used to generate a geospatial database within a Geographic Information System (GIS) framework. Remote line mapping of habitats in the study area will be completed using a hierarchically nested habitat typing system (Table 4.3-1). The habitat classification hierarchy is composed of three levels representing: 1) geomorphic reach (developed from the Geomorphology Study described in Section 4.5); 2) macrohabitat type; and 3) mesohabitat type. Habitat typing will be classified to Level 2 (macrohabitat) due to the confounding presence of shadows and/or riparian cover.

A linear network will be created in GIS by drawing segments along the stream channel center line as viewed using aerial imagery or LiDAR. Mainstem habitats will be uniquely identified and delineated into segments. Divided channels will be assigned multiple segments. The lengths of the segments will be based on macrohabitat classifications (Table 4.3-1). Note that since there can be multiple macrohabitat types laterally

distributed within the floodplain, the total length of habitat identified during remote line mapping can be longer than the length of each geomorphic reach.

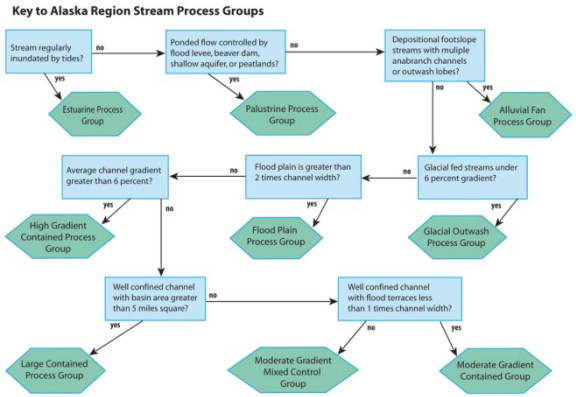
While mapping the Martin River in GIS, any tributaries or sloughs will be delineated in the aerial imagery up to 0.5 miles from the centerline of the main channel or off-channel confluence. Tributaries will be differentiated from sloughs based on their gradient characteristics and whether they originate above the floodplain. Tributary mouths will be mapped using a single line segment showing the length of the wetted area of the tributary mouth that extends from the vegetation line out to the edge of the gravel bank.

Main channel macrohabitats in the Martin River will be classified as single main channel when only a single dominant channel is present; split main channels when the flow is dispersed into two relatively evenly sized channels where the bar or island separating the channels is not vegetated; and multiple split main channels when the main channel splits into three or more separate channels each carrying a significant portion of the flow.

Side-channel macrohabitats are completely inundated under base flow conditions, connected at both upstream and downstream ends to the main channel, and flowing around a permanently vegetated island. Any dry portions of the channel will be delineated based on substrate and a lack of vegetation, indicating that water periodically inundates the channel during higher flow periods. The distance that the side-channel line segments extend into the main channel will be determined by an estimation of the continuation of the vegetated or high-water shoreline on either side of the mouth of the side channel. The presence of clear or turbid water under low flow conditions will be used as an indicator to differentiate between sloughs and side channels.

Side sloughs have clear water at low flows and are only connected at the top of the channel to the main channel at high flows. These areas can be partially dry but show evidence that they are inundated regularly during high flows by lack of vegetation. Upland sloughs have similar characteristics in that water is relatively clear, but they are not open to the main channel at both ends as indicated by the presence of vegetation in the area between the upstream end of the slough and the main channel.

Table 4.3-1 Hierarchical Habitat Classification

Level	Unit	Category	Definitions
1	Geomorphic Reach	**Process Groups** Alluvial Fan Estuarine Floodplain Glacial Outwash High Gradient Contained Low Gradient Contained Moderate Gradient Contained Moderate Gradient Mixed Control Palustrine Lakes and Ponds	See Alaska Region Channel Type Classification Process Group Key (USFS 2001) 
2	Macrohabitat	Main Channel Off-Channel Tributary	**Main Channel Habitat:** Main Channel – Single dominant main channel. Split Main Channel – Three or fewer distributed dominant channels. Multiple Split Main Channel – Greater than three distributed dominant channels. Side Channel – Channel that is turbid and connected to the active main channel but represents a non–dominant proportion of flow. Tributary Mouth – Clear water areas that exist where tributaries flow into main channel or side channel habitats. **Off-Channel Habitat (also referred to as macrohabitat):** Side Slough – Overflow channel contained in the floodplain but disconnected from the main channel. It has clear water. Upland Slough – Similar to a side slough but contains a vegetated bar at the head that is rarely overtopped by mainstem flow. Has clear water. Backwater – Found along channel margins and generally within the influence of the active main channel with no independent source of inflow. The water is not clear. Beaver Complex – Complex ponded water body created by beaver dams. **Tributary Habitat:** Tributaries will be mapped to the upper limit of Martin River hydrological influence

Level	Unit	Category	Definitions
3	Mesohabitat	Pools Fast water Beaver Pond	Pool – Slow water habitat with minimal turbulence and deeper due to a strong hydraulic control. Glide – An area with generally uniform depth and flow with no surface turbulence. Low gradient; 0-2 percent slope. Glides may have some small scour areas but are distinguished from pools by their overall homogeneity and lack of structure. Generally deeper than riffles with few major flow obstructions and low habitat complexity. Riffle – A fast water habitat with turbulent, shallow flow over submerged or partially submerged gravel and cobble substrates. Generally broad, uniform cross-section. Gradient; usually 2.0-4.0 percent slope. Cascade – A fast water habitat with turbulent flow; many hydraulic jumps, strong chutes, and eddies and between 30-80 percent white water. High gradient; usually greater than 4 percent slope. Much of the exposed substrate composed of boulders organized into clusters, partial bars, or step-pool sequences. Beaver Pond – Water impounded by the creation of a beaver dam. Maybe within main, side, or off-channel habitats.

Ground Mapping

The intent of the ground mapping effort is to provide mesohabitat classifications in clearwater habitats and to ground-truth a sample of macrohabitat classifications from the remote line mapping. Field surveys will use the same hierarchically nested habitat typing system (Table 4.3-1). This overview describes the general methods applied to habitat mapping and surveys overall.

The Martin River will be categorized into Geomorphic Reaches as part of the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Study (see Study 4.5). The geomorphic reach breaks will be based in part on factors including: 1) planform type (single channel, island/side channel, braided); 2) confinement (approximate extent of floodplain, off-channel features); 3) gradient; 4) bed material / geology; and 5) river confluences.

Habitat data collected in this study will use a hierarchical habitat classification system (Table 4.3-1) as well as standard protocols outlined in the U.S. Department of Agriculture, Forest Service (USFS) Aquatic Habitat Surveys Protocol developed for Alaska (USFS 2001). Habitat metrics will be collected using a USFS Tier I through Tier II stream habitat survey protocol (USFS 2001). Some of the habitat metrics listed in the USFS protocol assume that the stream being surveyed is wadable; however, some of the habitat units selected for ground surveys are likely to only wadable along stream margins. Modifications will be made to accommodate non-wadable stream reaches.

Habitat Metrics

The following habitat metrics will be collected for each selected geomorphic reach, and for each clearwater macrohabitat unit:

- Mesohabitat unit type.
- Global Positioning System (GPS) location of channel measurements.
- Measured or estimated gradient.
- Measured unit length (range finder or remote using GPS waypoints).
- Measured or estimated bankfull width (BFW) (three measurements per unit).
- Measured average wetted width (three measurements per unit).
- Measured bankfull depth (BFD) of unit (three measurements per unit).

- Measured or estimated wetted maximum depth (thalweg) (three measurements per unit).
- Estimated percent substrate composition within wetted width of unit.
- If pool, estimated or measured maximum depth.
- If pool, estimated or measured pool crest depth.
- If pool, identified structural feature forming the pool.
- Large woody debris (LWD) count within wetted width of unit.
- Estimated percent undercut, each bank in unit.
- Estimated percent erosion, each bank in unit.
- Type and percent in-stream cover in unit.
- Estimated percent riparian vegetation cover in unit.
- Dominant riparian vegetation type for each unit.
- Photograph of each unit.

Field surveys will be conducted by two- or three-person survey crews. Each survey crew will consist of a qualified lead biologist and field technician(s). To the extent possible, field surveys will be conducted at flows similar to those recorded during the capture of imagery and reference photographs.

4.3.6 Deliverables and Schedule

AEA will conduct the Aquatic Habitat Characterization Study in the 2023 study season. LiDAR along the mainstem of the Martin River is anticipated to be collected by AEA in the Spring of 2023. Imagery and field data collection is expected to occur during 2023. A report summarizing 2023 study activities will be included in the 2023 Study Report.

4.3.7 Cost and Level of Effort

Study costs are estimated to be approximately $275,000.

4.3.8 References

Brittain, J.E. and A. Milner. 2001. Ecology of glacier-fed rivers: current status and concepts. Freshwater Biology, 46(12), 1571-1578. https://doi.org/10.1046/j.1365-2427.2001.00845.x.

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4.4 Martin River Fish Use

4.4.1 Goals and Objectives

The goal of this study is to characterize fish use of aquatic habitats in the Martin River basin that have the potential to be affected by the proposed Dixon Diversion Project. Specific objectives are to:

1. Characterize the distribution and relative abundance of fishes in clearwater habitats of the Martin River;
2. Operate an autonomous video counting tower (AVCT) at Red Lake outlet to estimate daily count of adult Pacific salmon during daylight hours from approximately June 15–October 15; and
3. Document evidence of Sockeye and Coho salmon spawners in suitable clearwater habitats in the Martin River and Eulachon (*Thaleichthys pacificus*) spawners in the lower Martin River.

4.4.2 Known Resource Management Goals

Characterizing fish use in the Martin River Basin will support resource management goals related to fish and wildlife habitat protection. Both the construction of the proposed Dixon Diversion Project features and operation will have the potential to impact aquatic habitat conditions in downstream waters which in turn could impact fish resources. The ADF&G, NMFS, and USFWS have resource management goals directly related to the potentially affected resource.

The Fish and Game Act requires the ADF&G to "...manage, protect, maintain, improve, and extend the fish, game and aquatic plan resources of the state in the interest of the economy and general well-being of the state." The NMFS's Alaska Geographic Strategic Plan for 2020-2023 (NOAA 2020) identifies 1) ensuring healthy, sustainable fisheries and mariculture over the long term with ecological, economic, and socio-cultural benefits for the nation, and 2) supporting the socio-economic well-being of fisheries, and fishing communities through science-based decision-making and compliance with regulations. The overarching resource management goal of the USFWS as described in their mission is to "conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people." The USFWS has this authority under Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (33 U.S.C. 1344), National Environmental Policy Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), Bald and

Golden Eagle Protection Act (54 Stat. 250, as amended, 16 U.S.C. 668a–d), and Migratory Bird Treaty Act (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964 (Public Law 88-577), Alaska National Interest Lands Conservation Act (Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd–668ee).

4.4.3 Background and Existing Information

As summarized in the ICD, information about fish use in the Martin River is limited (AEA 2022). A review of the ADF&G's Anadromous Waters Catalog classifies the Martin River (241-14-10600) from the mouth to Red Lake as habitat for Sockeye Salmon, Coho Salmon, Chum Salmon (*O. keta*), and Dolly Varden (AWC 2022; Geifer and Blossom 2021). Previous surveys have documented the presence of Chum, Coho, and Sockeye salmon, and Dolly Varden between the mouth of the river and Red Lake. Juvenile Pacific salmon were found in off-channel habitats within the mainstem Martin River including sloughs, tributaries, and wetland complexes, as well as the mitigation ponds near the mouth of the Martin River and Red Lake (AEA 2022; ADF&G Study Request). Based on this previous work, ADF&G has identified 3 off-channel habitat complexes of interest for this study (Figure 4.4-1). The lowermost off-channel habitat appears to be a slough that drains from the west and enters the mainstem at approximately RM 1.2. Upstream, a large wetland complex connects to the mainstem around RM 3, and there is a small channel draining wetlands around RM 4. During AEA site reconnaissance in 2022, a fourth clear water channel was evident on river right, between river miles 3 and 4. This channel was observed only from the air and the location of its connection to the mainstem has not yet been identified.

In addition to the data summarized in the ICD, AEA has worked with ADF&G to operate a video weir at the Red Lake outlet stream for monitoring adult salmon run timing. This data collection is ongoing and proposed to continue through October 2022. Preliminary results indicate this method is effective at documenting upstream migration of Coho Salmon and Pink Salmon adults into Red Lake (see Section 3.3; Appendix B).

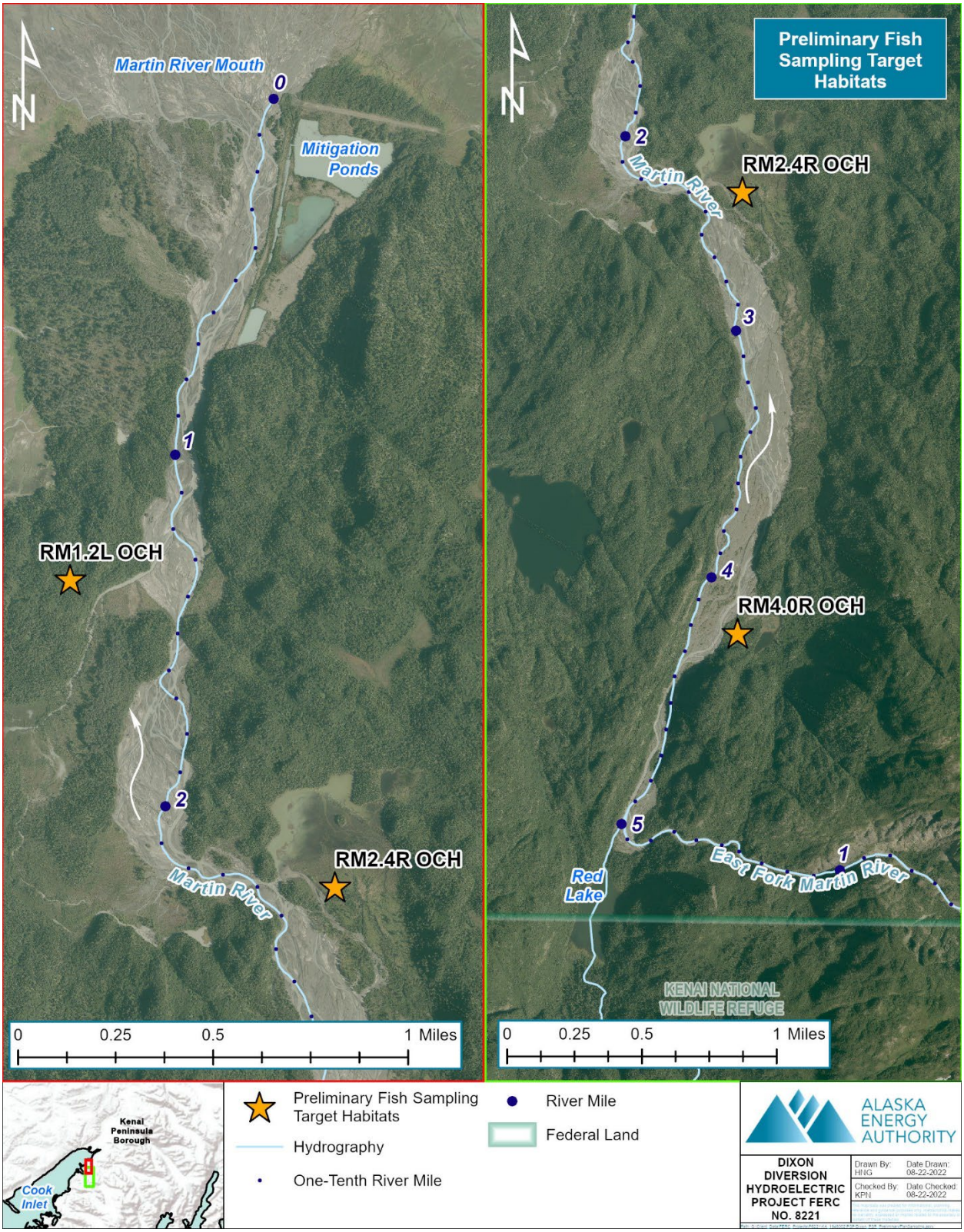

Figure 4.4-1 Preliminary Fish Sampling Target Habitats in the Martin River in Reaches Between the Mouth (Left Image) Upstream to Red Lake (Right Image)

Adult salmon observations in the Martin River Basin all have occurred in Red Lake, both via aerial observations and boat-based observations of fish breaking the surface (Otis 2016), or more recently from video monitoring in the lake outlet. However, based on data from other rivers in Alaska, if sufficient winter flow is provided from nonglacial sources, Sockeye Salmon could also be spawning in the turbid main channel and side channels. Spawning in turbid glacial habitats has been documented in other glacial river systems in Alaska (Eiler et al. 1992) where upwelling provides suitable incubation conditions despite heavy silt loads (Tappenbeck 2008).

4.4.4 Project Nexus

The proposed Dixon Diversion may have indirect effects on fishes in the Martin River Basin by diverting flows from the Dixon Glacier out of the East Fork Martin River. Under the Dixon-Martin Alternative, flows downstream of the proposed powerhouse would be unaltered and potential effects would be limited. Under the Dixon-Bradley Alternative, flows would not be returned to the Martin River at the confluence with Red Lake outflows. Fishes have the potential to be impacted by the proposed reduction in Martin River flows via flow-based changes in fish habitat or access to fish habitat.

4.4.5 Methodology

The effectiveness of fish sampling methods in riverine habitats can depend on sampling conditions (water velocity, depth, turbidity, water temperature, etc.), target fish species and life stages and their behavioral characteristics, and the timing of sampling. This study proposes a variety of methods to meet multiple study objectives. Sampling will focus on fish use of Martin River habitats from May through October which is during the season of potential impacts by the proposed Dixon Diversion.

Objective 1. The Distribution and Relative Abundance of Fishes in Clearwater Habitats

Due to the highly turbid and fast flowing nature of the main channel, sampling for juvenile anadromous and resident fishes in rearing habitats will focus on clearwater off-channel habitats and tributaries during 2023 and 2024. Clearwater habitats will be identified in 2023 as part of Study 4.3 Aquatic Habitat Characterization. Potential fish sampling methods include minnow trapping, backpack electrofishing, and seining.

Gee-type minnow traps (17.5 inches x 9 inches, with approximately 1-inch openings and 0.25-inch mesh) will be baited with salmon eggs that are commercially preserved (or

disinfected with a 10-minute soak in a 1/100 Betadyne) and soaked overnight at a density of ≥1 trap/20-meter sample length. Distances between traps will depend upon habitat complexity, and traps will be set more densely in complex habitats with appropriate depth (Bryant 2000). Minnow traps will be set in microhabitats with slow water and/or cover to maximize catch and will be set overnight for a period ranging from sixteen to twenty-four hours. The number of traps deployed and their locations will be recorded to maximize trap recovery. Trap retrieval lines will be tethered to streamside vegetation or staked and marked with fluorescent flagging that includes a trap identification number and ADF&G permit information.

Electrofishing is effective for a wide range of fish species, life stages, and habitat types (Temple and Pearsons 2007). Electrofishing can be an effective technique in habitats that are not easily sampled by traps or nets, especially for benthic fish (e.g., sculpin) or species that hide in undercut banks (Temple and Pearsons 2007); however, electrofishing does have some limitations and can be harmful if not conducted properly. Use of electrofishing as a fish capture technique is tightly regulated by ADF&G. If electrofishing is permitted, consistent with past permit conditions, it likely will be limited to use in areas where no adult salmonids are present. The ADF&G recommended target voltage settings for juvenile salmonid sampling in cold water will be used as a reference at the onset of sampling (Buckwalter 2011). Electrofishing may not be effective in some glacial systems subject to high turbidity and low conductivity (Temple and Pearsons 2007). Suspended materials in turbid water can affect conductivity, which may result in harmful effects on fish, especially larger fish due to a larger body surface in contact with the electrical field. All backpack electrofishing procedures will follow NMFS (2000) Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act.

A Smith-Root LR-24 backpack electrofishing unit will be operated by a trained field crew leader assisted by up to two people with dipnets. Each backpack unit will be fitted with a standard Smith-Root cathode and a single anode pole with a steel ring. Single-pass electrofishing surveys will be conducted through the selected study reach moving in an upstream direction. All stunned fish will be captured with dipnets away from the electric field and held in buckets for later processing. Backpack 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). Prior to electrofishing, ambient water chemistry will be recorded including conductivity

(microSiemens), turbidity (nephelometric turbidity unit [NTU]), and surface water temperature (°C) with a digital meter at the downstream end of the sampling site to help determine initial backpack electrofishing unit settings. In all cases, the electrofishing unit will be operated and configured with settings consistent with guidelines established by the manufacturer (Smith-Root 2009), ADF&G (Buckwalter 2011), and NMFS (2000). Personnel operating electrofishing units will be trained and certified as per ADF&G permit requirements. The location of each electrofishing unit will be mapped using handheld GPS units and marked on high-resolution aerial photographs. Start and stop times will be recorded to quantify sampling effort between surveys.

Beach seines are an effective method to capture a range of fish species and life stages in a multitude of slow-water habitats. In addition, seining allows the sampling of relatively large areas in short periods of time as well as the capture and release of fish without significant stress or harm. Limitations to beach seining include fast flows, water depth, coarse substrates, and woody and organic debris (Hahn et al. 2007). Woody debris and boulders can create snags and lift off the lead line allowing the fish to escape. Ideal habitats for beach seining are wadable, slow moving water with level uniform substrate (e.g., gravel and/or sand). In wadable systems, smaller nets are used and deployed by hand 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. With most seine sets, lead and cork lines should be withdrawn at approximately equivalent rates until close to shore. Once the lead line approaches the shore, it should be withdrawn more than the cork line until a secure pond or corral is formed in the bag of the net and the lead line is on the beach or gravel bar (Hahn et al. 2007). To the extent possible, the same area will be fished during each sampling event; and net sizes and soak times will be standardized. Seine nets of various sizes are available for use that range from 14 to 120 feet long, 3 to 6 feet wide, and have mesh diameters that range from 0.125 to 1 inch.

The following water quality parameters will be collected at each fish sampling reach using a calibrated multiparameter probe: temperature (°C), dissolved oxygen (mg/L and percent saturation), and conductivity. Water visibility will be estimated using a turbidity tube (Myre and Shaw 2006).

Objective 2. Run Timing of Sockeye and Coho Salmon into Red Lake

Run timing for Pacific salmon entering Red Lake will be evaluated for a second year using AVCT that employs above-stream remote video cameras and digital time-lapse recording equipment to record fish entry into the lake. The Red Lake AVCT will be located along the outlet stream joining Red Lake to the Martin River. The AVCT system is comprised of several off-the-shelf electronic and video components attached to a pole located streamside at a site conducive for counting fish and generating sufficient solar power to operate the system. The camera is enclosed in a weatherproof camera housing affixed to the 3.1-m pole extension atop the tower with a field of view that encompasses the entire cross section of the creek, from bank to bank. A high-contrast substrate panel comprised of a 4.6-millimeter (0.1875 inch) mesh beach seine is stretched across the stream bottom perpendicular to the channel to make it easier to see fish swimming past the AVCT.

Installation of the Red Lake video system should occur no later than June 15 and will be operated from mid-June through mid-October. There are approximately 4 hours each night (00:00-04:00) when it is too dark to see fish in the AVCT in June/July with daylight shortening throughout the monitoring period. Although disk space required for a day's video varies with the complexity of the images (e.g., varying light conditions, cloud shadows, etc.), the 2 TB hard drives used typically accommodate about 50 days of recorded video. A time-lapse recording rate of 3 frames per second is proposed to optimize hard drive space without compromising the reviewer's ability to track individual fish transiting the video site. During the season, staff will periodically swap out the hard drives during regularly scheduled site visits when they are approaching maximum storage capacity (approximately 7 weeks). Removal of the video station will occur in mid-October before significant ice formation occurs, while still allowing for the passage of most anadromous species.

Hard drives will be retrieved at least once every 50 days and reviewed. Fish counts and other noteworthy observations (e.g., weather, dawn/dusk, video quality, and sightings of bears, moose, or other wildlife captured on video) will be recorded. Daily fish counts will be stratified by species into 6-hour time blocks (e.g., 00:01-06:00, 06:01-12:00, 12:01-18:00, and 18:01-24:00). Staff will also record any periods of video loss or other technical difficulties. Daily counts will be used to describe run timing and escapement indices for Red Lake by species during the study period.

Objective 3. Document adult Coho Salmon, Sockeye Salmon, and Eulachon.

Pacific Salmon

Evidence of Sockeye and Coho salmon spawning in suitable clearwater habitats may be documented using either visual observations of adult spawners within the habitats or in mixing zones between clearwater and the more turbid mainstem Martin River, or evidence of successful spawning may be inferred using the presence of young-of-year or emergent fry life history stages of Coho and Sockeye salmon.

Adult salmon and carcass surveys will be completed along RM1.2L OCH and in the clearwater channels on river right flowing into RM2.4R OCH, both of which have been preliminarily identified as potential spawning habitats. In addition, select side channel habitats identified in Study 4.5 (Hydraulic Modeling, Geomorphology, and Habitat Connectivity Evaluation) with suitable substrate and the potential for upwelling may be targeted for seining in summer 2024 as conditions allow.

Within these clearwater habitats, pedestrian surveys will be conducted from a downstream to upstream direction to enumerate live adult salmon by species in the survey reach. Where multiple stream channels are present in braided areas, each channel will be surveyed and adult salmon counts will be separated into right side braids, left side braids, and single channel. Field data will be entered on prepared forms including the GPS locations of observed salmon spawners, spawning activity, or established redds (latitude/longitude in decimal degrees in the WGS84 datum). In addition to GPS locations of spawning areas, aerial photos and survey maps will be used to record notes about fish observations and behavior during each survey. Survey results will be delivered as a GIS product including locations of any observed evidence of Sockeye or Coho salmon spawning.

Weather, temperature, turbidity, discharge, timing of a survey, and the experience of observers can affect adult fish counts in spawning habitats. Observers will evaluate and record these environmental conditions for fish surveys. Water temperature (°C), visibility (m), and turbidity (NTU) will be collected during each spawner survey at established locations. Water visibility in tenths of meters will be estimated with a survey rod to indicate the visible depth to the stream substrate. Surveys will be conducted mid-day to minimize shadow effects on visibility. Polarized glasses will be worn by observers.

In neighboring Battle Creek, water is more turbid from glacial influence during late September but clears in October when temperatures and glacial melt decrease (AEA 2017). Storms can also change water clarity at any time throughout the year, and commonly occur during the late summer and fall. If fall storms result in high water conditions that are hazardous to survey participants or create turbid water conditions that do not facilitate fish observations, the foot survey may not be possible until flow and survey conditions improve. Storm events and stream conditions will be documented and described in the annual report.

Emergent fry and young age-class Coho and Sockeye salmon juveniles may be encountered during sampling under Objective 1 (Fish Distribution in Clearwater Habitats) during the portion of the year (May/June and Sept/Oct) when a combination of low water levels, decreased turbidity, and safe access allow the use of minnow traps, backpack-electrofishing, or seining. Successful collection of early age-class fish, especially emergent fry in mainstem habitats during improved visibility conditions, will provide context for more focused efforts in Study Year 2 to identify the potential for riverine spawning areas used by adult Sockeye in mainstem reaches.

Eulachon

Stream water temperature can affect the timing of the spawning migration of Eulachon in Alaska streams with peak migration dates varying among years. Regional information suggests that Eulachon may enter rivers in the vicinity of the Martin River between mid-May and late June (AEA 2022). This timing corresponds with the period of the ADF&G personal use Eulachon fishery in Cook Inlet (ADF&G 2022). To improve the likelihood of encountering migrating Eulachon in the Martin River, two sampling efforts will be made during this period.

Eulachon presence in the lower Martin River will be assessed using drifted or fixed gill/trammel nets in the lower mainstem between the upper extent of tidal influence near the airstrip and the first right bank hydraulic control. This location is approximately 0.6 RM upstream from the mouth which corresponds to the upstream extent of the right bank levee protecting the mitigation ponds.

Gill/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). Gillnets are designed to collect fish by entangling them as they try to swim through the net mesh. As a result,

gill/trammel nets are not species selective and are able to collect a combination of both targeted and non-targeted species and life stages. Gill/trammel nets either drifted or fixed for Eulachon sampling will use 1.5-inch mesh size as appropriate for an average body size of 10 inches (ADF&G 2022). Gill/trammel nets will have a buoyant top line with flotations and a leaded bottom line.

Net set locations will be selected to include habitat suitable for migrating Eulachon. As weak swimmers, Eulachon spawners favor slow-moving waterways without long stretches of high velocity flow. Up to five right bank set locations will be identified where water velocity, channel morphology, and net-set feasibility are appropriate. For fixed applications, one end of the gill/trammel net will be fixed to a stake on shore or shallow water and the other will be weighted and placed at an oblique angle to the flow to obviate flow disturbance or fish deterrence. In drifting applications, the net will be floated from upstream to downstream along a specified transect (Davidson et al. 2011) and pulled to shore at the first indication of successful capture. In areas too deep to wade, a raft may be required either to set fixed net anchors or to control the end of drifting nets. No gill/trammel nets will be left unattended.

During each sampling event, sampling unit, soak time, location, GPS coordinates, water temperature, and DO will be recorded. The location of each gill/trammel net set will be marked using handheld GPS units and marked on high-resolution aerial photographs.

To avoid unnecessary stress or harm to migrating adults, the capture of any Eulachon in a net set will result in the determination of "presence" and no further sampling will be completed at that location. Eulachon presence in the lower Martin River will be investigated in both 2023 and 2024.

Analytical Methods

Evaluation of the presence of Coho or Sockeye salmon spawners will include GIS products (maps) of adult salmon observations as well as any other evidence of spawning (redds, carcasses, etc.). The presence of resident fishes or juvenile anadromous fishes encountered during minnow trapping, electrofishing, or seining will also be documented using GIS spatial tools. The size distribution of sampled fishes will be provided in summary tables along with water quality parameters measured during each sampling effort. Catch per Unit Effort (CPUE) will be calculated for all sampling techniques including minnow trapping (number of fish/trap set, number of fish/unit area), backpack

electrofishing (number of fish/unit time), seining (number of fish/haul, number of fish/ unit area), and fixed and drift- gill/trammel netting (number of fish/set).

4.4.6 Deliverables and Schedule

AEA will conduct the Martin River Fish Use Study during the 2023 and 2024 study seasons with data collection occurring both years. A report summarizing 2023 study activities and recommendations for the 2024 field activities will be included in the 2023 Study Report. A final, cumulative report will be developed for the 2024 Study Report.

4.4.7 Cost and Level of Effort

Study costs are estimated to be approximately $635,700.

4.4.8 References

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4.5 Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation

4.5.1 Goals and Objectives

This study plan describes an interdisciplinary effort that will be undertaken to identify and evaluate the effects of potential Dixon Diversion Project-induced changes in water depth and stream bed elevation (i.e., sediment deposition and transport) on aquatic habitat connectivity. Several other fish and aquatic resource studies (Section 4.3 Aquatic Habitat Characterization and Section 4.4 Martin River Fish Use) will be integrated with this study to address future Dixon Diversion Project effects related to flow and sediment dynamics.

Specific objectives of the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Study are as follows:

- Develop calibrated hydraulic and sediment dynamics models to predict the magnitude and trend of Martin River channel response to proposed Dixon Diversion Project operations.
- Apply models to estimate the potential for channel change for with-Dixon Diversion Project operations compared to existing conditions for both hydraulic (flow) changes and sediment transport/deposition changes.
- Using modeling and data from field surveys, evaluate the potential changes to connectivity of mainstem and off-channel habitats for multiple fish species and life stages (adult migration, spawning, juvenile rearing, and incubation).
- Evaluate the spatial and temporal variability in mainstem and off-channel habitat connectivity related to future flow conditions and water depth/surface elevations.

These objectives will be met with existing information, consulting with the other study leads, and by using additional methods described in this study plan. Environmental variables affecting hydraulic conditions and sediment load and transport in the Martin River are dynamic; therefore, results of this study will represent a "snapshot-in-time." The connectivity of mainstem and off-channel aquatic habitats change from season to season with the rise and fall of stream flow, and the natural shifting in sediment transport and deposition. The dynamic alluvial riverbed of the mainstem Martin River also changes with variable flows over time (AEA 2022). Thus, the bed elevations into and within sloughs, side channels, and at the mouths of tributaries may change in response to daily, weekly, seasonal, or annual high flow events under both existing conditions and with potential future flow change scenarios. These shifts in bed elevation may alter the

connectivity of aquatic habitat conditions, sometimes eliminating and sometimes creating the opportunity for access to aquatic habitat within relatively short time periods (hours to days).

4.5.2 Known Resource Management Goals

Several natural resource agencies have jurisdiction over aquatic species and their habitats in the Dixon Diversion Project area. These agencies will be using, in part, the results of this and other fish and aquatic studies to satisfy their respective mandates. The federal and state agencies mentioned below have identified their resource management goals or provided comments in the context of FERC licensing related to instream flow, habitat connectivity, and fisheries related issues.

U.S. Fish and Wildlife Service

The following text is an excerpt from the August 15, 2022, USFWS letter and Instream Flows and Habitat Utilization:

> *Under Section 18 of the FPA, the Service has authority to issue mandatory fishway prescriptions for safe, timely, and effective fish passage. Under Section 10(j) of the FPA, the Service is authorized to recommend license conditions necessary to adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat) affected by the development, operation, and management of hydropower projects. Section 10(a)(1) of the FPA requires the Federal Energy Regulatory Commission (FERC) to condition hydropower licenses to best improve or develop a waterway or waterways for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat) based on Service recommendations and plans for affected waterways. Specific management goals are the protection of anadromous, trust fish species, and their habitats.*
>
> *Consistent with our mission and with the legal authorities described above, our resource goal in this matter is to conserve exis*ting *fish and wildlife resources and their habitats in the Quiet Creek-Frontal Kachemak Bay watershed (Hydrologic Unit Code 1902030111).*

Alaska Department of Fish and Game

The following text is an excerpt of the August 9, 2022, ADF&G letter and Instream Flow Assessment:

The Fish and Game Act requires the Alaska Department of Fish and Game 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).

4.5.3 Background and Existing Information

Limited information is available on the fish assemblage, aquatic habitat availability, level of use, migration timing, hydrologic connectivity of mainstem and off-channel habitat, sediment input or transport in the Martin River Basin. Licensing studies conducted for the original Bradley Lake Project identified the Lower Bradley River as having the largest fish run sizes among the Bradley River, Battle Creek, and Martin River (FERC 1985). Battle Creek was studied extensively in 2010 and 2011 with study reaches beginning at tidewater and extending upstream to the terminus of Battle Glacier (AEA 2011). Seven fish species were documented in Battle Creek including resident and anadromous species. Resident fishes collected from freshwater and tidally influenced habitats included Ninespine Stickleback (*Pungitius pungitius*), Threespine Stickleback (*Gasterosteus aculeatus*), sculpin, and Starry Flounder (*Platichthys stellatus*) (FERC 2016).

The ADF&G Anadromous Waters Catalog (ADF&G 2020) lists the Martin River as important for spawning, rearing, or migration of anadromous fishes including Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon, and Sockeye Salmon, and Dolly Varden. Historical fish surveys of Martin River (1977-1996) reported the river supported small anadromous population of Coho, Sockeye, and Pink salmon (ADF&G 2009). The Sockeye Salmon returning to the system were believed to primarily be beach spawners within Red Lake.

During contemporary fish surveys, ADF&G has documented occasional fish observations both from aerial surveys, minnow trapping, seining, and electrofishing of adult and juvenile salmon (Coho and Sockeye salmon) and Dolly Varden (Geifer and Blossom 2021). These studies have not evaluated the connectivity or access of aquatic habitats to adult salmon migration to Red Lake or access to other off-channel habitats.

4.5.4 Project Nexus

Construction and operation of the Dixon Diversion Project will affect flow, surface water elevation, sediment load and transport, and water depth in the mainstem channel of the Martin River downstream from the diversion structure. Under the Dixon-Martin Alternative, flow would be returned to the river upstream from the outlet to Red Lake,

so flow-related changes would be minimized downstream from the Martin River powerhouse Figure 1.1-1. Under the Dixon-Bradley Alternative, flow in the Martin River would be reduced when the Dixon Diversion Project is operational, potentially resulting in flow-related changes at tributary confluences as well as at the inlets and outlets to side channels, sloughs, and various off-channel habitat features. These potential changes in mainstem flow, water elevations, and sediment transport can potentially limit aquatic habitat connectivity. The maintenance of aquatic habitat connectivity is particularly important for fish species that must migrate within the Martin River and require access to off-channel habitats to complete their life cycle.

Off-channel habitat (e.g., sloughs, side channels, ponds, lakes) are expected to be important for Martin River fishes as they provide clear and potentially productive habitat in an otherwise highly dynamic and turbid system. Potential changes to river flow and stage may in turn affect the connectivity to these off-channel habitats. For example, if they become inaccessible to fishes, this could affect fish populations. River stage and connectivity also can be affected by changes in the bed elevations due to sediment transport processes. Understanding how sediment dynamics and water surface elevation (i.e., water depth) change over a range of stream flows will provide baseline information needed for predicting the likely extent and nature of potential changes to aquatic habitat connectivity resulting from any Dixon Diversion Project induced flow and water elevation changes.

The operational strategy of the Dixon Diversion Project could result in a variety of flow responses to the Martin River. These may include seasonal and daily changes in river stage that would vary laterally and longitudinally along the river. Having a clear understanding of the effects of the Dixon Diversion Project on fluvial processes and aquatic habitat connectivity present within the Martin River will support environmental analysis of the undertaking.

4.5.5 Methodology

The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation is divided into three main study components:

1 Develop two-dimensional (2D) hydraulic model to define connectivity between mainstem and off-channel habitats under current conditions;

2 Geomorphology and sediment transport analysis to help determine how channel and habitat connectivity may change in response to flow manipulation; and

3 Aquatic habitat connectivity evaluation to determine the spatial and temporal variability of mainstem and off-channel habitat connectivity under proposed Project operational scenarios.

Each of these components is explained further in the following subsections.

Develop Two-Dimensional Hydraulic Model

Modeling of hydraulic conditions will be used to provide a basis for comparing stream flow, channel morphology, and aquatic habitat connectivity under baseline conditions and proposed Dixon Diversion Project operational scenarios. A 2D numerical model will be developed to simulate the hydraulic and sediment transport characteristics of the Martin River. The 2D model will be used to simulate the spatial distribution of water depth and velocity needed to assess relationships between flow and habitat connectivity.

There are several software options for 2D hydraulic modeling including HEC-RAS 2D (USACE 2016), SRH-2D (Lai 2008), and River2D (University of Alberta). The model selection will depend on 1) the level of detail required to meet the overall study objective(s); 2) the regime of flows that are expected to be modeled; 3) consistency with the spatial and temporal scale of the area to be investigated; and 4) the availability of necessary data for model development and calibration. Final model selection will be made in consultation with the geomorphology and aquatic habitat study leads.

The proposed approach for 2D model development and calibration will follow a stepwise process including:

1 Define hydraulic model domain (Figure 4.5-1);

2 Obtain topographic (LiDAR data provided by AEA) data for the model domain area

3 Collect bathymetric and hydraulic data within the model area (field surveys during low flow conditions);

4 Select the appropriate mesh size for different portions (mainstem vs. off-channel) of the study area;

5 Establish upstream and downstream boundary conditions;

6 Merge topographic and bathymetric data to triangulate and interpolate elevations to the mesh nodal points;

7 Obtain channel substrate mapping from the geomorphology study component;

8 Integrate LiDAR, model mesh, and boundary conditions for model development;

9 Compare depths and velocities predicted by the 2D model with measured data from field measurements;

10 Adjust channel roughness to achieve reasonable agreement between measured and modeled water-surface elevations; and

11 Obtain daily flow values for longest available period of record (provided by AEA).

Once developed, the 2D model will be used to simulate how changes in flow interact with local channel morphology to produce variable patterns in water depth and velocity. These results will then be applied to a flow record under natural and alternative flow conditions to investigate the temporal variability of aquatic habitat connectivity.

Field Data Collection

The 2D modeling approach relies on remote sensing surveys to generate high-resolution topographic measurements within the modeling domain (provided by AEA; see schedule below). The accuracy of the 2D modeling is strongly dependent on the resolution and accuracy of the underlying topographic mapping. For planning purposes, it is assumed that drone-based LiDAR will be used to provide topographic mapping of the river channel. Drone-based LiDAR has been recommended for this study because it provides much higher resolution data and, compared to traditional survey methods, can be completed much faster.

The detailed topographic data provided by the LiDAR survey will be combined with empirical field measurements of flow, water surface elevation, and supplemental topographic and bathymetric data collected under low-flow conditions at a subset of the identified habitat connectivity points. The expanse and complexity of sloughs, side channels, and off-channel lakes and ponds will prohibit total coverage of all such potentially affected areas. Thus, sub-sampling of these habitats will be necessary. This task will be coordinated with the fisheries and geomorphology study leads to identify a maximum of five off-channel features that represent the range of conditions present in the Martin River.

Data collection will be completed during a single sampling event under low flow, clearwater conditions to ensure the greatest channel visibility and access to mainstem and off-channel habitat features.

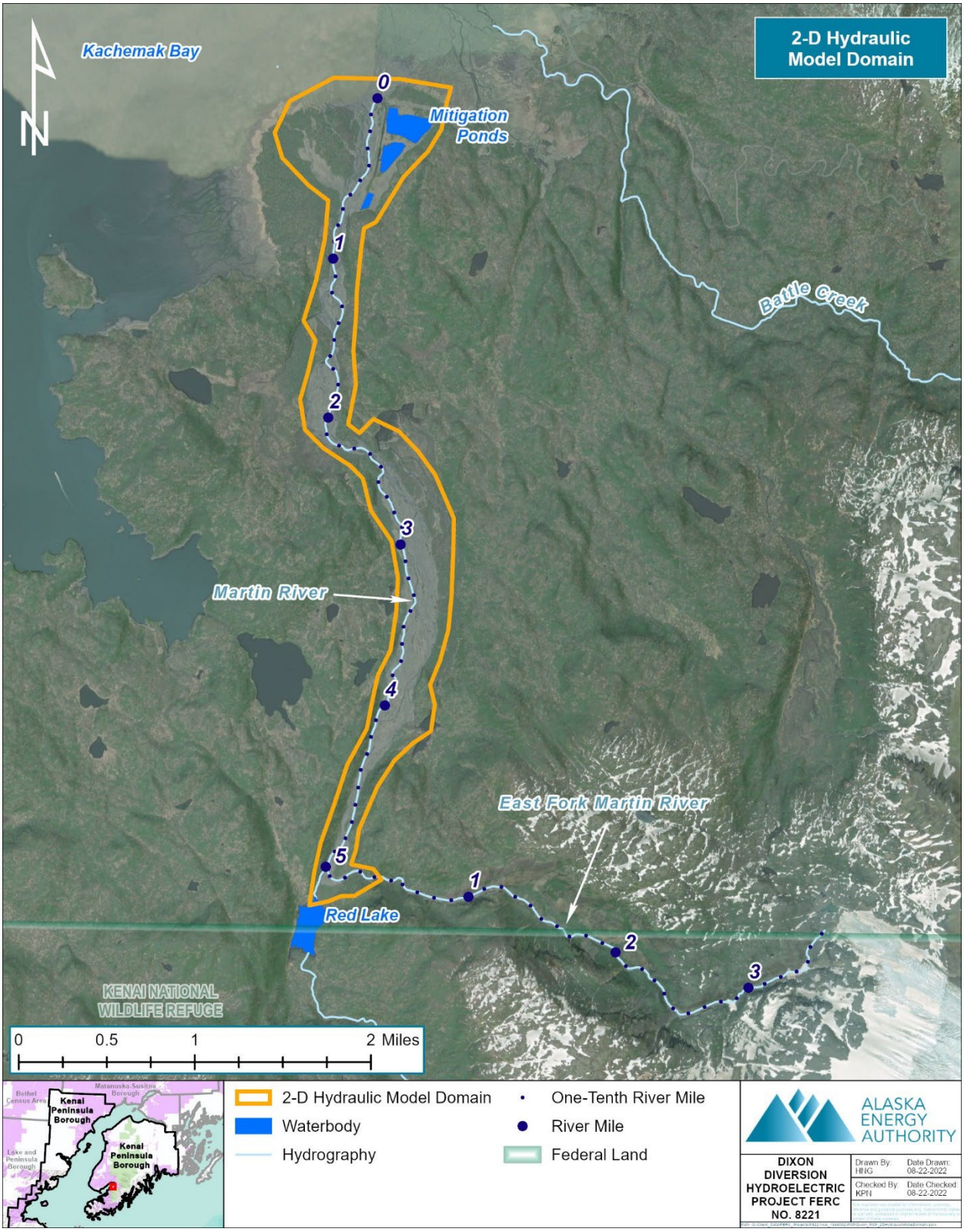

Figure 4.5-1 Proposed Extent of 2D Model Domain for Evaluation of Aquatic Habitat Connectivity in the Martin River, Alaska

Site-specific data collection will include:

- Measurement of water surface elevation in relationship to vertical control points established as part of the LiDAR survey;
- Survey of local topographic and bathymetric features to ensure accurate elevations obtained from the LiDAR survey and added model resolution;
- Opportunistic measurement of channel profile and water depth in mainstem and side channel features to fill-in and/or validate bathymetry developed from raster points; and
- Characterization of dominant substrate composition using size gradients comparable to the geomorphology evaluation.

Geomorphology and Sediment Transport Analysis

The Martin River flows from the Dixon Glacier outflow through a high-gradient canyon to the confluence with the Red Lake outflow and then through a lower-gradient, very dynamic glacial outwash plain to Kachemak Bay. The Dixon Glacier supplies a large amount of sediment to the river and includes material from boulder to clay size. This material is transported through the canyon reach and then deposited in the outwash plain as the valley widens and water velocity drops, forming a braided river pattern. Initial observations of the outwash plain show several distinct geomorphic reaches based on confinement where the adjacent bedrock has developed into a wide valley or narrower pinch points. Substrate generally fines in a downstream direction, and vegetation patterns in the wider valley segments suggest long-term aggradation consistent with a pro-glacial stream environment. The geomorphology and sediment transport analysis will analyze available historic aerial photograph and LiDAR data as well as collect current information on substrate size and analyze potential future sediment transport and accumulation trends based on output from the 2D hydraulic model described in the prior section. Tasks include:

- Segment the Martin River into geomorphic analysis reaches based on confinement, degree of braiding, and gradient.
- Delineate past changes to Martin River, adjacent forest community growth/destruction patterns (resulting from channel migration), and stream/pond connectivity through time using historic aerial photographs (1984 through present are available, possibly older series as well).

- Map degree of channel braiding in each reach of Martin River through time to determine past changes to braiding patterns in each geomorphic reach. This step will help to determine expected future variability in braiding patterns.
- Compare LiDAR and any other topographic datasets to estimate average annual volume of coarse-grained sediment provided to river (combined Martin River and East Fork Martin River) from the Dixon Glacier based on aggradation volumes.
- Collect pebble count data and sub-surface samples during low flow conditions in each geomorphic reach.
- Analyze sediment transport and deposition potential along the Martin River based on the 2D hydraulic model output under current/proposed flow regime(s).
- Compare sediment input and sediment transport potential to estimate future deposition rates and locations.
- Coordinate with team members assessing riparian and aquatic habitat conditions and connectivity to help develop a multi-disciplinary analysis of the effects of changes in flow regimes.

Aquatic Habitat Connectivity Evaluation

Determining aquatic habitat connectivity is dependent on the fish species and life stage of concern, stream discharge, water depth, and the relationship of fish movement with stream discharge. For this study, habitat connectivity related to water depth are more of a concern in adult upstream migration and adult and juvenile access to sloughs, side channels, and mouths of tributaries, than physical barriers (cascades and waterfalls). No high gradient cascades or waterfalls are present within the proposed modeling domain as shown in Figure 4.5-1.

Methods for the study of aquatic habitat connectivity will likely consist of the following study components (these components will be refined in coordination with other study leads):

- Identify fish species and life stages to be included in the aquatic habitat connectivity study;
- Determine the periodicity or timing of use of aquatic habitats by the identified fish species and life stages;
- Define connectivity/passage criteria for the identified fish species and life stages;
- Identify potential aquatic habitat connectivity points to be sampled as part of field surveys;
- Conduct field data collection at identified aquatic habitat connectivity points;

- Coordinate with other interdependent studies (geomorphology, aquatic habitat characterization, and fish habitat use); and
- Utilize 2D model results to evaluate potential effects of altered fluvial processes on habitat connectivity between mainstem and off-channel habitats.

Identify Fish Species and Periodicity

The fish community of the Martin River includes 10 documented fish species (AEA 2022). Within this community, some fish species exhibit life history patterns that rely on multiple habitats during spawning and rearing activities and are thus considered more sensitive to changes in access to side channels, sloughs, and/or tributary habitats. Although all fish species that utilize the Martin River were considered for inclusion, a subset of these species have been identified as the focus of the aquatic habitat connectivity analysis based on their level of use of the Martin River, migration needs (water depth) and timing, and use of off-channel habitats to complete their life history (Table 4.5-1). The species list may be refined in response to input from the Martin River Fish Use Study.

Table 4.5-1 List of Fish Species Reported to Use the Martin River and Those Proposed for Inclusion in the Aquatic Habitat Connectivity Evaluation

Fish Species List	Proposed Species	Proposed Life Stages
Chinook Salmon	Coho Salmon	Migration, Spawning, Juvenile Rearing
Chum Salmon	Sockeye Salmon	Spawning
Coho Salmon	Dolly Varden	Spawning, Adult and Juvenile Rearing
Pink Salmon		
Sockeye Salmon		
Dolly Varden		
Ninespine Stickleback		
Threespine Stickleback		
Sculpin		
Starry Flounder		

In general, the degree to which Martin River flow conditions prohibit aquatic habitat connectivity relates directly to the timing of use by the identified fish species and life stages. Information presented in the ICD (AEA 2022), collected under the Martin River Fish Use Study Plan, and resource reports from similar river systems in close proximity to the Martin River were used to develop a periodicity table for the identified fish species

and life stages (Table 4.5-2). The periodicity table is meant to summarize the timing of fish habitat use of mainstem and off-channel habitats for migration, spawning, incubation and emergence, and adult and juvenile rearing. The final periodicity table will be developed in consultation with the Martin River Fish Use Study.

Table 4.5-2 Proposed Periodicity for Fish Species and Life Stages to be Evaluated in the Habitat Connectivity Evaluation of the Martin River, Alaska

Life Stage	Species	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Adult Migration	Coho												
	Chinook												
	Sockeye												
Adult Spawning	Coho												
	Chinook												
	Sockeye												
	Dolly Varden												
Egg Incubation and Emergence	Coho												
	Chinook												
	Sockeye												
	Dolly Varden												
Juvenile Outmigration (smolts)	Coho												
	Chinook												
	Sockeye												
Rearing (Fry, parr, resident adult)	Coho												
	Chinook												
	Sockeye												
	Dolly Varden												

Habitat Connectivity Criteria for the Selected Fish Species and Life Stages

Adult salmonids returning to spawn must do so at the proper time and with free access to suitable spawning habitat to complete their life cycle (Bjornn and Reiser 1991). Delays in migration caused by restricted upstream movement may impact at least a portion of the spawning population and lead to reduced production. The level of flow necessary for upstream passage through shallow water areas depends on the ability of fish to negotiate specific water depths.

Although the conditions for successful access to aquatic habitat varies by fish species and size, minimum depth criteria for fish passage have been reported for many fish species (ADF&G and Alaska Department of Transportation 2001; Bates et al. 2003; Bell 1990; Powers and Orsborn 1985; Thompson 1972; Webb 1975). A literature review of habitat connectivity criteria will be conducted for the identified fish species and life stages. In general, salmonid passage criteria are well researched and some criteria exist for all salmonid species. Passage criteria for many non-salmonids have not been extensively researched, and in some cases, criteria do not currently exist. Where criteria

for selected species are not available, closely related "surrogate" species will be substituted. Basic categories of fish passage criteria for use in this study include water depth and fish swimming ability (as related to velocity criteria). Depth criteria will be used to assess adult upstream passage and access into, within, and out of side channels, sloughs, and tributaries by adult and juvenile life stages. The velocity component of passage at a physical or depth barrier will be applied where velocity may influence successful passage.

Aquatic Habitat Connectivity Analysis

Modeling and analyses of aquatic habitat connectivity will compare the physical capabilities and periodicity of the target fish species and life stage with the environmental variables of water depth and velocity. Several channel metrics will be used to define the extent of habitat connectivity along the migration path of adult salmon and the connection to off-channel habitats including the proportion of channel meeting the minimum depth criteria, the number and distribution of unsuitable areas, and the length of contiguous channel meeting the criteria. Additionally, the assessment will include an evaluation of the temporal variability in habitat connectivity due to changes in flow over time. This will include an evaluation of the frequency and duration of minimum water depth to ensure habitat connectivity.

The hydraulic modeling approach presented above will allow for a quantitative evaluation of the spatial and temporal connectivity of mainstem and off-channel habitats for the target fish species and life stages. When combined with daily flow records and anticipated effects on sediment dynamics, the 2D hydraulic modeling approach will provide a valuable tool for aquatic habitat connectivity-flow relationships and evaluating alternative flow regimes.

Study Products

The hydraulic modeling, geomorphology, and aquatic habitat connectivity study components will include the following work products:

- Map displaying 2D hydraulic modeling domain, hydraulic and off-channel habitat sampling areas, and identified fish habitat connectivity features;
- Electronic copies of all physical and hydraulic field data collected including field notes, photographs, site maps, and datasheets;

- Hydraulic modeling calibration results including cross-sectional profiles, stage vs. discharge relationships, velocity calibrations, 2D grid, and digital terrain modeling;
- Maps and graphs of current substrate grain size and geomorphic changes through time;
- Results of future sediment transport and geomorphology analysis;
- Results of flow versus habitat connectivity modeling for each target species and life stage; and
- Tabular summary for comparison of the results of habitat connectivity modeling for each of the proposed Dixon Diversion Project operations scenarios.

4.5.6 Deliverables and Schedule

AEA will conduct the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation Study during the 2023 and 2024 study seasons with data collection primarily occurring in 2023. A report summarizing 2023 study activities and will be included in the 2023 Study Report. A final, cumulative report will be developed for the 2024 Study Report.

4.5.7 Cost and Level of Effort

Based on a review of study costs associated with similar efforts conducted at other hydropower projects, and in recognition of the size of the Dixon Diversion Project and logistical challenges and costs associated with the remoteness of the site, study costs are estimated to be approximately $420,000.

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4.6 Wetland Delineation

4.6.1 Goals and Objectives

The goal of the wetland delineation study is to identify:

- Wetland and waterbody extents.
- Wetland quality and functions.

Objectives of the wetland delineation are to:

- Delineate wetlands into distinct polygons based on Cowardin Classification (Subclass designation), Viereck Class IV vegetation types, and hydrogeomorphic classes to provide acreages.
- Evaluate wetland functions by using the Alaska Wetland Assessment Method (DOT&PF 2010).
- Analyze Dixon Diversion Amendment impacts based on alternatives (compare alternatives by acres filled).
- Obtain a Section 404 permit from the U.S. Army Corps of Engineers (USACE).
- Identify wetlands to be avoided or to minimize impacts.
- Identify areas which could be used as compensatory mitigation.
- Comply with the Section 404(b)(1) guidelines.
- Determine compensatory mitigation requirements.
- Collect vegetation data to be used for wildlife habitat mapping.

Data deliverables will include a wetland delineation report, figures of wetlands and waterbodies by Cowardin and Viereck classification at 1:2,000 scale, a GIS file geodatabase of mapped aquatic resources, wetland delineation and functional assessment data forms, and photo log.

4.6.2 Known Resource Management Goals

The Emergency Wetlands Resources Act of 1986 (Public Law 99-645) directs the USFWS to produce the National Wetlands Inventory maps of wetlands of the United States, as well as conduct decadal status and trends report of wetlands to Congress. The USFWS produces and distributes maps and other geospatial data depicting wetland and deep-water habitats, changes, and presents the information to the public.

The USFWS has authority to request fish and wildlife resource studies related to the Dixon Diversion Project in accordance with provisions in the Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (CWA, 33 U.S.C. 1344), National Environmental Policy Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), Bald and Golden Eagle Protection Act (BGEPA, 54 Stat. 250, as amended, 16 U.S.C. 668a-d), and Migratory Bird Treaty Act (MBTA, 40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964 (Public Law 88-577), Alaska National Interest Lands Conservation Act (ANILCA, Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd – 668ee).

Under Section 18 of the FPA, USFWS has authority to issue mandatory fishway prescriptions for safe, timely, and effective fish passage. Under Section 10(j) of the FPA, USFWS is authorized to recommend license conditions necessary to:

> *"adequately and equitably protect, mitigate damages to, and enhance, fish and wildlife (including related spawning grounds and habitat) affected by the development, operation, and management of hydropower projects."*

Section 10(a)(1) of the FPA requires FERC to condition hydropower licenses to best improve or develop a waterway or waterways for the adequate protection, mitigation, and enhancement of fish and wildlife (including related spawning grounds and habitat) based on USFWS recommendations and plans for affected waterways. Specific management goals are the protection of anadromous, trust fish species and their habitats, specifically in the Quiet Creek-Frontal Kachemak Bay watershed (Hydrologic Unit Code [HUC] 1902030111) as well as working with other Federal and State agencies, Tribes, local government, private organizations, and individuals to achieve a goal of No Net Loss of wetlands.

The Alaska Department of Environmental Conservation issues state water quality certifications under Section 401 of the CWA. The USACE issues permits under Section 404 of the CWA. The USFWS oversees streams and wildlife habitat impacts under the FWCA when federal actions result in the control or modification of a natural stream or body of water. FERC reviews permit applications for energy projects and must give "equal consideration" to purposed actions other than power generation, including environmental concerns under Section 4(e) of the FPA. FERC may also be required to provide fishways as appropriate under Section 18 of the FPA.

4.6.3 Background and Existing Information

The proposed Dixon Diversion Project will modify wetlands in three contiguous HUC12 watersheds: the Martin River (190203011104), Battle Creek (190203011103), and Bradley Lake (190203011101) watersheds. These HUC12 watersheds makeup about 25 percent of the larger Quiet Creek-Frontal Kachemak Bay HUC10 (1902030111) watershed at the headwaters of Kachemak Bay. The USFWS National Wetlands Inventory (NWI) wetland mapper shows that the Dixon Diversion Project area drains into estuarine and marine wetlands (E2USN) on the coast of Kachemak Bay (USFWS 2022).

The USFWS mapped the Bradley Creek Project area in 1977 using photo interpretation at 1:65,000 scale and color infrared imagery. There is no local wetland information available for this area.

The USACE typically requests a wetland delineation be conducted for projects with potential impacts to waters of the U.S. The NWI, USGS National Hydrologic Dataset (NHD), National Resource Conservation Service (NRCS) soil surveys, ADF&G anadromous waters catalog, and remote elevation data are existing data which can be used to preliminary map wetlands. The NWI mapping is insufficient for study needs, as the USACE requires a wetland delineation to meet the USACE Wetlands Delineation Manual (USACE 1987) standard to permit wetland impacts under Section 404 of the CWA.

4.6.4 Project Nexus

Construction and operation of the proposed Dixon Diversion Project would affect wetlands and waters, which can be important habitats for fish and wildlife. The wetland delineation data will be used to analyze wetlands and develop PM&E measures including those related to an agency's authority under 401 of the CWA, FWCA, and sections 4(e) and 18 of the FPA, as appropriate. The wetland delineation data will also inform environmental concerns and identify important habitat for fish and wildlife.

4.6.5 Methodology

The wetland delineation data that will be collected to meet USACE requirements and for use in future federal and state permitting including under Section 404 of the Clean Water Act and Section 491 of the Alaska Department of Environmental Conservation's guidance. The wetland delineation data will be utilized to determine compensatory mitigation requirements during the permit phase of the Dixon Diversion Project.

A study area for the wetland delineation will be created based on Dixon Diversion Project features with a buffer to account for potential modifications during design. The wetland delineation study plan proposes:

- 50-foot buffer for transmission line.
- 80-foot buffer (centerline) for access roads.
- 100-foot buffer for inlets and outlets of tunnels.
- 250-foot buffer for the powerhouse.
- 250-foot buffer for dam on Bradley Lake.
- The area between elevation 1180 and 1208 (feet) around Bradley Lake.

The following data will be reviewed prior to conducting the field investigation:

- USFWS NWI wetland mapper.
- Cook Inlet Wetlands Mapping (Across Kachemak Bay).
- USGS NHD.
- USGS Quadrangles (1:25,000).
- NRCS Web Soil Survey.
- Aerial Imagery.
- ADF&G Anadromous Waters Catalog.

Preliminary mapping will be conducted of the study area based on best professional judgement using readily available data (includes data sources described above and any AEA supplied data). Preliminary mapping will include wetlands, waterbodies, and uplands as polygons and streams as lines. The preliminary mapping will be used to coordinate field efforts on specific aerial signatures and field point coverage of the study area. Prior to field work, locations of representative wetland and upland communities as well as transition areas or difficult wetland situations will be identified for specific data collection.

Fieldwork will be conducted in accordance with *Part IV of the USACE Wetlands Delineation Manual* (USACE 1987) and the *Regional Supplement to the USACE Wetland Delineation Manual: Alaska Region* [*Version 2.0*, (USACE 2007)]. Wetlands will be classified and grouped according to guidelines outlined in the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979), all vegetation will be classified to Level IV of the Alaska Classification System (Viereck et al. 1992), and

hydrogeomorphic classifications will be assigned to wetlands for use in the functional assessment (Brinson 1993).

Data will be collected at *test holes* using the three-parameter approach combining site-specific indicators of hydrophytic vegetation, hydric soils, and wetland hydrology. Field notes will be taken to document landscape topography and general site characteristics in a Rite-in-the-Rain field notebook. At each sampling location, soil pits will be excavated to a depth of at least 24 inches, or to the presence of a restrictive digging layer. Soil and hydrology characteristics of texture, color, saturation, and depth to water table (if encountered) will be recorded on USACE Routine Wetland Determination Rite-in-the-Rain forms. Soil color will be recorded using *Munsell Soil-Color Charts*. Data collected at test holes (TH) will be prefixed with 'TH'. Additionally, *photo points* will be taken to document site conditions, confirm dominant plant species, assess landforms, extrapolate data from similar habitat areas, or to make a wetland/upland determination when soil excavation is not necessary (i.e., pond, rock outcrop). Photo point locations will be prefixed with 'PP'. One field team consisting of two will collect data at approximately 7-10 test holes and 20-30 photo points per day for one field crew.

The following references will be used to assist with the field identification of dominant vegetative species:

- Alaska Trees and Shrubs (Viereck et al. 1992).
- Plants of the Pacific Northwest Coast (Pojar and MacKinnon 2016).
- Plants of the Western Boreal Forest and Aspen Parkland (Johnson et al. 1995).
- Field Guide to Alaskan Wildflowers (Pratt 1990).
- Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants (Hultén 1968).
- Wetland Sedges of Alaska (Tande and Lipkin 2003).
- Willows of Southcentral Alaska (Collet 2002).

An Apple iPad tablet with ESRI Arc Collector Global Positioning System with 10-feet accuracy will be used to reference TH, PP, and streams. Data from the field will be used to delineate wetland/upland boundaries in ESRI ArcMap and calculate acreages. Preliminary mapping will be adjusted based on data collection, interpretation of aerial and site photos, topographic data, and field observations to produce a final wetland map.

Wetland delineation tasks will be focused on the Dixon Diversion and Martin River Powerhouse, Dixon-Bradley tunnel outlet, Bradley Lake proposed roads, edges of Bradley Lake (pool raise). Once permission is granted, the field crew will access the study area by walking, vehicle, and/or helicopter (remote areas).

A functional assessment will be completed using the Alaska Wetland Assessment Method (AKWAM) (DOT&PF 2010) which uses the hydrogeomorphic (HGM) approach. AKWAM datasheets will be filled out by assessment areas based on HGM classification and will include various wetland types (i.e., depressional may include PEM1 and PSS1 wetland types).

Final products will include:

- Map of defined wetland area.
- Draft Wetland Delineation Report and attachments.
    - Attachments: figures of wetlands and waterbodies by Cowardin and Viereck classification at 1:2,000 scale, a GIS file geodatabase of mapped aquatic resources, wetland delineation and functional assessment data forms, and photo log for USFWS review.

4.6.6 Deliverables and Schedule

AEA will conduct the Wetland Delineation Study over two study seasons. We anticipate the report summarizing study activities would be included in the 2024 Study Report.

4.6.7 Cost and Level of Effort

Study costs are estimated to be approximately $245,000.

4.6.8 References

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4.7 Vegetation and Wildlife Habitat Mapping

4.7.1 Goals and Objectives

The overall goals of the Vegetation and Wildlife Habitat Mapping study are to prepare baseline maps of the existing and predicted future vegetation and wildlife habitats in those areas of the Dixon Diversion Project that will undergo habitat loss (from the expansion of Bradley Lake and fill for project infrastructure), and habitat change (from reductions in flow in the Martin River). This mapping information, in conjunction with the categorization of habitat values for wildlife species in the Wildlife Habitat Evaluation study (see Section 4.9), will be used to assess impacts to wildlife resources from the proposed Dixon Diversion Project alternatives. The information from the two studies will be used in the FERC license amendment application to quantitatively assess habitat loss and habitat alteration effects from the proposed expansion for the set of wildlife species considered to be of most concern to Bradley Lake Project stakeholders (to be determined in consultation with resource management agencies). The results of the two studies also will be used to develop any necessary PM&E measures to minimize the impacts to wildlife habitats. The information on predicted future wildlife habitats developed in this study will be used in conjunction with the results of the Wildlife Habitat Evaluation (see Section 4.9) to evaluate how wildlife resources in the area may change in the future as a result of the proposed Dixon Diversion Project.

The specific objectives of the Vegetation and Wildlife Habitat Change study are to:

- Identify, delineate, and map existing vegetation and wildlife habitat types in the study area based on an expansion of the more narrowly delimited vegetation and wetland map to be prepared in the Wetland Delineation study (see Section 4.6).
- Quantify long-term habitat change in the Dixon Diversion Project study area by preparing a wildlife habitat map depicting predicted future habitats (based on both proposed construction and operation impacts).

Specific products of the study will include vegetation and wildlife habitat maps for existing and future conditions and an impact assessment (prepared in the FERC license amendment application) for the habitats of focal wildlife species of concern.

4.7.2 Known Resource Management Goals

The Vegetation and Wildlife Habitat Mapping study is not intended to meet the requirements of any resource management goals. Instead, it was designed to support the Wildlife Habitat Evaluation (see Section 4.8) in identifying any potential impacts to

important wildlife habitats as a result of the proposed Dixon Diversion Project. It was also designed to determine how wildlife habitats in the area are likely to change over the long term as a result of Dixon Diversion Project effects. If mitigation for wetland habitat loss is required through the Section 404 CWA wetland permitting process, the results of the Vegetation and Wildlife Habitat Mapping study can be used together with the wetland functional assessment (see Section 4.6) to identify on-site, high-value wetland habitats that may be candidates for permittee-responsible compensatory mitigation.

4.7.3 Background and Existing Information

Currently, no wildlife habitat map exists for the Dixon Diversion Project area. However, some publicly available datasets may provide useful site-specific detail for some of the landscape attributes used in the hierarchical mapping approach proposed in this study. For example, older NWI mapping that predates the construction of the Bradley Lake Project facility is available for the area (USFWS 2022). This mapping could provide historical detail on wetland habitat composition in the area and may help to document wetland change post-construction of the dam. The 1985 Supplemental Environmental Impact Statement (EIS) for the Bradley Lake Project also includes a basic hand-drawn vegetation map and extensive discussion on the existing environmental characteristics of vegetation and landforms in the area prior to Bradley Lake Project construction (FERC 1985). Finally, the Alaska Center for Conservation Science (ACCS) has developed a coarse-scale raster-based mosaic map of Alaska that could provide broad-scale information on upland habitats in the Project area (ACCS 2022). These data sources for the study area should be useful in developing a map of existing wildlife habitats.

In addition to the generally older and coarse-scale landscape information that is specific to the Dixon Diversion Project area, there are additional mapping resources that immediately adjacent to the study area, which could be used to infer mapping attributes. The Kenai Peninsula Borough maintains a wetland map based on a classification system developed by the Kenai Watershed Forum that has current mapping covering the Homer area and the northern shore of Kachemak Bay (Gracz 2017; KWF 2022). ABR, Inc. (ABR) also prepared a broad-scale raster land cover map of Kenai Fjords National Park, which shares a boundary with the Dixon Diversion Project area (Wells et al. 2014). The Kenai Fjords mapping is at a broad scale but is associated with a comprehensive field dataset with documentation of many of the variables needed for habitat mapping.

Lastly, the ongoing wildlife habitat mapping and habitat evaluation work being conducted for the Eklutna Hydroelectric Project in Southcentral Alaska will document habitat change over the 25 years of operations in the area, which includes dewatering of the Eklutna River. This study is still in progress but elements of the assessment of historical impacts could be used to predict the long-term outcome and resulting wildlife habitats that have potential to be affected due to construction and operation of the proposed Dixon Diversion Project. Other public datasets that will be useful in determining future conditions and predicted vegetation community structure in the study area include historical climate records, climate change modeling, and state forest health records.

4.7.4 Project Nexus

According to published documentation, 97 bird species and 27 mammal species are known or likely to occur in the vicinity of the Bradley Lake Project (USACE 1982; APA 1984; FERC 1985). The proposed action (under each alternative) would include modification of the Bradley Lake Dam and construction of a new stream diversion that would result in substantial increase in the normal maximum surface area or elevation of Bradley Lake; this water level change would result in the loss of habitat to birds, mammals, and amphibians. The 7-foot Alternative would result in an increase of the lake area to 3,914 surface acres, an increase of 94 acres over the current conditions. The 14-foot Alternative would result in an increase of the lake area to 4,021 surface acres, an increase of 201 acres, and the 28-foot Alternative would result in an increase of the lake area to 4,224 surface acres, an increase of 404 acres. A total of approximately 7.3 or 10.1 miles of new, 16-foot-wide, gravel-surfaced access roads would be constructed to support operations and maintenance of the new project facilities. Additionally, the partial diversion of the Martin River, including reduced flows, may impact water quality and alter riparian habitat. There will also be temporary construction activity impacts on wildlife including increased noise and people in the area. The proposed Dixon Diversion Project construction and operation activities will result in the loss and alteration of wildlife habitats, which necessitates implementation of the Vegetation and Wildlife Habitat Mapping study, in combination with the Wildlife Habitat Evaluation study (see Section 4.8), to address potential impacts to wildlife habitats.

The wildlife habitat map of current pre-Dixon Diversion Project conditions combined with the Wildlife Habitat Evaluation (see Section 4.9) will identify habitats for the wildlife species of concern and define the extent of the most valuable habitats for each species

in the area. Valuable habitats may be classified by a variety of factors including the number of species using individual habitats, relative rarity of the habitat, and seasonal use.

The Vegetation and Wildlife Habitat Mapping study also facilitates a quantification of habitat loss post-construction, stratified by species of concern and habitat value. This quantification will allow for a spatially explicit identification of habitats that may benefit from PM&E measures across a variety of impacted wildlife species.

4.7.5 Methodology

Study Area

The Vegetation and Wildlife Habitat Mapping study area will be developed using the Wetland Delineation study area (see Section 4.6) as a base and buffering individual project footprint elements to include a broader range of wildlife habitats that are likely to be used by focal species in the area. The size of specific buffer zones applied will be finalized in consultation with agency stakeholders and in conjunction with the development of a focal wildlife species list in the Wildlife Habitat Evaluation study (see Section 4.8).

Mapping Approach

Wildlife habitats will be mapped using a hierarchical methodology based on Integrated Terrain Unit (ITU) mapping methods developed for Ecological Land Surveys conducted in tundra, boreal forest, and coastal regions in Alaska (see Wells et al. [2014] for an example study in Kenai Fjords National Park). The ITU mapping approach involves mapping individual terrain units such as vegetation type, physiography, surface form, and disturbance type, and then combining them into composite units, which represent the range of land cover variation in the study area. When deriving wildlife habitats, ITUs are aggregated into broader, ecologically important categories that represent the habitats used by wildlife in the study area.

A vegetation map at Level IV of the Alaska Vegetation Classification (Viereck et al. 1992) and a wildlife habitat map based on the best combination of ITUs will be produced to yield a habitat map that accurately reflects current use by wildlife. The vegetation and wetland mapping attributes within the Dixon Diversion Project footprint (see Section 4.6) will be used as a base layer and expanded to include additional ITU variables, as needed, and combined with additional ITU mapping outside the boundary of the

Wetland Delineation so the entire wildlife habitat study area is mapped. The existing NWI mapping, Kenai Fjords ITU mapping (Wells et al. 2014), and Cook Inlet wetland mapping (KWF 2022) will be used to guide the expansion of the Wetland Delineation mapping within the footprint and buffer and the additional ITU mapping outside that area.

A second thematic map will be prepared to represent post-Dixon Diversion Project wildlife habitat and will include all direct and indirect impacts predicted to occur during construction and operation of the Dixon Diversion Project. Future wildlife habitat characteristics will be predicted using a combination of publicly available datasets including historical and forecasted climate trends, forest health data and plant succession information, as well as post-project habitat mapping for the similar Eklutna Hydroelectric Project in Southcentral Alaska (see also Vegetation and Wildlife Habitat Change Detection below).

Mapping and Derivation of Wildlife Habitats

Preliminary mapping of the study area will be prepared in early 2024 to help focus the field survey work in summer 2024 on those vegetation types and habitats that were more difficult to identify from satellite imagery alone. All mapping will be conducted by delineating map polygons using ESRI ArcMap. Polygons for vegetation and wildlife habitats will be delineated at a relatively broad scale, using a minimum mapping size of 1.0 acre for vegetated areas and 0.25 acres for waterbodies. Each vegetation map polygon will be attributed with preliminary Level III or IV vegetation types (Viereck et al. 1992), as well as preliminary ITU attributes, including physiography, surface form, and disturbance type.

After the 2024 field season, the preliminary mapping will be revised so that it accurately reflects the field-verified occurrences of Level IV vegetation types, physiography, surface form, and disturbance types. To derive wildlife habitat types, the ITU attributes assigned to each map polygon (vegetation, physiography, surface form, and disturbance type) will be combined to produce a set of multivariate habitat types. These initial multivariate habitats then will be aggregated into a smaller set of derived habitat types that share similar characteristics considered important to the focal wildlife species that occur in the study area, such as the expected levels of available (plant) food sources, vegetation structure for breeding and overwintering activities, and cover for escape and/or shelter. These factors can be directly related to the quantity and quality of vegetation,

physiographic position, surface form, microtopography, soils, hydrology, and/or microclimates present. In the derivation of wildlife habitats, vegetation, physiography, surface form, and disturbance types will be used as the primary factors representing wildlife habitat quality. The development of wildlife habitats is an iterative process tailored to the specific set of wildlife species to be evaluated for impacts from the proposed Dixon Diversion Project.

Field Surveys

Ground-reference plots will be surveyed in conjunction with the Wetland Delineation field survey in summer 2024. Plot locations will be selected prior to the field survey to cover the range of mapped types identified during the preliminary mapping. To maximize data collection efficiency at each ground-reference plot, data will be collected simultaneously for vegetation and wildlife habitat mapping as well as wetlands mapping, as appropriate. At each plot, a standard USACE wetland determination and data form will be completed (USACE 1987; USACE 2007; see the Wetland Delineation study, Section 4.6). Additional data elements sufficient to satisfy data requirements for Viereck Level IV vegetation classification (Viereck et al. 1992) will be recorded as needed. Additional vegetation and wildlife habitat data elements will be recorded digitally in the field on an Android tablet computer using a customized data entry form designed to link directly to a relational database (PostgreSQL). Additional site characteristics to be recorded will include physiography, surface form, microtopography, site disturbances, and plant phenological observations as described by Schick and Davis (2008). Observations will typically be recorded within a 10-meter (33-foot) radius of relatively homogeneous vegetation as specified in USACE Wetlands Delineation Manual (USACE 1987). The size and dimensions of the plots may be modified depending on the characteristics of the plant community at the site (e.g., narrower plots will be used in riparian fringe habitats). The locations of all incidental observations of rare plants, invasive plants, wildlife species, or significant wildlife habitat features (e.g., raptor nests) will be documented.

Vegetation and Wildlife Habitat Change Detection

In the determination of future habitats post-construction, measurable natural changes to vegetation community structure (spruce bark beetle kill and plant succession), along with direct climate change effects (increased temperatures and precipitation), and indirect climate change effects (extreme weather events beyond the long-term climate

normals) will be considered along with Dixon Diversion Project disturbances to predict how wildlife habitats will develop in the future. Information on long-term habitat change at the Eklutna Hydroelectric Project in Southcentral Alaska also will be used to predict future habitats in the Dixon Diversion Project area.

Habitat change from Dixon Diversion Project development will be measured by comparing the current and post-project wildlife habitat maps and calculating the acreage of habitat loss, alteration, or gain for specific habitats, and the loss or gain in habitat value using the habitat-value ranking results from the Wildlife Habitat Evaluation study (see Section 4.8). These results can be used to target elements of the Dixon Diversion Project with the highest impacts to individual species for use in developing PM&E measures.

4.7.6 Deliverables and Schedule

AEA will conduct the Vegetation and Wildlife Habitat Mapping Study within the 2024 study season. A report summarizing study activities will be included in the 2024 Study Report.

4.7.7 Cost and Level of Effort

Study costs are estimated to be approximately $133,000.

4.7.8 References

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4.8 Wildlife Habitat Evaluation

4.8.1 Goals and Objectives

The goal of the Wildlife Habitat Evaluation study is to provide Dixon Diversion Project-specific habitat evaluation information for birds, mammals, and amphibians to facilitate quantitative assessments of the impacts on wildlife habitats from development of the proposed Dixon Diversion Project. The Wildlife Habitat Evaluation study has two fundamental objectives:

- Review Dixon Diversion Project-specific wildlife habitat-use information and the scientific literature to determine local habitat associations for those wildlife species occurring in the Dixon Diversion Project area that are of conservation, management, cultural, or ecological concern (species of concern) and that are known or expected to use the wildlife habitat types mapped in the area.
- Categorically rank habitat values for each wildlife species of concern for each of the wildlife habitat types mapped in the Dixon Diversion Project area.

The habitat-association data to be developed in this study, together with the wildlife habitats that will be mapped digitally in the Vegetation and Wildlife Habitat Mapping Study (see Section 4.7) for the Dixon Diversion Project, will be used in the license amendment application to conduct spatially-explicit analyses with GIS to derive quantitative estimates of habitat loss, habitat alteration, and disturbance effects for birds, mammals, and amphibians.

4.8.2 Known Resource Management Goals

ADF&G has specific management objectives for game species such as moose, bears, and ptarmigan, and the USFWS mandate is "To conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people" (USFWS 2022). The Wildlife Habitat Evaluation, however, is habitat-focused and is not designed to assess how the Dixon Diversion Project could affect meeting wildlife population management goals of state and federal agencies. The study is broad ranging and will consider a large number of bird, mammal, and amphibian species of concern to address—in combination with the Vegetation and Wildlife Habitat Mapping study (see Section 4.7)—possible stakeholder concerns over potential habitat impacts to those species.

4.8.3 Background and Existing Information

According to published documentation, 97 bird species and 27 mammal species are known or likely to occur within the Bradley Lake Project area (USACE 1982; APA 1984; FERC 1985). According to data compiled by the ACCS, the single amphibian species that occurs in Southcentral Alaska, wood frog (*Lithobates sylvaticus*), has not been found in the vicinity of the Dixon Diversion Project, but the area is within the range of the species (ACCS 2022) and suitable waterbody habitats may exist in lower elevations in the Dixon Diversion Project area.

Wildlife habitat maps provide land-cover classifications that are better suited to evaluate habitat use by birds, mammals, and amphibians than is a vegetation map alone, primarily through the incorporation of physiography, landform, and vegetation structure information (see Section 4.7). A wildlife habitat map has not been previously created for the Dixon Diversion Project area (AEA 2022) and is needed for the evaluation of potential species-level habitat impacts from the proposed Dixon Diversion Project. Similarly, a habitat evaluation for bird, mammal, and amphibian species of concern in the Dixon Diversion Project area has not been conducted. This gap will be remedied with the Wildlife Habitat Evaluation study so that potential habitat impacts to bird, mammal, and amphibian species of concern can be assessed in the FERC license amendment application.

4.8.4 Project Nexus

The proposed action (under each alternative) would include modification of the Bradley Lake Dam and construction of a new stream diversion that would result in substantial increase in the normal maximum surface area or elevation of Bradley Lake; this water level change would result in the loss of habitat to birds, mammals, and amphibians. The 7-foot Alternative would result in an increase of the lake area to 3,914 surface acres, an increase of 94 acres over the current conditions. The 14-foot Alternative would result in an increase of the lake area to 4,021 surface acres, an increase of 201 acres, and the 28-foot Alternative would result in an increase of the lake area to 4,224 surface acres, an increase of 404 acres. A total of approximately 7.3 or 10.1 miles of new, 16-foot-wide, gravel-surfaced access roads would be constructed to support operations and maintenance of the new Dixon Diversion Project facilities. Additionally, the partial diversion of the Martin River, including reduced flows, may impact water quality and alter riparian habitat. There will also be temporary construction activity impacts on

wildlife including increased noise and people in the area. The proposed Dixon Diversion Project construction and operation activities will result in the loss and alteration of wildlife habitats, which necessitates implementation of the Wildlife Habitat Evaluation study, in combination with the Vegetation and Wildlife Habitat Change study (see Section 4.7), to address potential impacts to wildlife habitats.

4.8.5 Methodology

Study Area

The Bradley Lake Project is located on the Kenai Peninsula approximately 25 miles northeast of Homer, Alaska in the Southcentral region of Alaska. The wide range of habitats and climatic conditions within Southcentral Alaska supports a diversity of bird, mammal, and amphibian species that may use the Dixon Diversion Project area (see Section 4.9.4 above).

The Wildlife Habitat Evaluation study will rely on Dixon Diversion Project-specific habitat-use information for nesting raptors and migrating birds (see Section 4.9) and on an analysis of existing information on wildlife habitat use in Alaska (e.g., from the scientific literature). This habitat-use information will be used to systematically evaluate the use of the specific wildlife habitat types that will be mapped for the Dixon Diversion Project in the Vegetation and Wildlife Habitat Mapping study (see Section 4.7). In the habitat evaluation, categorical habitat values (high, moderate, low, and negligible value) will be determined for each mapped habitat type and each wildlife species of concern to be assessed for impacts during the FERC license amendment process. In addition to those wildlife species specifically surveyed for or recorded incidentally in the Dixon Diversion Project area, the wildlife habitat evaluation provides a mechanism to address habitat loss and alteration effects for any other set of wildlife species of concern that are known or expected to occur in the Dixon Diversion Project area but that were not specifically studied in the field.

The specific study area for the Wildlife Habitat Evaluation will be developed in conjunction with the study area used in the Vegetation and Wildlife Habitat Mapping study (see Section 4.8). The study area will rely on the Wetland Delineation study area (see Section 4.6) as a base focus (i.e., buffers around footprints of individual Dixon Diversion Project components) plus include a broader range of wildlife habitats that are likely to be used by focal species in the Dixon Diversion Project area. The size of specific

buffer zones applied will be finalized in consultation with agency stakeholders and in conjunction with the development of a focal wildlife species list.

Habitat Evaluation Procedures

The proposed methods for the Wildlife Habitat Evaluation study involve the use of Dixon Diversion Project-specific habitat-use data and relevant habitat association information from the scientific literature for birds, mammals, and amphibians in coordination and conjunction with the preparation of a current and predicted future vegetation and wildlife habitat map for the Dixon Diversion Project area (see Section 4.7). This study will be an office-based effort, performed after the Vegetation and Wildlife Habitat Mapping study for the Dixon Diversion Project area is completed. The methods will typically follow those outlined in ABR (2008), Schick and Davis (2008), PLP (2011), and ABR (2017).

The first task in the Wildlife Habitat Evaluation study is the selection of a set of wildlife species of concern for which Dixon Diversion Project-related habitat impacts will be evaluated. A species will be selected if it meets one or more of the following criteria, which will be discussed with and agreed upon with federal and state resource management agencies:

- A federally- or state-protected species.
- A bird species of conservation and management concern, determined from lists maintained by various management agencies, agency working groups, and non-governmental conservation organizations (as outlined in the FERC–USFWS Memorandum of Understanding [MOU] on migratory birds; FERC and USFWS [2011]).
- A bird or mammal species of management concern for federal and/or state management agencies (primarily game and furbearer species).
- A species that is an important subsistence resource or is culturally significant for Alaska Natives.
- An ecologically important species with demonstrable ecosystem effects, such as ecosystem engineers (e.g., beaver), and species that occupy prominent positions in the trophic structure as predators or prey.

A matrix will be constructed listing each species of concern and each wildlife habitat type mapped in the study area, and a habitat-value ranking will be assigned to each cell in the matrix. As with the species selection process, the ranking procedure will be developed with input from federal and state resource management agencies, but it is

likely that a categorical habitat-value system will be used (e.g., high, moderate, low, and negligible value). Habitat-use information from the scientific literature for Southcentral Alaska, previous habitat evaluation results in Southcentral Alaska conducted by ABR, and/or professional judgment will be used to derive habitat-value rankings.

Habitats will be ranked for the various life history stages of each of the species of concern addressed (e.g., breeding/calving, post-calving, spring and fall migration, overwintering) to encompass the complete seasonal range of habitat use. Additionally, specific habitat-use maps can be prepared for high-profile game animals such as moose and bears to illustrate specific areas and seasons of use, in addition to identifying habitat types that are important to those species.

The study methods discussed above have been successfully used for recent wildlife habitat evaluations on several projects in Alaska (e.g., ABR [2008]; Schick and Davis [2008]; PLP [2011]; and ABR [2017]). The methods have been favorably received by agency reviewers.

Use of the Habitat Evaluation Data

Analysis of habitat evaluation data will include:

- Species habitat-value rankings for each mapped habitat type (see Section 4.7). The areas within the Dixon Diversion Project footprint that are important for each species of concern (e.g., high- and moderate-value habitats) will be identified, and the total areas that may be directly affected by habitat loss and habitat alteration from development of the Dixon Diversion Project will be determined quantitatively in GIS.
- The indirect effects of disturbance will be assessed by applying species-specific disturbance buffers to the Dixon Diversion Project footprint, while determining the total areas of important habitats for each species of concern that could be influenced indirectly by disturbance effects during Dixon Diversion Project construction and operations.
- Data from this study may also be used to help assess the potential for fragmentation of habitat for species of concern as a result of Dixon Diversion Project development.
- The wildlife habitat values will be used to develop PM&E measures, as appropriate, to minimize habitat impacts on bird, mammal, and amphibian species.

- In conjunction with the predicted habitat change map produced in Section 4.7, the habitat-value rankings developed in this study will be used to predict how wildlife species will respond to the changes in wildlife habitats that are expected to occur with construction and operation of the proposed Dixon Diversion Project modifications.

This information will be documented in a study report that will include individual sections for each species or species group assessed. The available habitat-use information will be linked to the specific habitat values derived (to illustrate the logic used in determining habitat values for each species).

4.8.6 Deliverables and Schedule

AEA will conduct the Wildlife Habitat Evaluation Study as a desktop study during the 2024 study season using study products from the Vegetation and Wildlife Habitat Mapping Study (Section 4.7) and the Raptor Nesting and Migration Study (Section 4.9). A report summarizing 2024 study activities will be included in the 2024 Study Report. A final, cumulative report will be developed for the 2024 Study Report.

4.8.7 Cost and Level of Effort

Study costs are estimated to be approximately $55,000.

4.8.8 References

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4.9 Raptor Nesting and Migration

4.9.1 Goals and Objectives

The goal of this study is to provide data for evaluating and mitigating the potential effects of Dixon Diversion Project construction, facilities, and activities on eagles and other raptors that nest or move through the Dixon Diversion Project study area. Four specific objectives have been identified for the study:

1. Survey forest, riparian, and cliff habitats suitable for nesting by eagles and other raptors to locate and map active and inactive nests of raptor species (as well as Common Ravens [*Corvus corax*]) in the Dixon Diversion Project study area.
2. Based on the field data for nesting raptors, identify the important habitat parameters for nesting raptors in the Dixon Diversion Project study area.
3. Conduct spring and fall visual surveys to assess the extent to which planned overhead transmission lines may pose an electrocution and/or collision risk to migrating or nesting raptors and other migrant bird species.
4. Develop recommendations for work timing windows and identify avoidance areas for Dixon Diversion Project-related field activities to prevent disturbance of known raptor nest sites.

4.9.2 Known Resource Management Goals

Information on Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*), and other raptor nest sites and habitats will be used to comply with the Bald and Golden Eagle Protection Act (BGEPA), the Migratory Bird Treaty Act (MBTA), and Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. The location of Bald Eagle, Golden Eagle, Peregrine Falcon (*Falco peregrinus*), and other raptor nest sites, territories, habitats, and movement paths will be used to avoid or mitigate potential impacts from construction activities and a potential Dixon Diversion Project transmission line, and to compare potential impacts to raptors and other avian species among the different Dixon Diversion Project alternatives.

The USFWS has requested raptor surveys and research on the potential for a new transmission line to "pose a collision and electrocution risk to migrating birds including raptors." The USFWS has authority to request fish and wildlife resource studies related to this project in accordance with provisions in the Federal Power Act (FPA, 16 U.S.C. § 791 et seq.), Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), Clean Water Act (CWA, 33 U.S.C. 1344), National Environmental Policy

Act of 1969 (NEPA, 83 Stat. 852; 42 U.S.C. 4321 et seq.), BGEPA (54 Stat. 250, as amended, 16 U.S.C. 668a-d), and MBTA (40 Stat. 755, as amended; 16 U.S.C. 703 et seq.), Wilderness Act of 1964 (Public Law 88-577), Alaska National Interest Lands Conservation Act (ANILCA, Public Law 96–487), and National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 U.S.C. 668dd–668ee).

4.9.3 Background and Existing Information

A total of 12 raptor species are known to occur in the vicinity of the Dixon Diversion Project (AEA 2022). This includes one species listed by the USFWS as a bird of conservation concern (BCC) (Short-eared Owl [*Asio flammeus*]; USFWS 2021) and three species listed by the USFWS as birds of management concern (BMC) (Bald Eagle, Peregrine Falcon, and Short-eared Owl; USFWS 2011). In addition, Golden Eagles may nest on suitable cliffs and hunt in open alpine areas near the Dixon Diversion Project.

Bald Eagles are the most commonly observed raptors in the area. They were observed nesting along the Martin River, Battle Creek, lower Bradley River, and in the Fox River Valley, and were recorded overwintering in the Fox River Valley and along the Martin River (FERC 1985). Six Peregrine Falcons were observed in the Bradley Lake Project area during surveys conducted in 1980, and they were thought to be migrating birds (FERC 1985). In addition, at least 97 avian species are known or expected to occur in the Project area (AEA 2022). Although they have not been documented in the area, it is possible that Kittlitz's Murrelets (*Brachyramphus brevirostris*) or Marbled Murrelets (*Brachyramphus marmoratus*) nest in the vicinity of the Dixon Diversion Project. Marbled Murrelets typically nest in large old-growth conifer trees near the coast (Nelson 2020). Kittlitz's Murrelets are a Bureau of Land Management (BLM) Sensitive Species for Alaska (BLM 2019) and typically nest in high elevation rocky areas with little vegetation (Felis et al. 2016).

As a result of the proposed Dixon Diversion Project activities, impacts to nesting raptors and to food sources for Bald Eagles could occur without proper safeguards, including buffer areas around existing nests and conducting some Dixon Diversion Project activities outside the nesting period. Although transmission lines can be a source of mortality for eagles and other raptors by electrocution and collision, it is assumed that all new transmission lines and power transfer stations for the Dixon Diversion Project will be built to the "eagle-safe" standards developed by the Avian Power Line Interaction

Committee (APLIC 2006), and therefore will not be likely to constitute a significant source of electrocution risk for raptors. However, significant lengths of new transmission lines will be constructed across an open and undisturbed landscape, therefore collision risk assessments for raptors and other migratory birds are recommended in the siting of overhead power transmission lines (APLIC and USFWS 2005).

4.9.4 Project Nexus

Under the BGEPA, the "take" of eagles without a permit is prohibited (16 USC 668-668c). The BGEPA defines take to include "pursue, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb," and prohibits take of individuals and their parts, nests, or eggs, or destruction of eagle nests. The term "disturb" is further defined by regulation and indicates "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, injury to an eagle, a decrease in productivity…, or nest abandonment" (50 CFR § 22.3).

Construction and operation of the Dixon Diversion Project could affect potential raptor nesting habitats through clearing of trees and inundation of habitat. Construction and operation will increase human activity in the Dixon Diversion Project area, which may disturb nesting eagles and other raptors, and the construction of a transmission line will add a potential collision hazard for flying eagles and other migratory birds. This study was designed to locate active and inactive Bald Eagle, Golden Eagle, and other raptor nests, to characterize raptor nesting habitats in the Dixon Diversion Project area, to assess bird movements in the area related to the potential transmission line, and to evaluate other potential project-related habitat and disturbance effects on birds.

4.9.5 Methodology

Raptor Nesting Survey

The aerial raptor nesting survey will be conducted in spring 2024, likely in late April or early May. The field protocols for raptor nesting surveys generally follow established techniques for cliff- and tree-nesting raptors in North America (e.g., Anderson 2007). Specific survey methods for nesting raptors will follow established aerial and ground-based protocols for eagle nest surveys (USFWS 2007; Pagel et al. 2010), using appropriately trained observers and a suitable survey platform, most likely a Robinson R44 helicopter. Surveys will be conducted by experienced raptor biologists within a 2-mile survey buffer zone surrounding existing and proposed Dixon Diversion Project

facilities (USFWS 2020), south of the Fox River on the south side of Kachemak Bay. Although the primary study focus will be to evaluate the potential for the Dixon Diversion Project to affect eagles and eagle nests (in accordance with the BGEPA; USFWS 2009), all nests of raptors and Common Ravens will be recorded during the survey. Common Ravens are recorded because they also nest in cliff habitats and often use old raptor nest sites; other raptors will also use vacant Common Raven nests. The timing and survey area may have to be modified to minimize disturbance of mountain goats (*Oreamnos americanus*) when kids are being born (mid-May to mid-June). The optimum timing may be late April, when raptors are initiating nesting and before the mountain goat reproductive period. The helicopter will carry two observers in addition to the pilot. Flight altitude and speed will follow standard survey protocols for each habitat type (Pagel et al. 2010). Observers will be seated on the same side of the aircraft during surveys. Nest location coordinates and nest attribute data, including species, nest substrate, and nest status, will be collected for entry into a geodatabase. Nest characteristics will be recorded according to a protocol developed in consultation with the USFWS, including the protocols developed for the USFWS Alaska Bald Eagle Nest Atlas. Per consultation with state and federal resource agencies, precise raptor nest locations may not be made available to the public to protect the nesting species. Local Bald Eagle and Golden Eagle territory sizes will be estimated using inter-nest distances as described in the Eagle Conservation Plan Guidance (USFWS 2013).

Visual Migration Surveys

The visual migration surveys will be conducted in the spring and fall of 2024, likely in April and late August/early September, which are the periods expected to have the highest movement rates of raptors and other avian species in the Dixon Diversion Project area. Visual migration surveys will be conducted by a survey crew with experience in avian research during the spring and fall migration periods in Alaska. Similar surveys have been conducted during daylight hours in other areas of Southcentral Alaska to quantify raptor movement rates in relation to proposed transmission lines (ABR 2015a) and to quantify movement rates of waterbirds, shorebirds, and landbirds as well (ABR 2015b). Data collected from these types of surveys can be used to estimate potential eagle take. Data collected on eagle movements will be adequate to calculate eagle-minutes flying within the transmission line corridor per hour per square kilometer.

Visual surveys for raptors and other migratory birds will be conducted for approximately 5 days during both the spring and fall. Ground-based survey crews will be located in positions where sections of the proposed transmission line corridor are visible. The observation locations will be determined based on logistical considerations and availability of areas with good visibility of the proposed transmission corridor.

Observations will be conducted during different sampling periods scheduled throughout the day. Survey efforts, however, will be timed to focus on times of day when thermal updrafts are most likely to occur (from midday through the afternoon hours). During each sampling period, observers will use binoculars and spotting scopes to watch for flying raptors and other avian species. For each bird observation, the species (when possible), number, direction of travel, and estimated height above ground will be recorded. In addition, the weather and visibility conditions will be recorded during each sampling period.

These visual surveys, to assess whether migrating raptors would be at risk for collision with the proposed power transmission lines, will be conducted using fixed-radius migration point counts. These surveys generally will follow the USFWS's recommended point-count protocol, based on the standard hawk migration counting protocols described in Appendix C of the Eagle Conservation Plan Guidance (USFWS 2013). Migration point counts will be centered in plots with a radius of 2,625 feet (800 meters). Data recorded for each bird observation will include date, time, species (or taxon), flock size, transect crossed (four transect lines, oriented in each of the cardinal directions—north, east, south, west), distance crossed (distance from observer), flight direction, flight behavior, and an estimate of minimal flight altitude above the ground. Weather data will be recorded during each sampling session. Surveys may not be conducted during some individual sampling sessions if visibility conditions are poor. These methods may have to be modified based on logistical considerations and available viewing locations.

Study Products

A draft raptor nesting and bird migration survey report will be prepared and will include the following:

- Maps and associated metadata for historical eagle and other raptor nest locations, with survey extents to facilitate comparisons with the current survey data.

- Maps and associated metadata with geographic coordinates for current nest locations, nest activity status, and migration observation locations.
- Summary of the bird migration data including the species observed, numbers by date, timing of movements, and altitude of flights.
- Summary and mapping of suitable forest, riparian, and cliff habitats to evaluate the extent of suitable nesting habitats within the study area.
- Recommendations for work timing windows and maps of field activity avoidance areas to prevent disturbance of known raptor nest sites.

4.9.6 Deliverables and Schedule

AEA will conduct the aerial raptor nesting survey and the visual migration surveys in the 2025 study season assuming that the proposed transmission line remains a component of the Dixon Diversion Project alternative. The final 2024 Study Report is expected to be completed in 2025.

4.9.7 Cost and Level of Effort

Study costs are estimated to be approximately $220,000.

4.9.8 References

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4.10 Cultural Resources

4.10.1 Goals and Objectives

The goals of the 2023 Cultural Resources Study Plan are to inventory the Dixon Diversion Project's Area of Potential Effects (APE) for historic properties[1] which may be affected by the proposed Dixon Diversion Project. This is to comply with the implementing regulations[2] of Section 106 of the National Historic Preservation Act (NHPA; 54 USC 306108) and meet the reasonable and good faith identification standard, consistent with 36 CFR 800.4(b)(1).

The objectives of the study are to:

- Consult with the State Historic Preservation Office (SHPO), Indian Tribes[3], and other interested parties during the planning and implementation of the proposed cultural resources study;
- Establish, through consultation, the proposed Dixon Diversion Project's APEs for direct and indirect effects; and
- Conduct the necessary research, data collection, and field work necessary to support the development of a Historic Properties Management Plan for the proposed Dixon Diversion Project. These activities may include:
    - Consultation with Indian Tribes to determine the presence of historic properties of religious and cultural significance within the APEs.
    - Field surveys to identify and document archaeological, historic, or ethnographic resources within the APEs of the proposed Dixon Diversion Project.
    - Evaluation of documented cultural resources for their eligibility for listing in the National Register of Historic Places (NRHP).
    - Assessing the proposed Dixon Diversion Project's potential to effect historic properties within the APEs.

[1] "Historic properties" are sites, objects, structures, districts, or buildings which are listed in, or have been determined eligible for listing in the National Register of Historic Places (NRHP).
[2] 36 Code of Federal Regulations (CFR) § 800
[3] Consistent with 36 CFR 800.16(m), "Indian Tribes" includes federally-recognized tribal governments and village and regional corporations established under the Alaska Native Claims Settlement Act (ANCSA).

4.10.2 Known Resource Management Goals

Section 106 of the NHPA requires federal agencies and departments to consider the effects of their undertakings on historic properties prior to the issuance of any permit, authorization, or funding. The issuance of a federal license amendment by FERC is an "undertaking" and as such is required to comply with Section 106 of the NHPA (54 USC 306108). To support this compliance responsibility, the proposed study will identify and document cultural resources within the APE through research, consultation, and field studies and assess their status as historic properties, which require consideration under Section 106 of the NHPA.

4.10.3 Background and Existing Information

Queries of the Alaska Heritage Resources Survey (AHRS) database, FERC's e-Library, and the University of Alaska Anchorage Consortium Library were performed to determine the nature and extent of previous cultural resources investigations and known cultural resources within the vicinity of the proposed Dixon Diversion Project. This review indicates that five previous cultural resources investigations have been conducted in association with the existing Bradley Lake Project, four of which were conducted for the initial development of the Bradley Lake Project (APA 1984; Steele 1979, 1982; Woodward-Clyde Consultants 1984) and one conducted for a subsequent license amendment to support the development of the Battle Creek Diversion Project (HDR 2013).

Previous investigations for cultural resources were conducted in the Bradley Lake vicinity in support of the original Bradley Lake Project licensing efforts in 1979, 1980, and 1983. The 1979 and 1980 cultural resource surveys consisted of reconnaissance level pedestrian transects throughout the entire Bradley Lake Project area (with the exception of steep slopes, rock outcrops, and marshy, wetland areas) (AEA 2015). Shovel testing was conducted in the original Bradley Lake inundation areas. As a result of the 1979 and 1980 surveys, five previously recorded archaeological sites were relocated (AEA 2015). No additional sites were identified (AEA 2015).

The 1983 Bradley Lake cultural investigations consisted of low elevation helicopter flight reconnaissance and a literature search and archival research, including research into BLM homestead files, Native Allotment applications, and Alaska Native Claims Settlement Act (ANCSA) 14(h)(1) selections. As a result of the 1983 survey effort, two

historical sites (historic fox-fur farms) eligible for inclusion in the NRHP were identified in the vicinity of the Bradley Lake Project (AEA 2015).

In 2015, AEA filed a license application with FERC for a new water diversion and conveyance system on Battle Creek as a supplemental source of water for the Bradley Lake Project. Battle Creek is located approximately 2 miles southwest of Bradley Lake. To supplement the original Bradley Lake cultural resource inventories, AEA conducted an on-site cultural resource investigation of the Battle Creek Diversion APE in September 2012. The investigation consisted of a low elevation helicopter flight reconnaissance, followed by a pedestrian survey with discretionary shovel testing within the areas to be affected by the construction of Battle Creek Diversion structures, including a quarter-mile buffer area around staging areas, access routes, and material sites. No cultural resources were identified within the Battle Creek Diversion APE as a result of the 2012 survey or during consultation (AEA 2015). In addition, an AHRS records search and literature review, including previous surveys that included the Battle Creek Diversion APE, identified no historic sites (AEA 2015). The SHPO reviewed the associated cultural resources report for the Battle Creek Diversion (HDR 2013) and provided its concurrence with the finding of no historic properties affected.

In addition to these previous surveys, the AHRS indicates that two historic properties (SEL-00126 and SEL-00127) are located along the coastline of Kachemak Bay in the vicinity of the proposed APE.

Cultural resource inventories will be required for areas directly affected by the proposed Dixon Diversion Project as the previous surveys listed above did not provide adequate geographic coverage, as they were focused on the original Bradley Lake and Battle Creek project areas, respectively. In addition, the specificity with which the survey methods were employed within high potential areas for containing undiscovered cultural resources across the broader project area may not be consistent with current best practices for cultural resources identification in Alaska. Methods, technology, and reporting standards have advanced since these previous surveys, and current field inventories to identify cultural resources will be necessary to meet the reasonable and good faith identification standard of the Section 106 process, and to inform the Dixon Diversion Project's compliance with the NHPA.

4.10.4 Project Nexus

The construction and operation of the proposed Dixon Diversion Project has the potential to directly, or indirectly, affect archaeological, historic, and/or cultural resources. The data generated through this study would facilitate consultation with the SHPO, potentially affected Alaska Native Tribes, and other consulting parties and be used to evaluate potential effects to these resources and to support compliance with Section 106 of the NHPA to avoid, minimize, or mitigate any adverse effects to historic properties, which is consistent with 36 CFR 800.1(a).

4.10.5 Methodology

As noted below, each of the proposed alternatives will have an APE established through consultation with the SHPO, with each alternative having an APE for direct and indirect effects. Methods to identify, document, and evaluate cultural resources within the proposed Dixon Diversion Project APEs will include background research, consultation, and field inventories and associated reporting.

Study Area

Consistent with the implementing regulation of Section 106 of the NHPA at 36 CFR 800.4(a)(1), AEA anticipates initiating consultation with the SHPO in the fourth quarter of 2022 to develop the APE for direct (direct APE) and indirect (indirect APE) effects. The APE is the geographic area(s) within which the character or use of a historic property may be affected by the construction and operation of the proposed project. Although AEA's consultation with the SHPO is ongoing, AEA has proposed that the APEs for direct and indirect effects by Dixon Diversion Project alternative to consist of the following components:

- Dixon-Bradley Alternative:
    - AEA proposes that the APE for direct effects consist of the disturbance footprint of the proposed dam diversion structure at the toe of Dixon Glacier, the subsurface power tunnel to Bradley Lake, the ground surface which would be submerged under the maximum potential impoundment increase at Bradley Lake (e.g., the 28-foot Alternative), and the footprint of the approximately 7.3 miles of roads.
    - To account for potential indirect effects, AEA proposes that a 0.25-mile buffer from all direct APE components is sufficient to account for potential

indirect effects. Due to dense vegetation and irregular and undulating terrain this distance is justified for olfactory, auditory, and visual effects.

- Dixon-Martin Alternative:
    - AEA proposes that the APE for direct effects consists of the disturbance footprint of the proposed dam diversion structure at the toe of Dixon Glacier, the subsurface power tunnel and proposed Martin River powerhouse, the ground surface which would be submerged under the maximum potential impoundment increase at Bradley Lake (e.g., the 28-foot Alternative), the footprint of the approximately 10.1 miles of roads, and the approximately 6.9 mile transmission line.
    - To account for potential indirect effects, AEA proposes that a 0.25-mile buffer from all direct APE components is sufficient to account for potential indirect effects. Due to dense vegetation and irregular and undulating terrain this distance is justified for olfactory, auditory, and visual effects.

Archaeological and Historic Resources

Dixon Diversion Project considerations of archaeological and historic resources will be addressed using a phased approach consisting of three sequential tasks:

1 Initial review of existing cultural resources data, consultation with interested parties (e.g., Indian Tribes, local governments) and development of a landscape model to identify areas of high and low potential for containing archaeological and/or historic resources;

2 Reconnaissance-level cultural resources fieldwork guided by the results of the desktop review of data sources, consulting party input, and the output of the landscape model;

3 Evaluation-level investigation of resources identified (either through reconnaissance fieldwork or consultation) to support the preparation of determinations of eligibility for listing in the NRHP.

Task 1

This task will consist of a systematic and detailed review of existing data and literature to assemble a baseline of the ethnographic, archaeological, and Euro-American property types and patterns of land use which may exist within the Dixon Diversion Project's APEs. A component of this review will include seeking to engage in collaboration with Alaska Native Tribes regarding cultural resources of cultural and religious significance which may be located within the APEs for the proposed Dixon Diversion Project. In addition to the SHPO, AEA will consult with the following parties: the Seldovia Village

Tribe; the Nanwalek Council IRA; the Port Graham Village Council; the Kenaitze Tribe; the English Bay Corporation; the Port Graham Corporation; the Seldovia Native Association, Inc.; the Chugach Alaska Corporation; and the Cook Inlet Regional, Inc.; as well as the Pratt Museum in Homer; the City of Homer; the City of Seldovia; and the Kenai Peninsula Borough.

Concurrent with these activities, a landscape analysis using publicly available and Dixon Diversion Project-generated GIS data will be developed to characterize the terrain and topography of the APEs to isolate terrain features associated with high potential (e.g., level areas near terrain breaks, terraces, areas of prominent local relief) and low potential (e.g., slopes greater than 25°, inundated areas, recently deglaciated terrain) for containing and preserving intact archaeological and historic resources.

Combined, these efforts will inform the locations, methods, and intensity of cultural resources field survey activities performed under Task 2.

Task 2

Based on the data assembled in Task 1, an "identification-level" cultural resources field survey will be conducted consistent with Alaska Office of History and Archaeology (OHA) guidance (OHA 2018), and will be supervised by an archaeologist who meets the Secretary of the Interior's (SOI) Professional Qualification Standards for Archaeology (62 Federal Register 33708, Friday June 20, 1997). Fieldwork methods will include an initial aerial overflight to orient field teams and pilots with the terrain and topography of the survey areas, identify, record, and establish access and egress locations, note any potential physical or geographic barriers to pedestrian survey, and to field verify areas identified as having a low versus high potential for containing undiscovered cultural resources.

Preliminary review of existing data suggests that very little previous cultural resources work has occurred in portions of the proposed Dixon Diversion Project APEs; thus, it is anticipated that pedestrian surveys will be conducted prioritizing high potential areas. These surveys will identify surface features, artifacts, historic structures, trails, or other indications that historic or archaeological resources may be present in the area. Pedestrian survey of the APEs for direct effects will be conducted with 15-meter crew spacing. Subsurface tests will only be considered in areas deemed suitable for site preservation and will be placed judgmentally at the direction of the SOI-qualified crew lead in areas which may contain subsurface archaeological deposits or in areas

containing surface archaeological or historic materials. Subsurface tests will be excavated with hand tools, and excavated sediment will be screened through 0.25-inch hardware mesh onto a tarp. Subsurface tests will be excavated to bedrock, gravels, glacial till, or until they reach the limits of hand tools (usually about 3 feet [1 meter]). Subsurface test locations and results are recorded on GPS units and on standardized paper forms, and the tests are then backfilled. Subsurface tests will not be excavated in areas which are clearly unsuitable for site preservation (e.g., unstable or steep slopes, bare ground/bedrock, standing water/wetlands).

Task 3

If ethnographic, archaeological, or historic materials are encountered during collaboration with consulting parties or identification level field survey activities, additional fieldwork will be conducted to collect detailed data to document the property at an "evaluation" level of effort (OHA 2018). The specific nature and composition of the resource will ultimately determine the appropriate documentation. However, these documentation efforts may include all or some of the following activities:

- Mapping the precise property location and preliminary boundary using a mapping-grade GPS unit with sub-meter capabilities (via Satellite based Augmentation System [SBAS] or other means);
- Site maps in plan view (to scale) which depict visible features or components of the property, and as applicable, plot locations and results of subsurface tests;
- Detailed photographs of the property, surroundings, and features/components (with scale);
- Documenting the cultural significance of the property and its role in the ethnohistory of the region;
- Systematic subsurface testing based on cardinal directions to determine the distribution of archaeological materials across the property;
- Descriptions of artifact and/or feature types, distributions, and locations;
- Collection of environmental or carbon samples for subsequent analysis;
- Preliminary assessments of site formation/stability based on stratigraphic and topographic data; and
- Mapping of a preliminary site boundary based on landform, surface features, subsurface testing, or environmental variables.

Ethnographic Research and Consultation

As noted in the tasks outlined above, the proposed Dixon Diversion Project will seek to identify, record, and evaluate ethnographic resources which may be historic properties of religious and cultural significance to Indian Tribes. This process will include direct outreach and collaboration with Alaska Native Tribes to determine if possible historic properties of religious and cultural significance may be present within or intersecting with the proposed Dixon Diversion Project APE. Coordination efforts will be initiated in Task 1 as described above; this may include additional collaboration such as:

- Workshops executed in collaboration with potentially affected Alaska Native Tribes (Seldovia Village Tribe, Nanwalek Council IRA, Port Graham Village Council, and the Kenaitze Tribe) to seek tribal input on potential ethnographic resources near the proposed Dixon Diversion Project;
- Research in existing data repositories and archives (e.g., Alaska Native Claims Settlement Act 14(h)(1) data housed at the Bureau of Indian Affairs) to locate previously recorded ethnographic resources;
- Targeted site visits with tribal representatives to identified ethnographic resources within the APE;
- Interviews with traditional knowledge bearers or tribally-designated experts in ethnographic history.

4.10.6 Deliverables and Schedule

AEA will conduct the Cultural Resources Study within the 2023 and 2024 study seasons. Initiation of Task 1 (e.g., literature research, tribal collaboration, landscape modelling, and other desktop-based activities) will begin in 2023 and will continue throughout the year. AEA anticipates that limited field-based efforts will occur during the 2023 field season, with a focus on targeting areas of the proposed Dixon Diversion Project APEs that are shared by both alternatives (e.g., Bradley Lake impoundment). A report summarizing 2023 study activities will be included in the 2023 Study Report. Identification and Evaluation-level fieldwork will be conducted in 2024. A final, cumulative report will be developed for the 2024 Study Report.

4.10.7 Cost and Level of Effort

As noted above, the specific tasks and scope of work required to comply with Section 106 of the NHPA and conduct a "reasonable and good faith effort" to identify historic properties within the Dixon Diversion Project APE will be determined through

consultation with the SHPO, local Tribes, and other affected consulting parties, as well as the extent and results of the pedestrian surveys. Study costs are estimated to be approximately $560,000.

4.10.8 References

Alaska Energy Authority (AEA). 2015. FERC No. P-8221-AK Application for a Non-Capacity Amendment to the Bradley Lake Hydroelectric Project License Battle Creek Diversion. Exhibit E – Environmental Report.

Alaska Power Authority (APA). 1984. Application for License for Major Unconstructed Project, Bradley Lake Hydroelectric Project, Bradley River, Kenai Peninsula, Alaska. FERC Project No. 8221. Vol. 3, Exhibit E.

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APPENDIX A

STUDY REQUEST COMMENT MATRIX

Table A-1 Summary of AEA's Response to Requested Studies

Alaska Department of Fish and Game			
Study Request 1: Fish Species Abundance and Seasonal Distribution in Martin River and its Off-Channel Habitats – Dixon-Bradley Lake Alternative			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-1	Survey anadromous and resident fish species assemblages and their relative abundance and distribution throughout Martin River and its' off-channel habitats, and Red Lake. Surveys should be conducted during all seasons to ensure sufficient temporal coverage of fish usage.	Modified	Studies of fish use will be conducted during the ice out period which is the time when the Dixon Diversion would operate, as provided under the proposed Martin River Fish Use Study (Section 4.4). When the diversion is not operating, the flows in the Martin River will be consistent with the baseline condition – therefore, no project nexus with fish distribution and abundance in the Martin River during the ice-in period, approximately November to April, has been identified.

Comment ID	Objective	Approach	AEA Response
ADF&G-2	Estimate the run timing for all anadromous species currently known to utilize the river (Chinook salmon, coho salmon, sockeye salmon, and Dolly Varden) for both their spawning migration and smolt outmigration.	Modified	Run timing for adult Pacific salmon and Dolly Varden is proposed to be monitored using an autonomous video counting tower (AVCT) at the Red Lake outlet between mid-June and October under the Martin River Fish Use Study (Section 4.4). Identification of additional spawning habitats is also proposed as a component of the Martin River Fish Use Study. The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation Study (Section 4.5) will evaluate flows to maintain connectivity of off-channel habitats under current conditions and under proposed Dixon Diversion Project operational scenarios. Evaluation of smolt outmigration timing will be assessed using regional information with no field study proposed at this time. AEA is not aware of data indicating that Chinook Salmon utilize the river; if there is a data source that we have not considered, AEA would be willing to discuss implications for the study.
ADF&G-3	Continue monitoring adult salmon escapement into Red Lake.	Adopted	See Martin River Fish Use study plan (Section 4.4).
ADF&G-4	Identify locations of salmon redds to determine spawning habitat.	Adopted	See Martin River Fish Use study plan (Section 4.4).

Comment ID	Objective	Approach	AEA Response
ADF&G-5	Collect environmental DNA (eDNA) samples to determine the presence of aquatic organisms in Martin River (down to tidewater), its' off-channel habitats, and Red Lake.	Not Adopted	AEA does not propose to use eDNA to characterize the fish assemblage in the Martin River for two primary reasons: the high potential for false positives and the challenges associated with filter clogging in turbid environments. False positives can occur due to transfer of DNA among water bodies by humans, predators, or scavengers. False negatives can occur in turbid systems where filter clogging limits the water filtration volume and particulate matter can decrease sensitivity or even eliminate eDNA detections when the target species is present.
Study Request 2: Fish Species Abundance and Seasonal Distribution in Martin River and its Off-Channel Habitats – Dixon-Martin River Alternative			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-6	Survey anadromous and resident fish species assemblages and their relative abundance and distribution throughout Martin River, its' off-channel habitats, and Red Lake. Surveys should be conducted during all seasons to ensure sufficient temporal coverage of fish usage.	Modified	See Response for Comment ID ADF&G-1.

Comment ID	Objective	Approach	AEA Response
ADF&G-7	Collect environmental DNA (eDNA) samples to determine the presence of aquatic organisms in Martin River, its' off-channel habitats, and Red Lake.	Not Adopted	See Response for Comment ID ADF&G-5.
Study Request 3: Instream Flow Assessment – Dixon-Bradley Lake Alternative			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-8	The Instream Flow Incremental Methodology (IFIM) should be used to guide the process for evaluation of streamflow versus fish habitat assessment. IFIM provides a framework to help determine the benefits and consequences of different water management alternatives on riverine habitat resources. It includes scoping and planning elements and is designed to encompass an array of instream flow issues, model(s) selection and integration.	Not Adopted	One of the primary assumptions of the IFIM is that the stream channel (e.g., cross sectional profile, flow/velocity pattern, substrate composition) will remain relatively unchanged between sampling events. Given the dynamic nature (e.g., braiding, sediment deposition, side channel development) of the Martin River downstream of the confluence with the East Fork Martin River it is assumed that potential fish habitat modeling sites would be unstable between sampling events, limiting the value of an IFIM in evaluation of flow management alternatives. Alternatively, AEA is proposing to conduct a Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation (Section 4.5), an Aquatic Habitat Characterization Study (Section 4.3), and a Martin River Fish Use Study (Section 4.4) to address potential impacts of flow changes on fish habitat.

Comment ID	Objective	Approach	AEA Response
ADF&G-9	Habitat types should be mapped and assessed in relative proportion to their representation, including off-channel habitats, to assist with study design and evaluation of model results.	Adopted	Mapping of mainstem and off-channel habitat is proposed under the Aquatic Habitat Characterization study plan (Section 4.3) based on available imagery. This information will be used during identification and prioritization of off-channel habitat connectivity sampling sites. Habitat connectivity with the mainstem will be assessed under the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation Study (Section 4.5).
ADF&G-10	Off-channel habitat connectivity should be assessed to determine streamflows at which off-channel habitat become connected or disconnected to Martin River.	Adopted	See Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation study plan (Section 4.5).

Comment ID	Objective	Approach	AEA Response
ADF&G-11	Spawning Incubation Analysis • Evaluate potential project effects on incubation, such as an effective spawning habitat analysis for alternative instream flow scenarios. • Assess fish spawning, incubation, and emergence timing under different project operation scenarios based on fish developmental temperature units for identified target fish species.	Modified	Due to the heavy sediment load transported by the mainstem Martin River during the spawning period, it is assumed that spawning primarily occurs in off-channel (clearwater) areas. This assumption is supported by existing information on salmon use of Red Lake and outlet. As such, the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation study plan (Section 4.5) will evaluate the potential effects of water management alternatives on access to off-channel habitat. In addition, the Martin River Fish Use study plan (Section 4.4) will conduct spawner surveys in identified off channel habitats. Based on the water clarity evident in off-channel habitats, it is assumed that intergravel water temperature in off-channel spawning areas is influenced primarily by the temperature of hyporheic and/or groundwater inflows. These flows and corresponding water temperatures are not expected to be affected by water management alternatives.

Comment ID	Objective	Approach	AEA Response
ADF&G-12	Use habitat duration analyses to compare project release flow alternatives against baseline conditions. Study results (weighted usable area versus discharge, or similar metrics) should be combined with hydrologic data to produce habitat time series and associated duration curves and tables. Habitat duration curves are cumulative frequency plots that show the probability of a certain amount of habitat being equaled or exceeded during a time period. These curves are useful because they combine WUA, flow, and time into one graph.	Modified	Due to the dynamic nature of the Martin River, weighted usable area (habitat) versus discharge relationships are not proposed. Existing data in combination with site reconnaissance during the salmon spawning window suggest that off-channel habitats provide the preponderance of suitable habitat for fishes. The proposed Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5) will provide an evaluation of the extent and duration of connectivity between mainstem and off-channel habitats under alternative flow management scenarios. The habitat connectivity duration analysis will be presented as a cumulative frequency and a percentage of time that the connectivity is maintained or equaled under the proposed operational scenario.
ADF&G-13	Provide a summary of seasonal and long-term streamflow characteristics for the Martin River, including daily, monthly, and annual summaries, exceedance summaries, and recurrence internals of peak flow events.	Modified	Development of daily flow values is proposed by AEA using site-specific data, gage data from nearby basins (i.e., Battle Creek and Bradley Lake basins), and regional regression analysis. These values will be used to evaluate the impact of proposed water management alternatives against baseline/natural flow conditions using daily time series/habitat duration analysis.

Study Request 4: Streamgage on Red Lake Outlet Stream – Pertains to both the Dixon-Bradley Lake and Dixon-Martin River Alternatives			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-14	Install and operative a continuous stream gage on the Red Lake outlet stream.	Adopted	See the Streamflow Gaging study plan (Section 4.1).
ADF&G-15	Provide outlet streamflow summaries, including monthly and annual flow characteristics and monthly exceedance tables.	Modified	The Streamflow Gaging study plan (Section 4.1) proposes to develop a daily flow record for the Red Lake outlet. These data will be summarized in the annual reports including monthly flow characteristics. Monthly exceedance tables are infeasible due to the short period of record proposed (i.e., May to October in 2023 and 2024).
ADF&G-16	Record continuous stream temperature at the gaging station.	Adopted	See the Water Quality Monitoring study plan (Section 4.2).
Study Request 5: Sediment Transport – Pertains to both the Dixon-Bradley Lake and Dixon-Martin River Alternatives			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-17	Assessment should include a pre- versus post-project sediment transport evaluation including: • small-scale bed mobilization for flushing spawning gravels, and • large-scale bed mobilization to maintain channel form and function.	Adopted	See Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5).

Study Request 6: Mountain Goat Populations, Distribution, and Habitat Use – Pertains to both the Dixon-Bradley Lake and Dixon-Martin River Alternatives			
Comment ID	**Objective**	**Approach**	**AEA Response**
ADF&G-18	Monitor mountain goat (*Oreamnos americanus*) population demographics, home ranges, and seasonal movement patterns before, during, and after project construction to better understand current habitat use and the effects of this type of disturbance.	Modified*	Sufficient information exists on mountain goats in the Dixon Diversion Project area to complete the alternatives and impact analyses and to develop potential PM&E measures. A monitoring and assessment study will be implemented once a final alternative has been selected.
Cook Inletkeeper			
Study Request 1: Martin River Data			
Comment ID	**Objective**	**Approach**	**AEA Response**
CIK-1	Baseline Stream Temperature of Martin River.	Adopted	See Water Quality Monitoring study plan (Section 4.2).
CIK-2	Baseline Dissolved Oxygen of Martin River.	Adopted	See Water Quality Monitoring study plan (Section 4.2).

National Marine Fisheries Service			
Study Request 1: Habitat Mapping of Martin River Including Both Forks			
Comment ID	**Objective**	**Approach**	**AEA Response**
NMFS-1	Map and document the one or two lowest bedrock fish barrier that will not change regardless of how much material moves downstream.	Modified	The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5) will model hydraulic conditions from near the mouth of the Martin River upstream to the entrance to the East Fork Martin River Canyon. This study will support evaluation of aquatic habitat connectivity of mainstem and off-channel habitats. No sampling is planned within the East Fork Martin River Canyon. This reach is very high gradient with flashy flows, high velocities, high turbidity due to glacial till, bedload mobilization, and lacks any clearwater or off-channel habitat that would be suitable for fish use. Further flow conditions during summer of 2022 suggest this stream poses significant safety concerns for fish or aquatic habitat surveys.
NMFS-2	Map and document barriers downstream of the bedrock barrier that could change over time. This includes barrier formed by boulders, velocity barrier, and barrier formed by the presence of predatory fish.	Not Adopted	See Response for Comment ID NMFS-1.

Comment ID	Objective	Approach	AEA Response
NMFS-3	Map and document both gravels that are being used for spawning and those that are unused but appear sufficient and indicate which anadromous species might spawn in each.	Modified	The geomorphology objectives of the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5) will characterize reach-scale availability of sediment grain sizes that can be characterized with respect to their suitability as spawning substrate for anadromous fishes. The dynamic nature of this glacial channel (e.g., bedload redistribution resulting in braiding, sediment deposition, side channel development) makes mapping substrate within geomorphic reaches less informative for evaluating potential Dixon Diversion Project effects. Off-channel clearwater habitats within the study area will be mapped and substrate characterized.
NMFS-4	Identify overwinter habitat for coho and sockeye salmon. This data would be best collected during low flow periods from January thru mid-March. If the USGS stage gage indicates very low flow in December or April that might also be an acceptable time to collect the data.	Not Adopted	See Response for Comment ID ADF&G-1.

Comment ID	Objective	Approach	AEA Response
NMFS-5	Map and identify summer rearing habitat for anadromous fish. Methods to address this objective may include use of historical aerial photographs to determine if these rearing locations appear the same through time.	Adopted	Analysis of aquatic habitat change over time is proposed as a component of the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5). Summer rearing habitat evaluation is proposed as a component of the Martin River Fish Use study plan (Section 4.4).
NMFS-6	Determine if stranding may become a problem for juvenile fish as the water levels drop in the fall.	Not Adopted	Juvenile fish habitat use will be studied under the Martin River Fish Use study plan (Section 4.4). Based on existing data and site reconnaissance in 2022, it is expected that the predominant fish habitats are clear lateral habitat fed by hyporheic and/or ground water inflow. Analysis of aquatic habitat change over time is proposed as a component of the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation study plan (Section 4.5). Fish rearing habitat evaluation is proposed as a component of the Martin River Fish Use study plan (Section 4.4). These studies will be conducted in 2023 and will inform the fish use of mainstem habitat and potential for any fish stranding associated with Dixon Diversion Project flow changes.

Study Request 2: Water Quality in the Martin River and Adjacent Lakes			
Comment ID	**Objective**	**Approach**	**AEA Response**
NMFS-7	Measure existing turbidity levels in each river reach containing fish habitat enough times to understand the variability during the two study years. While we expect less frequent sampling in the winter, a full year of monitoring is needed to understand annual turbidity fluctuations as coho and sockeye rear over a winter in the river or lake.	Modified	Monthly water clarity and turbidity measurements are proposed during 2023 and 2024 during the period in which the Dixon Diversion is proposed to operate, May through October. Details are provided in the Water Quality Monitoring study plan (Section 4.2).
NMFS-8	Measure continuous temperature using remote logger set to record each hour or more frequently. Temperature loggers should be placed in water bodies important to fish for two years.	Adopted	See Water Quality Monitoring study plan (Section 4.2).

Comment ID	Objective	Approach	AEA Response
NMFS-9	Measure phosphorous, dissolved nitrogen, total nitrogen, and dissolved oxygen in a systematic method. The results of fish year of data will determine if this needs a second study year.	Modified	The Water Quality Monitoring study plan (Section 4.2) provides for systematic monitoring of dissolved oxygen in the Martin River. AEA does not propose to monitor phosphorous, dissolved nitrogen, or total nitrogen. Measures of nitrogen are typically conducted to distinguish glacial sources from non-glacial flow sources. This distinction is not a study goal consistent for the water quality monitoring study.
NMFS-10	Sample for heavy metals in both forks and the main stem of the Martin River. This could be done twice in the first study season.	Not Adopted	AEA does not propose to sample for heavy metals in the Martin River Basin. There are no anthropogenic sources such as mining or urbanization in the basin and no Dixon Diversion Project nexus is evident.

Study Request 3: Future Flows in the Martin River			
Comment ID	**Objective**	**Approach**	**AEA Response**
NMFS-11	Measure of year around flow exiting the Dixon Glacier for three years using direct measurements. The new USGS Gage #15238950 will support this objective.	Modified	The USGS has installed a gage at the Dixon Glacier outlet (#15238950). Currently temperature and stage are being collected. No streamflow measurements have been conducted due to high and variable flow conditions and associated safety considerations and it is unclear if measurement will be attainable during the study implementation. If the USGS is unable to develop a continuous streamflow record for this site, characterization at this location will instead rely on any field measurements USGS has collected, gage records from nearby basins (i.e., Battle Creek and Bradley Lake basins), and calculated estimates as described in the Streamflow Gaging study plan (Section 4.1).
NMFS-12	Use isotopic dating to determine the percentage of old glacial water versus this year's precipitation exiting the Dixon Glacier.	Modified*	AEA is planning to conduct a study on Future Flows in the Martin River which is independent of this FERC study plan and will be conducted on a different time schedule, if performed. This study would address the proportion of water from glacial and non-glacial sources.

Comment ID	Objective	Approach	AEA Response
NMFS-13	Determine how much water is added to the Martin River Valley below the proposed intake and midway down the Martin River Valley.	Modified	Streamflow gaging is proposed at three locations in the Streamflow Gaging study plan (Section 4.1). These data along with data collected by the USGS in the basin (#15238950) and nearby basins will be used to estimate the flow coming from the East Fork Martin River.
NMFS-14	Determine the temperature and precipitation changes 60 years out, divided into three equal periods, using downscaled products from CMPI 6 global circulation models.	Not Adopted	See Response for Comment ID NMFS-12.
NMFS-15	Determine the change in glacier water flux in the three periods using the downscale data and glacier mass balance equations.	Not Adopted	See Response for Comment ID NMFS-12.
NMFS-16	Determine how much flow increases in each month (or week) based on that change in temperature and precipitation project by the model (Wobus 2015) using an integrated watershed model.	Not Adopted	See Response for Comment ID NMFS-12.
NMFS-17	Calculate residence time the small diversion basin will have during all months when the average air temperature is above freezing.	Not Adopted	Residence time of diverted water is expected to be less than 24-hours and will not have an impact on water temperature. This will be quantitatively described in the application along with the potential for water temperature changes as a result of Dixon Diversion Project operations.

U.S. Fish and Wildlife Service			
Study Request 1: Fish Distribution and Abundance			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-1	Determine the seasonal distribution, relative abundance (as determined by catch per unit effort, fish density, and counts), and fish-habitat associations of anadromous and resident fish species in Martin River, Red Lake, associated tributaries and off-channel ponds, and East Fork Martin River up to identified fish barriers.	Modified	In the Martin River Fish Use study plan (Section 4.4), AEA proposes to evaluate the seasonal distribution, relative abundance (as determined by catch per unit effort, fish density, and counts), and fish-habitat associations of anadromous and resident fish species in clearwater off-channel habitats and tributaries of the Martin River. Run timing for Pacific salmon entering Red Lake will also be evaluated. Targeted sampling for adult Eulachon and Sockeye Salmon in turbid main channel habitats may occur if geomorphic analysis identifies geomorphic reaches with suitable grain sizes for spawning.
USFWS-2	Describe the seasonal movements and migratory patterns of anadromous and resident fish species among mainstem habitats and between mainstem habitats and tributaries and off-channel ponds with an emphasis on identifying foraging and overwintering habitats.	Not Adopted	Studies of fish use as described in the Martin River Fish Use study plan (Section 4.4) will be conducted during the period in which the Dixon Diversion is proposed to operate (May through October). The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation study (Section 4.5) will evaluate the connectivity of aquatic habitats for available flow records. Understanding the current fish use of mainstem and clearwater habitats and habitat connectivity will inform potential effects on seasonal movements of fish into and out of foraging and overwintering habitats.

Study Request 2: Instream Flows and Habitat Utilization			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-3	Identify, delineate, and characterize riverine habitat types.	Adopted	See Aquatic Habitat Characterization study plan (Section 4.3).
USFWS-4	Determine upper extent of fish habitat on the East Fork Martin River, as well as tributaries to Martin River and Red Lake, by identifying natural permanent barriers to fish passage.	Modified	In the Martin River Fish Use study plan (Section 4.4), AEA proposes to evaluate the seasonal distribution, relative abundance (as determined by catch per unit effort, fish density, and counts), and fish-habitat associations of anadromous and resident fish species in clearwater off-channel habitats and tributaries of the Martin River. Due to the high gradient nature of the stream channel and a lack of suitable clearwater or off-channel habitat for fish upstream of the confluence with Red Lake outlet, no sampling is planned within the East Fork Martin River Canyon.

Comment ID	Objective	Approach	AEA Response
USFWS-5	Characterize the natural flow regime of the Martin River using the new gage station at the Dixon Glacier, as well as two additional gage stations: one at the outlet of Red Lake and one on the lower portion East Fork Martin River.	Modified	The natural flow regime of the Martin River will be characterized by the three gages proposed under the Streamflow Gaging study plan (Section 4.1) including one at Red Lake outlet, one at RM4.0R OCH (i.e., off-channel feature on the right side at river mile 4.0), and one at the Martin River RM 1.5 at the Downstream Constriction. Streamflow gaging on the lower portion of the East Fork Martin River was not successful in 2022 due to equipment damage from the movement of large bed material. Similar conditions are expected in future years making a gage at this location unfeasible. A gage has been installed by the USGS at the Dixon Glacier source, but no measurements have been collected due to safety considerations and it is unclear if future efforts will be successful. Given the dynamic nature of the river and its tributaries and the high velocities experienced, continuous gaging at the three proposed sites may not be feasible due to unpredictable and variable conditions that can damage equipment, and affect data collection and field crew safety. Field crew safety will remain paramount under all circumstances. If continuous streamflow records cannot be developed from collected data, alternate methods to characterize the existing flow regime and quantify the volume of flow at strategic locations will be implemented using collected spot measurement data and continuous records from streamflow gages in nearby basins.

Comment ID	Objective	Approach	AEA Response
USFWS-6	Identify, characterize, and integrate the timing, quantity, and function of instream flow on riverine processes; geomorphology; floodplain, riparian form, and vegetation; biological cues; water quality; surface/groundwater exchange; riverine habitat availability and quality; flows within designated Wilderness; etc.	Modified	Independent studies address riverine processes (Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation study plan), vegetation (Vegetation and Wildlife Habitat Mapping study plan), aquatic and terrestrial biology (Aquatic Habitat Characterization study plan and Wildlife Habitat Evaluation study plan), and water quality (Water Quality Monitoring study plan). Integration of the data across studies will occur during the impact assessment and will be provided with the exhibits to a license amendment.
USFWS-7	Characterize the site-specific conditions of meso- and microhabitat types by all fish species and life stages. This characterization should describe (quantify) the factors that control habitat suitability and utility (flow, water quality, structure, groundwater exchange, icing effects, temporal changes).	Not Adopted	Macro- and meso-habitats will be characterized in the Aquatic Habitat Characterization study plan (Section 4.3). Connectivity of aquatic habitats will be evaluated in the Hydraulic Modeling, Geomorphology, and Habitat Connectivity Evaluation study plan (Section 4.5). No instream flow study is proposed for this system due to the dynamic nature of the Martin River downstream of the confluence with the East Fork Martin River. It is assumed that potential fish habitat modeling sites would be unstable between sampling events limiting the value of an IFIM in evaluation of flow management alternatives.

Comment ID	Objective	Approach	AEA Response
USFWS-8	Develop a modeling framework to integrate results from this and other project studies and model results including all riverine functions, and to assess the temporal and spatial relationships between instream flow and riverine and biologic functions.	Modified	Due to the heavy sediment load transported by the mainstem Martin River during the proposed operation period, it is assumed that fish use primarily occurs in off-channel (clearwater) habitats. This assumption is supported by existing information on salmon use monitored at Red Lake outlet as well as use of lower river off-channel ponds by juvenile Coho Salmon. The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation Study (Section 4.5) will evaluate flows to maintain connectivity of off-channel habitats under current conditions and under proposed Dixon Diversion Project operational scenarios.
USFWS-9	Compare temporal and spatial analysis of riverine process studies and model results for a range of alternative operations and project alternatives.	Modified	The Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity Evaluation Study (Section 4.5) will evaluate flows to maintain connectivity of off-channel habitats under current conditions and under proposed Dixon Diversion Project operational scenarios.
Study Request 3: Geomorphology and Sediment Transport			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-10	Characterize and map the geology around the Dixon Glacier, identifying the controlling features for glacial outflow.	Modified	Geology around the Dixon Glacier will be characterized based on existing geologic mapping and aerial photographs.

Comment ID	Objective	Approach	AEA Response
USFWS-11	Quantify how much water in the smaller glacial outflow channel is glacial versus snowmelt.	Not Adopted	The small tributary south of the diversion site does not have a suitable gage location, cannot be accessed by helicopter, and would pose a safety hazard to measure. Therefore, data collection in this reach is unfeasible for gaging, however AEA has been taking photographs of the channel to estimate flow.
USFWS-12	Characterize and map the fluvial geomorphology of the Martin River and the East Fork Martin River.	Adopted	See Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5).
USFWS-13	Determine the sediment supply and transport capacity of the Martin River, East Fork Martin River, and associated tributaries.	Modified	Sediment supply and transport capacity of the Martin River is included in the Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5). The two reaches of the Martin River (Martin River and East Fork Martin River) will be analyzed as one sediment source. Sediment supply and transport of "associated tributaries" is not included in the proposed Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5) since these tributaries are very small and have a minimal sediment supply compared to the Martin River.
USFWS-14	Evaluate and model the potential magnitude and trend of geomorphic response to the project alternatives on downstream reaches.	Adopted	See Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5).

Comment ID	Objective	Approach	AEA Response
USFWS-15	Coordinate with other project studies to inform overall project design and recommendations for conservation of aquatic life.	Adopted	See Hydraulic Modeling, Geomorphology, and Aquatic Habitat Connectivity study plan (Section 4.5).
Study Request 4: Water Quality			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-16	Summarize available data, build upon and use as appropriate, the historical water quality data available for the study area.	Not Adopted	Available data has been summarized in the Initial Consultation Document. AEA is not aware of any additional historical water quality data. Monthly water quality data will be collected as described in the Water Quality Monitoring study plan (Section 4.2).
USFWS-17	Model expected water quality conditions in the proposed Dixon Glacier outflow impoundment, East Fork Martin River, Martin River, and Bradley Lake, and Bradley Creek, including (but not necessarily limited to) temperature, dissolved oxygen suspended sediment and turbidity.	Not Adopted	Water quality data will be collected under the Water Quality Monitoring study plan (Section 4.2). These data will be used, in combination with existing data from nearby Battle Creek and historic Bradley Lake data, to support the evaluation of compliance with water quality criteria under current conditions and under the proposed Dixon Diversion Project operation. No water quality modeling is proposed, as changes to the lake's water quality parameters are unlikely to approach critical water quality parameters.
USFWS-18	Coordinate study and model results with other study areas, including fish, and instream flow.	Not Adopted	See Response for Comment ID USFWS-17.

Study Request 5: Wetland Delineation			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-19	Identify and delineate wetlands that may be present within the Project footprint. The study will also provide information on the extent and quality of wetlands and aquatic vegetation.	Adopted	See the Wetland Delineation study plan (Section 4.6).
Study Request 6: Martin River Productivity			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-20	Characterize the pre-project benthic macroinvertebrate and algal communities with regard to species composition and abundance in the lower, middle, and upper Martin River.	Not Adopted	Water temperature within the Martin River is typically currently less 1°C. It is assumed the present macroinvertebrate community will consist predominantly of midges and be similar to that of Battle Creek. The existing information on macroinvertebrates from Battle Creek will be used to inform predictions on the potential Dixon Diversion Project effects to macroinvertebrates.
USFWS-21	Estimate drift of benthic macroinvertebrates in habitat with the lower, middle, and upper Martin River to assess food availability to juvenile and resident fishes.	Not Adopted	The existing information on macroinvertebrates from Battle Creek will be used to inform predictions.

Comment ID	Objective	Approach	AEA Response
USFWS-22	Conduct a trophic analysis to describe the potential changes in the primary and secondary productivity of the riverine community following post-project construction and operation.	Not Adopted	Existing information and site reconnaissance from 2022 suggests the predominant habitats of fish and macroinvertebrates within the Martin River Basin are located in clear water off-channel habitat features. As evidenced by the presence of clearwater year-round, these features are supported by groundwater inflows that would not be affected by Dixon Diversion Project related flow changes.
USFWS-23	Generate habitat suitability criteria for the Martin River benthic macroinvertebrate and algal habitats to predict potential change in these habitats.	Not Adopted	See Response for Comment ID USFWS-21.
USFWS-24	Characterize the benthic macroinvertebrate compositions in the diets of representative fish species in relationship to their source (benthic or drift component).	Not Adopted	See Response for Comment ID USFWS-21.
USFWS-25	Estimate benthic macroinvertebrate colonization rates in the middle and lower reaches to monitor baseline conditions and evaluate future changes to productivity in the Martin River.	Not Adopted	See Response for Comment ID USFWS-21.

Study Request 7: Wildlife and Habitat			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-26	Identify wildlife species in the Dixon Diversion Project area and surrounding areas affected by the previous phases of the Bradley Lake Project and Battle Creek Amendment including those that may be affected by direct, indirect, and cumulative impacts. The spatial and temporal scale should be related to specific stressors and specific habitat and species responses and effects.	Modified	The proposed Vegetation and Wildlife Habitat Mapping (Section 4.7) and the Wildlife Habitat Evaluation (Section 4.8) studies will provide information on wildlife habitats, along with categorical habitat values (by species) for those mapped habitats, to evaluate the important habitats for each species and inform the analysis of potential Dixon Diversion Project effects. The two studies will focus on the proposed Dixon Diversion Project area (focus of this amendment application) and are not intended to address previous project areas.

Comment ID	Objective	Approach	AEA Response
USFWS-27	Determine abundance and distribution and characterize habitat condition and utilization pre and post construction for the following: • Mountain goats (*Oreamnos americanus*) – capture and radio-collar mountain goats within and adjacent to the project areas to determine influence of construction on mountain goat behavior and spatial use patterns behavior, during, and post project construction. Coordinate data collection with the KNWR so it can contribute to existing data collection by the Interagency Mountain Goat Project on the Kenai Peninsula. Details are specified in the Service's Study Request number 8.	Modified*	See Response for Comment ID ADF&G-18.

Comment ID	Objective	Approach	AEA Response
USFWS-28	Determine abundance and distribution and characterize habitat condition and utilization pre and post construction for the following: • Wolverine (*Gulo gulo)* – determine occupancy and spatial distribution in and near the project area using remote camera grid surveys. This could be done in coordination with a future project on the KNWR to ensure consistent and comparable data collection on a poorly understood low density species that utilizes alpine habitats (Lukacs 2020).	Not Adopted	AEA has initiated coordination with the USFWS and Kenai National Wildlife Refuge (KNWR) staff, regarding collaboration with the KNWR wolverine study. The outcome of that collaboration would be premature at this time. The KNWR has to complete its study design first, which may involve both radio-tracking and camera traps, before collaboration with other groups on the study can be discussed.

Comment ID	Objective	Approach	AEA Response
USFWS-29	Identify migratory birds that occur in the area, further define species listed in the Initial Consultation Documentation (ICD). Given the proximity to Kachemak Bay, estimate acres of habitat loss and potential impacts to birds from overall Project related activities. • Marbled murrelets (*Brachyramphus brevirostris*) and Kittlitz murrelets (*B. marmoratus*) – identify nesting, feeding, and rearing habitat in and adjacent to project areas, and any changes during and after construction. • Non-migratory birds – including willow ptarmigan (*Lagopus lagopus*), rock ptarmigan (*L. muta*), and white-tailed ptarmigan (*L. leucura*). • Raptors – surveys will be necessary to determine the number, location, and activity status of raptor nests and territories in and near the	Modified	AEA will be conducting spring and fall bird migration surveys as part of the Raptor Nesting and Migration study (Section 4.9), which will identify migratory birds that occur in the Dixon Diversion Project area. The list of wildlife species to be assessed in the Wildlife Habitat Evaluation will be developed with agency input and informed by results of the Raptor Nesting and Migration study (Section 4.9). The list of species to be assessed will include resident mammals, amphibians, and both breeding and migratory bird species. In the Wildlife Habitat Evaluation (Section 4.8), potential high-value murrelet nesting, feeding, and rearing habitat (for both species) will be identified. Similarly, high value ptarmigan habitat (for all three species) will be assessed in the Wildlife Habitat Evaluation (Section 4.8). Raptor nesting surveys will be conducted in a broad area surrounding the Dixon Diversion Project as part of the Raptor Nesting and Migration study (Section 4.9), to locate both active and inactive raptor nests. These data will also be used in the Wildlife Habitat Evaluation (Section 4.8) to identify high-value raptor nesting habitat.

	project area. This may be one of the few areas on the Kenai Peninsula with nesting golden eagles (*Aquila chrysaetos*) and peregrine falcons (*Falco peregrinus*). This information will also be used to determine methods for avoiding and minimizing take associated with disturbance, nests or territories that may be lost or otherwise impacted by project construction and operations.		

Comment ID	Objective	Approach	AEA Response
USFWS-30	Identify overhead transmission lines associated with the project to determine where they may pose a collision and electrocution risk to migrating birds including raptors. Information will be used to determine avoidance and mitigation measures potential need for eagle take permits.	Modified	AEA will record migratory bird species passing through sampling locations along the proposed Dixon Diversion Project transmission line corridor during spring and fall in the Raptor Nesting and Migration study plan (Section 4.9). Sampling locations will be determined in consultation with the agencies. The goal is to identify and assess high-risk areas for possible collisions and electrocutions.
USFWS-31	Determine if and where infrastructure may result in additive effects from the original Bradley Lake hydroelectric project, together with those of the Battle Creek amendment, and the current proposal. • These include project related stressors, modifications of abiotic factors (e.g., hydrology, sediment transport, water temperature, and quality, etc.); biotic responses to multiple stressors and changes (e.g., terrestrial, and aquatic species, habitat composition); and overall effects on the Kachemak Bay ecosystem.	Not Adopted	Evaluation of the diverse biological and physical factors that could affect the Kachemak Bay ecosystem will be assessed in the Bradley Lake Project license amendment application, in which AEA will conduct assessments of potential effects from the proposed Dixon Diversion Project.

Comment ID	Objective	Approach	AEA Response
USFWS-32	Characterize how impacts may affect the resources and management goals and objectives of the KNWR (Service 2009) and the Kachemak Bay and Fox River Critical Habitat Areas (ADF&G 1993).	Not Adopted	Impact assessments for biological resources will be conducted in the Bradley Lake Project license amendment application. The proposed wildlife studies will gather baseline data to facilitate the impact assessments. Determinations of how Dixon Diversion Project impacts could affect the management goals and objectives of the KNWR and the Kachemak Bay and Fox River Critical Habitat Areas will be made in the course of assessing impacts to biological resources.
Study Request 8: Behavior and Spatial Use Patterns of Mountain Goats			
Comment ID	**Objective**	**Approach**	**AEA Response**
USFWS-33	Radio-collar and monitor mountain goat behavior and movements in relation to the proposed action, analyze project related impacts, and as appropriate develop methods to reduce effects.	Modified*	See Response for Comment ID ADF&G-18.

Modified*– AEA intends to conduct the identified studies (i.e., Mountain Goat Monitoring and Future Flows in the Martin River); however, their scope is in development and completion schedule is on a different timeline.

APPENDIX B

AVCT 2022 OBSERVATIONS

Table B-1 Daily and Accumulative Fish Passage by Species at a Remote Video Monitoring Station at the Outlet of Red Lake, 8 June–21 September, 2022

Date	Sockeye Salmon		Pink Salmon		Dolly Varden	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
8-Jun	1	1			3	3
9-Jun	20	21			13	16
10-Jun	11	32			-4	12
11-Jun	19	51			8	20
12-Jun	27	78			8	28
13-Jun	35	113			6	34
14-Jun	20	133			3	37
15-Jun	15	148				37
16-Jun	40	188				37
17-Jun	33	221			1	38
18-Jun	78	299				38
19-Jun	90	389				38
20-Jun	92	481				38
21-Jun	108	589				38
22-Jun	10	599				38
23-Jun	10	609				38
24-Jun	9	618				38
25-Jun	13	631				38
26-Jun	7	638				38
27-Jun	6	644				38
28-Jun	9	653				38
29-Jun	2	655				38
30-Jun		655				38
1-Jul	6	661				38
2-Jul	3	664				38
3-Jul		664				38
4-Jul		664				38
5-Jul	6	670				38
6-Jul	3	673				38
7-Jul	1	674				38
8-Jul		674				38
9-Jul		674				38
10-Jul		674				38
11-Jul		674				38

Date	Sockeye Salmon		Pink Salmon		Dolly Varden	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
12-Jul		674				38
13-Jul		674			1	39
14-Jul		674			1	40
15-Jul		674			3	43
16-Jul		674				43
17-Jul		674				43
18-Jul		674				43
19-Jul	1	675				43
20-Jul		675				43
21-Jul		675				43
22-Jul		675				43
23-Jul		675				43
24-Jul		675				43
25-Jul		675				43
26-Jul		675				43
27-Jul		675				43
28-Jul		675				43
29-Jul		675				43
30-Jul		675				43
31-Jul		675				43
1-Aug		675				43
2-Aug		675				43
3-Aug		675				43
4-Aug		675				43
5-Aug		675				43
6-Aug		675	2	2		43
7-Aug		675		2		43
8-Aug		675		2		43
9-Aug		675	1	3		43
10-Aug		675		3		43
11-Aug		675	1	4		43
12-Aug		675		4		43
13-Aug		675		4		43
14-Aug		675		4		43
15-Aug		675		4		43
16-Aug		675		4		43
17-Aug		675		4		43

Date	Sockeye Salmon		Pink Salmon		Dolly Varden	
	Daily	Cumulative	Daily	Cumulative	Daily	Cumulative
18-Aug		675		4		43
19-Aug		675		4		43
20-Aug		675		4		43
21-Aug		675		4		43
22-Aug		675		4		43
23-Aug		675		4		43
24-Aug		675		4		43
25-Aug		675		4		43
26-Aug		675		4		43
27-Aug		675		4		43
28-Aug		675		4		43
29-Aug		675		4		43
30-Aug		675		4		43
31-Aug		675		4		43
1-Sep		675		4		43
2-Sep	1	676		4		43
3-Sep	1	677		4		43
4-Sep	1	678		4		43
5-Sep	1	679		4	2	45
6-Sep		679		4	2	47
7-Sep	2	681		4	3	50
8-Sep		681		4		50
9-Sep		681		4		50
10-Sep		681		4		50
11-Sep		681		4		50
12-Sep		681		4		50
13-Sep		681		4	2	52
14-Sep		681		4		52
15-Sep		681	1	5		52
16-Sep		681		5		52
17-Sep		681		5		52
18-Sep		681		5	1	53
19-Sep		681		5		53
20-Sep		681		5		53
21-Sep		681		5		53

Note: gray shading indicates no fish of that species were observed that day.